Essays on Export Quality, Employment and Wage Inequality: Role of Trade, Fiscal and Monetary Policies

Dissertation submitted in partial fulfillment of the requirement for the Degree of Doctor of Philosophy in Arts of Jadavpur University

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And that neither this thesis nor any part of it has been submitted before for any degree or diploma anywhere / elsewhere.

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Preface

Evidences emerging from a large set of studies over the last two decades reveal that with the global rise in per capita incomes, buyers prefer to spend more on high quality products, even if they are high priced, rather than purchase the lower quality cheaper variants of such goods. This changing world demand pattern often constrains growth of exports of the developing countries to the upper-middle income and rich countries, in particular, and consequently jeopardizes their export-led growth prospects, because they typically produce and exports low-quality goods. Both the low-quality phenomenon in the developing countries, and importance of higher-quality goods for better export performances are well documented in recent empirical studies. These evidences suggest that export-promotion policies in the developing countries must target at improving quality of export goods to make their export baskets more aligned with the nature and structure of goods imported by the upper-middle income and rich countries. This is the focal point of analysis in this dissertation. More precisely, in this dissertation I explore whether and how trade, fiscal and monetary policies provide the domestic producers incentive to upgrade quality of the goods they produce and exports, and thereby promote exports at the extensive margin.

Further, I study the implications of such export-quality variations for the wage inequality among skilled and unskilled workers, or for the aggregate employment of unskilled workers. This issue assumes relevance because if quality-upgrading export-promotion policies distribute labour incomes in favour of the skilled workers and/or causes large scale displacements of unskilled workers, then potential conflicts and political risks there from may make it difficult for governments in the developing to pursue such policies to promote growth. Reversal of reforms in many democratic Latin American countries in the past is a point in case.

Both these broad issues are addressed theoretically in terms of a competitive general equilibrium framework of a small open economy.

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Chapter 1

Introduction

1.1 Perspective and Motivation

Since the time of Smith's (1776) vent for surplus productive capacity argument, and subsequent arguments of trade as an engine of growth by Robertson (1940) and "net" exports augmenting effective demand and consequently output by Keynes (1936) and Kalecki (1937), trade theorists and empiricists have debated, inconclusively though, on whether and how growth rates of countries are augmented by exports. A general consensus in this debate, however, has been that for the export-led growth hypothesis to work for a country, its export basket must be aligned with the import demand of its trading partners. Whereas Nurkse (1961) was among the foremost economists to point out that misalignment of export-supply with import-demand is a major reason for international trade not providing strong positive impact on growth, the current debate regarding the export-led growth hypothesis emphasizes upon the importance of what is being exported rather than how much is being exported.[1] Furthermore, evidences emerging over the last two decades reveal that non-price dimensions, primary among them being the export-quality, are the key determinants of both better export performances and stronger export-led growth effects (Baldwin and Harrigan (2011), Bayudan-Dacuycuy and Lim [2014], Das and Bandyopadhyay (2003), Dongwen, Na, Xin, and Li (2016), Fan et. al. (2018), Fischer (2010), Galera and Fraga (2022), Gambero and Garcia-Ramos (2015), Hallak (2006), Hausmann and Klinger (2006), Hausman et al. (2007), Johnson (2012), Manova and Zhang (2012a), Mukerji (2021), Rodrik (2006), Sutton (2001), Verhoogen (2008). Earliest recognition of the role of quality quotient in deciding the direction and intensity of trade dates back to the Linder hypothesis (1961). Subsequently, the New Trade Theories and the New Growth Theories developed during

[1] As a case in point, Nurkse (1961) argued that a shift in industrial production in richer nations from light industries towards heavy industries (such as engineering and chemicals) in the post WW II period caused a fall in demand for raw materials imported from the developing countries.

the 1980s and 1990s discussed vertical specialization by developing and developed countries along the quality-spectrum of goods, and importance of quality and variety of imported intermediate goods in augmenting growth rates of counties (Bond (1984), Falvey and Kierzkowski (1987), Flam and Helpman (1987), Grossman and Helpman (1991), Romer (1987)). While many of the empirical studies mentioned above have been motivated by these theoretical discourses, the evidences themselves provided some empirical support to such theories of vertical specialization and pattern of trade in quality-differentiated goods.

The quality dimension of the export-supply-import-demand misalignment problem for the developing countries emanates both from a shift in world demand towards high-quality goods, and low-quality phenomenon in the developing countries (which is essentially a reflection of their comparative disadvantages in producing and exporting high-quality goods). *The primary objective of this dissertation is to examine how trade policy, fiscal policy and monetary policy can work (through their domestic factor-cost effects) to improve export-quality of the developing countries and thereby align their export baskets with the changing world demand pattern.*

The demand-side argument for export-import misalignment constraining better export performances and stronger export-led growth impact for the developing countries is that rise in income, both aggregate and per capita, of consumers across the globe have made them increasingly sensitive towards the quality content of imports they demand. Buyers prefer to spend a larger proportion of their income on high quality products, even if they are high priced, rather than purchasing lower quality though cheaper varieties. For example, cross country estimates of Hallak (2006) show that richer countries have a relatively stronger demand for high unit value imports, which is usually considered as an indirect measure of export quality. Such a shift in the global demand pattern, observed more avidly among buyers in the rich developed countries, suggest that the developing countries aiming to push their exports in markets in richer nations must take into account this “higher willingness to pay for higher quality products” characteristic of the richer destination countries.

This changing world demand pattern also sets an altogether different perspective for export-promotion policies in the developing countries. Since export baskets of the developing countries consist mostly of low-quality goods – China, Brazil and India are no exceptions either despite their well-diversified export baskets – their export growth rates are severely constrained in the advanced richer countries (Baldwin and Harrigan (2011), Hallak (2006), Manova and Zhang (2012), Sutton (2001)). This is essentially the supply side of the quality-dimension of export-import misalignment constraining export performance and limiting the scope of the export-led growth for the developing countries. In such a context, export-promotion policies in the developing countries must target at improving quality of export goods rather than at making their low-quality exports cheaper. At the same time, as asymmetric quality variations across different product groups has been observed for a large number of developing countries (Acharyya and Ganguly (2023)), it may imply that the policy impacts may not be uniform across-the-board. This calls for designing targeted, or sector/product specific, export promotion policies as I shall elaborate upon later in the core chapters of this dissertation.

Quite a few alternative explanations have been put forward for such low-export-quality phenomenon in developing countries. These explanations include fundamentals like income disparity and low domestic demand for high quality goods in the developing countries (Fajgelbaum et al. (2011)); relatively poor technology of producing high-quality goods that translates into a comparative disadvantage in such goods for the developing countries (Flam and Helpman (1987), Matsuyama (2000)); scarcity of capital and/or skilled labour in the developing countries, which are more intensively used in producing the higher-quality varieties (Acharyya and Jones (2001), Falvey and Kierzkowski (1987), Murphy and Shleifer (1997)); and asymmetric information and related information externality (Bond (1984)). Another explanation, which is directly relevant for trade policies affecting quality choices, is that poor-quality of indigenous inputs constrains quality-upgrading of final export goods. Thus, input trade liberalization induces quality upgrading (Bas and Strauss-Khan (2013), Hu, Parsely and Tan (2017), Fan and Li (2013), Kugler and Verhoogen (2012)).

An important observation, however, can be made with regard to this argument of better input-quality improving export-quality that makes trade and exchange rate policies somewhat obvious for higher export-quality and better export performance. If higher qualities are contingent only on the intensive use of imported inputs, then reductions in tariffs on such inputs should unambiguously improve the quality of export goods across the board regardless of their import intensities. But, neither the non-monotonic movements in average quality of manufactured goods over time, nor the quality variations across different product groups – as documented in Ganguly and Acharyya (2022a) and Acharyya and Ganguly (2023), and reported later in this Chapter – corroborate with an apparently obvious across-the-board symmetric effect of input-trade liberalization. One plausible explanation for the observed asymmetric quality variations across different product groups is that quality-upgrading requires more intensive use of domestic inputs like skilled labour and/or capital. In fact, the recent evidence does reveals the importance of the availability of specific skills and of capital and consequent domestic factor costs for quality choices by the exporting firms (Brambilla et al. (2012), Brambilla et al. (2014), Brambilla and Porto (2016)). Schott's (2004) finding that higher-unit values of imports of the United States are from capital- and skill-abundant countries also suggests that higher-quality export goods may require intensive use of both capital and skilled labor. Since the standard trade theory (such as the Stolper-Samuelson theorem and its subsequent generalizations) suggests that trade policies asymmetrically change the skilled wage and the rate of return to capital, so depending on the relative skill-intensity of higher quality varieties, they may raise or lower the marginal cost of quality and accordingly either lower or raise the product quality. This can potentially explain not only the low-quality phenomenon in the developing countries, but most importantly, the asymmetric quality variations across different product groups. This domestic factor-cost dimension of export-quality upgrading and examination of the efficacy of trade policies, and other relevant policies as elaborated later, to upgrade export-quality constitute the focal point of my analysis in this dissertation. Alongside this re-examination of whether and how policies upgrade export-qualities, I also examine labour market implications of quality-upgrading, such as changes in the wage-inequality between skilled and unskilled workers, or change in the aggregate employment of unskilled workers. This issue assumes relevance since governments in large democracies may find it difficult to pursue export-promotion policies that have adverse income-distribution (and employment) effects and consequently cause conflicts and political risks there from.

1.2 Export-Quality and Labour Market Implications: Literature Review

For better comprehension, I review the existing literature on quality-dimension of better export performances and its labour market implications under four broad categories in the four sub-sections below.

1.2.1 Evidence on export-quality and export performances

As mentioned earlier, new evidences emerging from a wide variety of empirical research over the last two decades reveal the importance of better qualities of exports underlying better export performances of developing countries. Among many studies, Hummels and Klenow (2005) used quantities exported and proxies for the number of varieties to argue that quality differences are necessary to explain to some extent the observed differences in unit values. Sutton (2001), on the other hand, showed that firms producing low-quality products cannot achieve high sales in global markets. More recent studies highlighting the quality-dimension for better export performance include Galera and Fraga (2022), AbdGhani, NikMat and Sulaiman (2019), Gambero and Garcia-Ramos (2015), Fan et. al. (2018), and Dongwen, Na, Xin, and Li (2016).

There are also studies that focus on how quality relates to the performance of exporters using firm-level data, namely, Baldwin and Harrigan (2011), Hallak (2006), Johnson (2012), Manova and Zhang (2012). For example, Manova and Zhang (2012) find evidence for quality sorting in exports. Using a trade model with heterogeneous firms and Chinese firm-level export prices, they show that multi-product firms whose core competence lies in varieties of superior quality, nevertheless vary quality across their products by using inputs of different quality levels depending upon the type of market they target. Two key considerations in this context are the production complementarities between input quality, worker skill, and managerial capacity; and frictions in the allocation of resources across firms. Baldwin and Harrigan (2011) uses a variant of the Melitz model to show that high quality firms are the most competitive where such heterogeneous quality increasing is dependent on firms' heterogeneous costs. On similar lines, Fischer (2010) investigated the relationship between product quality and export performance for the EU countries. One important implication of their regression results is that EU agribusiness competitiveness can be enhanced by exporting better quality exports to the increasingly liberalized and quality-conscious markets.

A recent study by Galera and Fraga (2022) examines how important is the quality of Brazil’s exports for its export performance. Based on their estimate of export quality using two-stage least squares and an auxiliary regression, probit panel-regression results indicate that higher-quality exports have greater chances of reaching new markets as well as export survival. Rodrigue and Tan (2019), on the other hand, develop a model with heterogeneous firms who choose their optimal price and product quality to build demand in each export market. They find that though upon initial entry into export markets firms charge relatively low prices and sell low quality goods, subsequently they upgrade product quality and increase prices in response to larger demand.

Further evidence comes from the recent studies on export-led growth, which suggests that what matters is not how much a country exports, but what it exports. Growth rates are observed to be much higher for countries that export high-quality and high-technology intensive products than countries exporting low-quality products (Agosin (2007), Rodrik (2006), Hausman et al. (2007), Hesse (2008)). Future growth prospects can be boosted not by raising the volume of exports, but by continuing to latch on to higher income products over time. For example, while analysing China’s phenomenal export success, Rodrik (2006) found that much more than comparative advantage and free markets, it is the significantly sophisticated export basket of China that has been an important determinant of China's rapid growth. Study by Das and Bandyopadhyay (2003) also provide support the importance of quality in the export market under perceived quality uncertainty for India’s manufacturing sector during 1989-1997.

1.2.2 Low export-quality in developing countries

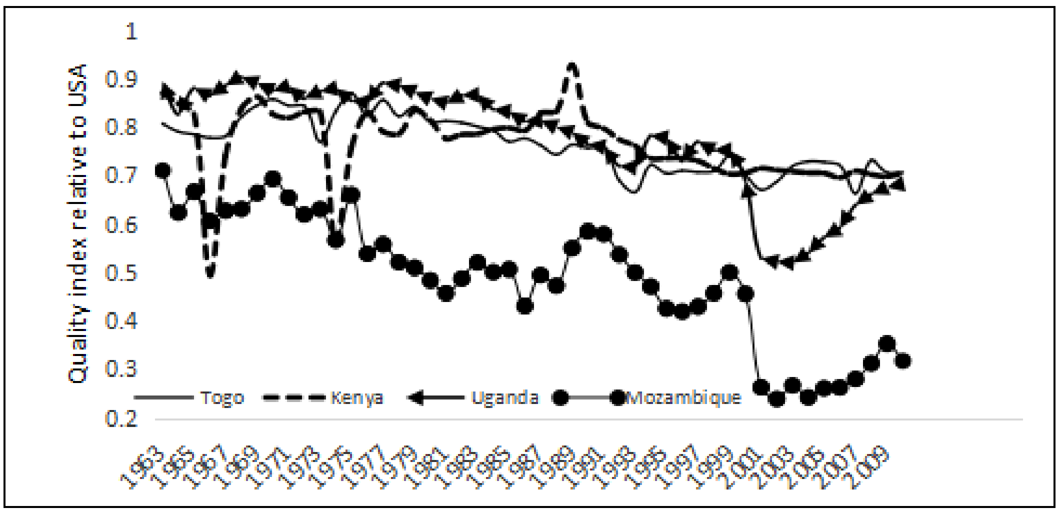
The supply side of the low-quality phenomenon has been substantiated by many studies (Schott (2004), Hummels and Klenow (2005), Hallak and Schott (2011)). Schott (2004), for example, shows that unit value of exports increase systematically with exporter per capita income and relative endowments of physical and human capital. Similar in spirit Markusen (1986) argued that the income elasticity of demand for capital-intensive manufactures is greater than one, so that high-income, capital-abundant countries specialize in manufactures that are exported to other high-income countries. Khandelwal (2010) estimates demand shifters using US import data and finds that they are positively related to exporting countries' GDP per capita and capital abundance. Feenstra and Romalis (2014) and Hallak and Schott (2011), using other methods, also report that higher-income countries export products inferred to be higher quality.

Extant literature (e.g., Balassa (1979), Chor (2010), Costinot et al. (2011), Hallak (2006, 2010), Romalis (2004)) has mostly utilized cross sectional data to investigate this, thus shedding light only on what happens at a point in time. Studies on a single or a handful of countries over shorter periods also exist in the literature (Fabrizio et al. (2007), Khandelwal (2010), Romalis (2004), Schott (2002), Verhoogen (2008)).

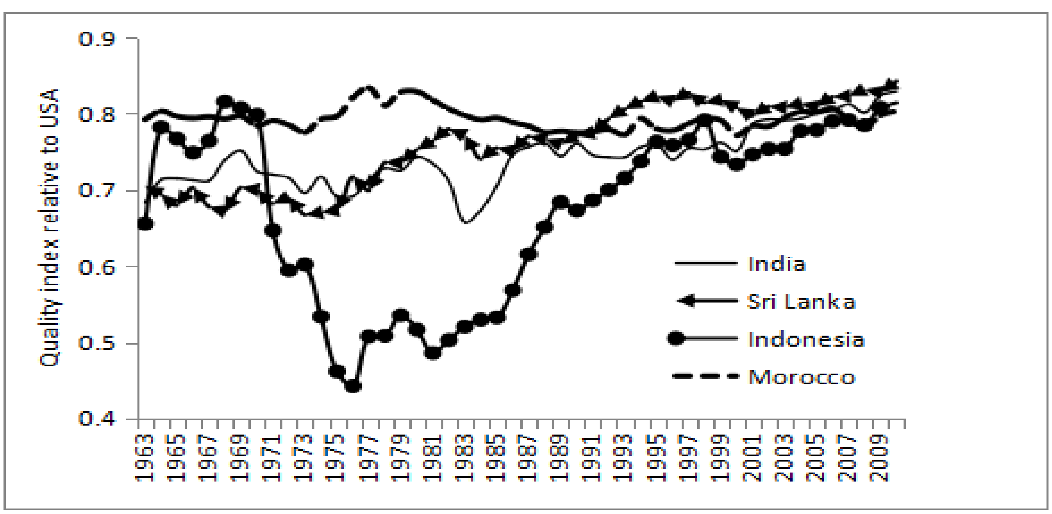
The quality estimates of Henn et al. (2013), on the other hand, provide more general and comprehensive evidence of poor quality of goods exported by most of the developing and poor countries. Drawing from this dataset, Acharyya and Ganguly (2023) makes some interesting observations in this regard. Figure 2.1, reproduced from their analysis, reflects upon the low-quality phenomenon in some selected developing countries in different income groups by comparing the export quality indices of their manufacturing goods with that of the United States for the period 1963-2010, whose average (aggregate) quality index always being among the top three during the entire period of the dataset (1962-2014).

For the low-income countries such as the four African countries reported in panel (a) as well as for the lower-middle income countries like India, Indonesia, Morocco and Sri

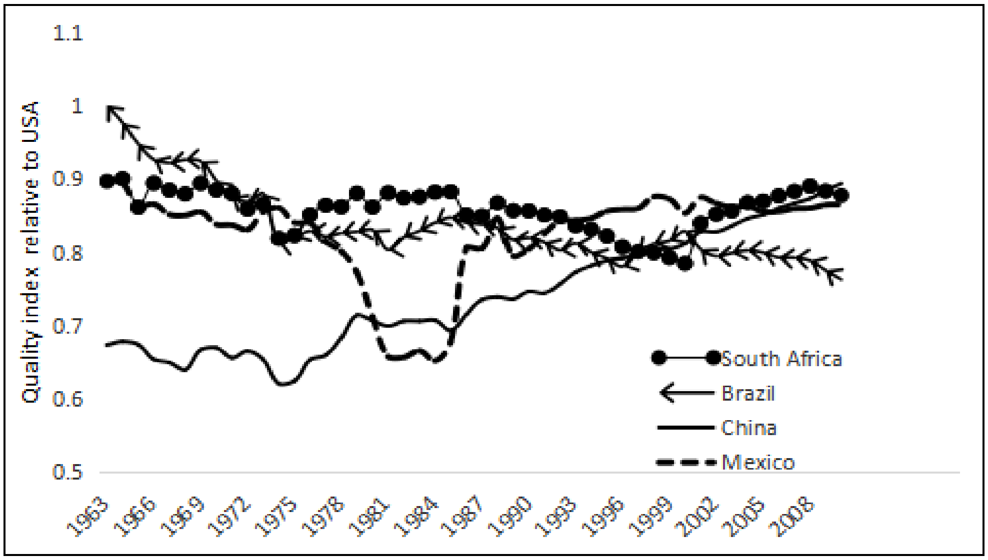
Lanka as reported in panel (b), lower average quality of their manufacturing exports is evident. Of course, the low-income countries lag behind to a larger extent than the lower-middle income countries. Lower average quality for the four upper middle-income countries – Brazil, China, Mexico and South Africa – is reported in panel (c). Quality of manufacturing goods produced by Brazil has deteriorated steadily. And a comparison with quality estimates reported in panel (b), by 2008 its average quality had fallen to the level of qualities produced by India, Indonesia and Sri Lanka. On the other hand, despite producing export goods of qualities lower than the United States, remarkable improvement has been achieved by China since early 1990s, catching up with South Africa by late 1990s and Mexico by 2005.



(a) Low income



(b) Lower-Middle income



(c) Higher-Middle income

Figure 1.1: Quality indices of Manufacturing goods relative to that of the United States (1963-2010)
Source: Acharyya and Ganguly (2023)

Apart from these non-monotonic movements in average quality, the data also reveals asymmetric variations in quality across some export product groups for some of the developing countries. In case of India, trends in asymmetric quality variations have been observed to be more pronounced after the mid-1980s that marks the beginning of its liberalization of import of capital and intermediate goods. As documented in Ganguly and Acharyya (2022a) and reproduced in Table 1.1, statistically significant negative correlation between electrical machinery and non-ferrous metals (-0.5944), between non-ferrous metals and medicinal and pharmaceutical products (-0.7302), and between leather manufactures and plastic materials (-0.7447) can be observed. Similar trends have been observed for leather manufactures, chemical elements and compounds and electrical machinery during that period. The data for Brazil, on the other hand, reveal that whereas the quality of chemicals was declining over the years, the quality of electrical machinery was improving (Ganguly and Acharyya (2021a)). In sharp contrast to these trends, the quality of manufacturing products had been extremely volatile, remained well below the quality levels of the other two product groups, and sharply declined during 1980–1995.

Table 1.1: Correlation Matrix

	Electrical machinery	Non ferrous metals	Medicinal and pharmaceutical products	Plastic materials	Leather, leather Manu-facture	Petroleum and petroleum products	Chemical materials and products
Electrical machinery	1						
Non ferrous metals	-0.5944*	1					
Medicinal and pharmaceutical products	0.5547*	-0.7302*	1				
Plastic materials	0.6589*	-0.3945	0.3212	1			
Leather, leather Manufacture	-0.8092*	0.7687*	-0.5841*	-0.7447*	1		
Petroleum and petroleum products	0.4050	-0.4614*	0.3800	0.4905*	-0.5409*	1	
Chemical materials and products	0.7336*	-0.6233*	0.5661*	0.6217*	-0.8521*	0.3889	1

Note: Correlation values are calculated for the period 1980-2000
Values with asterix (*) indicate statistical significant at 95% confidence interval.
Source: Ganguly and Acharyya (2022a)

1.2.3 Alternative explanations of the low-quality phenomenon

Intuitively, it is not surprising to expect the process of development of a country to be reflected in the increasing sophistication of its export basket. As surveyed in Acharyya (2005), and more recently in Acharyya and Ganguly (2023), major stumbling blocks that the developing countries face for upgrading their export-qualities range from backward technologies and low rates of innovation that keep marginal costs of improving quality high, to the problem of low domestic demand for higher quality varieties due to persistently low per capita income and uneven distribution of income in favour of a handful of rich. A large number of studies have looked at how these fundamentals explain the low quality phenomenon observed in the developing countrie (Bond (1984), Flam and Helpman (1987), Falvey and Kierzkowski (1987), Stokey (1991), Murphy and Shleifer (1997), Matsuyama (2000), Acharyya and Jones (2001), Acharyya (2005), Fajgelbaum et al. (2011), Ganguly and Acharyya (2023)). These analyses have put to use general equilibrium models to establish quality as a determinant of trade patterns. Protectionist trade policies and over-valued exchange rates for their domestic currencies also act as disincentives for domestic producers to become quality-competitive in the world markets.

The Linder hypothesis is one of the earliest theories that explains the effect of quality differences on the direction of trade. This has been subsequently formalized by Fajgelbaum et al. (2011) in the context of home demand determining the pattern of specialization to demonstrate that high income locations will export high-quality products. Considering a rich country and a poor country, both having identical technology and factor endowments, but different size and distribution of their labour forces, they establish the following result. A more dispersed distribution of income in the richer country results in a larger home demand for high-quality goods and a smaller home demand for low-quality goods. Consequently, more firms enter the market there to produce high-quality goods.

In contrast to this demand-side explanation for low-quality of exports, Flam and Helpman (1987) offers an explanation for such specialization patterns in terms of technological differences. In a Ricardian model with continuum of (quality-differentiated) goods, the developing country having diminishing comparative advantage in higher quality goods due to poorer technology specialize in a set of low-quality goods. Matsuyama (2000) had a similar reasoning: In a Ricardian continuum goods model, a high-income North has a comparative advantage in a higher spectrum of goods, and a low-income South has a comparative advantage in a lower spectrum. Murphy and Shleifer (1997), on the other hand, emphasize that the comparative advantage of the richer countries in producing high quality goods arises because of relative abundance of human capital there. Thus, the developing countries being scarce in human capital produce low quality goods. In contrast, Falvey and Kierzkowski (1987) allow for cross-country technology differences in production of the homogeneous good but the same technology for producing the continuum of quality-differentiated goods to bring out the role of both factor endowments and technology in explaining specialization by developing countries in low-quality goods.

Similar factor endowment explanation is offered in Acharyya and Jones (2001). But their analysis differs from Falvey and Kierzkowski (1987) – and also from Flam and Helpman (1987) – in two ways. First, they differentiate between skill levels of workers required to produce the quality-differentiated export good and the two homogeneous goods – a composite traded good and a non-traded good. Second, they study how redistribution of income across different domestic factors of production, resulting from changes in factor endowment, technology or government policy, can affect export qualities. Essentially, they focus on the domestic factor-cost effect. A smaller endowment of capital means a higher rate of return to capital and correspondingly a higher marginal cost of quality. The competitive firms thus choose a lower quality of the export good Z. That is, a relatively capital scarce country, typically the developing countries, will be producers of low-quality export good(s), whereas a relatively capital-abundant country, typically the developed countries, will be producers of high-quality export good(s). On the other hand, a reduction of tariff on an imported input used in production of the homogeneous non-traded good improves the export-quality. Thus, even if the imported input is not used in production of the quality-differentiated export good, a reduction of tariff on it does influence the quality choice by affecting the rate of return to capital.

Asymmetric information of foreign buyers regarding quality of the goods imported from low income developing countries and thus their willingness to pay being limited by their perception of average quality based on country-of-origin also acts as a disincentive for producing high quality export goods – *experience goods* in the terminology of Nelson (1974). In such cases of asymmetric information, buyers pay according to their perceptions about the average industry quality. Thus, producers have no incentive to provide a high quality. As long as cost increases with the quality, they would like to save upon it by providing a low quality. In addition to this moral hazard problem, there can also be an adverse selection when a producer decides about whether to put a good in the market for sale or to keep it for self consumption. Again, since a good of higher quality than the average industry quality cannot be recognized by the consumers because of its unobservable quality, the producer will be putting only goods of lower quality. Bad qualities thus drive out good qualities from the market. This is what Akerlof (1970) termed as lemons problem in the context of market for used cars in the United States. These moral hazard and adverse selection issues can explain low-quality phenomenon in the developing countries if buyers there have a poorer perception about the average industry quality than that in a richer country.

Apart from these fundamentals, restrictive trade and exchange rate policies create further disincentives for firms in the developing countries to produce high quality export goods. This is quite apparent in the context of a large literature that have stressed that export quality upgrading requires larger import of high-quality inputs. In such instances, tariff and non-tariff barriers, which had been prevalent at significantly high levels in developing countries until recently, raise the cost of producing higher quality goods. Over-valued exchange rates also raise the domestic-currency costs of imported inputs. Many recent analyses use this link between high quality imported input and high quality of export goods using variants of firm heterogeneity model a la Melitz (2003) and Bernard et al. (2003) to explore how devaluation (and input trade liberalization) induces quality upgrading (Atkin et al. (2017), Bas and Paunov (2021), Bas and Strauss-Khan (2013), Hu, Parsely and Tan (2017), Fan and Li (2013), Fieler et al. (2018), Hallak and Sivadasan (2013), Kugler and Verhoogen (2012), Manova and Zhang (2012), and Verhoogen (2008)). For example, using Chinese trade transactions data, Bas and Strauss-Khan (2013) conduct a quasi-natural experiment where firms in the control group are exempt from tariff payments while other firms face a reduction in tariffs. They find that those firms who were sourcing high quality inputs from the developed countries and experience a rise in export prices and upgrade quality of products they are exporting to the high income countries. In support of their use of export price rise as an indication of product quality upgrading, they have shown that the change in export prices are not driven by demand shocks or rise in marginal costs or mark ups for that matter. They also find that firms take advantage of the input-trade liberalization to increase both the number of inputs varieties they import and the price of their imported varieties which suggests a within firm quality upgrading of imported inputs. Of late, in case of Ecuador for 1997–2007, Bas and Paunov (2021) find that input tariff reductions allow firms to upgrade their input quality and raise their relative demand for skilled labour. Imported input quality and firms' skill-composition then jointly boost output quality. Fan et al. (2018), on the other hand, examines the effect of China's entry into the WTO on the quality choices of Chinese exporters. Their results reveal that the quality upgrading induced by China's tariff reductions was concentrated in the least productive Chinese exporters, which also redirected their exports towards high income markets where demand for high quality goods is strong. Essentially, the positive effects are derived from the efficiency with which firms use intermediate inputs.

Overvalued pegged exchange rate regime, on the other hand, acts as a disincentive from the revenue side. It lowers not only the per unit revenue from exports in domestic-currency for the exporting firms, but also the world demand for such exports since domestic goods get dearer in foreign currencies. On the other hand, devaluations or exchange rate depreciations may cause imported input-costs to increase. Yu (2013), for example, showed that firms would partially absorb the adverse effect of exchange rate shocks by lowering both the mark-up they charge and the product quality. Chen and Juvenal (2016), Hu, Parsely and Tan (2017) and Ganguly and Acharyya (2022) also examine the impact of exchange rate changes on exports both at the intensive and extensive margins. In such a situation, government interventions in the form of currency devaluation and input trade liberalization policies would play a central role to induce quality upgrading by the developing countries where firms depend largely on foreign technology to upgrade production processes.

1.2.4 Labour-market implications of better export-quality

The policy-target of making the country's exports more quality-competitive and thus more aligned with the world demand pattern through appropriate trade (and domestic) policies may come in conflict with a major challenge of improving – or, at least, not worsening – absolute as well as relative positions of low-skilled and unskilled workers and the poor that policymakers in most of the developing countries face. If higher qualities require more intensive use of capital and/or skilled labour, the scarcity of such factors may imply a trade-off between production of skill-based quality differentiated export goods and unskilled-labour produced other traded and non-traded goods. The consequent fall in the relative demand for unskilled workers causes job losses. The displaced workers, however, may not be absorbed elsewhere if unemployment already exists due to rigidity of wages. Thus, export-quality upgrading through an appropriate policy may increase the pool of unemployed in the short run. Informal sectors, a typical feature of developing countries, may absorb a part of the displaced workers but only for a significant drop in the informal wage.[2] This in turn accentuates wage inequality not only between skilled and unskilled workers, but also among the skilled workers themselves. In such cases, quality-upgrading export-promotion policies may be difficult to sustain in democracies since adverse labour market implications increases the potential political risk.

Many researchers have recently argued that recent inequality trends all over the world are not related to the distribution of national income between the factors of production but primarily to the rising inequality of labour income due to skill premium or wage inequality (Francese and Mulas-Granados (2015), Acemoglu and Robinson (2015), Mare (2016), Dabla-Norris et al. (2015), ECLAC (2012), Greenwood et al. (2012)). Evidence on the worsening of wage inequality over long and sustained periods of time almost universally in different countries, however, dates back even earlier to the empirical studies in the late 1980s and early 1990s. [3] Subsequent empirical studies have mostly found similar trends in wage inequality (Blum (2008), OECD (2008, 2011)**,** Roy and Sinha Roy (2017)).

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[2] Fields (1990), Marcouiller and Young (1995), Rogers and Swinnerton (2004) and Swinnerton (1996) argue that unskilled workers displaced from the formal sectors may not be fully absorbed in the short run for various reasons. .

[3] For an early survey of these empirical findings and theoretical discourses see Marjit and Acharyya (2003). More recent discussions can be found in Acharyya (2017).

A vast literature has been developed over the last three decades that emphasizes upon and demonstrates that significant and sustained episodes of trade liberalization across the globe during the 1980s and thereafter as the reason for such global increase in wage inequality (Acharyya (2012), Aizenman, Lee and Park (2012), Chakraborty and Sarkar (2010), Chakraborty (2009), Davis (1996), Feenstra and Hanson (1996), Leamer (1995, 2000), Marjit and Acharyya (2003), Marjit and Kar (2005), Marjit, Pant and Huria (2019), Pi and Zhang (2017), Roy and Sinha Roy (2017), Ruffin (2003, 2009), Wood (1998), Yabuuchi and Chaudhuri (2008), Zhu and Trefler (2001)). Among the many channels through which trade accentuates wage-inequality in the developing countries that these analyses talk about, segmented labour markets – co-existence of formal and informal markets – is a significant and most relevant one. In India and in many Latin American countries, formal and informal unskilled-labor markets coexist with more than 80% of the work-force employed in informal sectors. Evidences from such countries reveal that import liberalization contributes to increase in wage inequality through displacement of workers from the formal to the informal segments, a phenomenon known as informalization (Bogliaccini (2013), Brady et al. (2011), Marjit (2000, 2003), Marjit and Kar (2011), Marjit et al. (2007)). Other channels recognized in the literature include diverse trade pattern (Marjit and Beladi (1999)); existence of non-traded goods (Marjit and Acharyya (2003)), market imperfections and IRS (Chakraborty and Sarkar (2010), Ruffin (2003, 2009)); structural changes (Aizenman, Lee and Park (2012), Roy and Sinha Roy (2017)); immigration (Marjit, Pant and Huria (2019)), and conversion of quantitative restrictions into price restrictions and income effects (Acharyya (2012)).

On the other hand, employment effects of different export promotion policies have been analyzed in the existing literature mostly in an open economy macro-economy framework studying how policies augment effective demand for aggregate output and consequently aggregate demand for (unskilled) labour. Employment effects of currency devaluation in this context, has been studied by Alexander (1952), Cooper (1971a, 1971b), Dornbusch (1980), Hanson (1983), Krugman and Taylor (1976) and Meade (1951) among others. Krugman and Taylor (1976) offered a theoretical basis for the possibility of a contractionary effect of devaluation due to initial trade deficit; or, if the marginal propensity to save from profit is higher than that from wages; or, through redistribution of incomes from private to the government when devaluation is administered in presence of export taxes and tariffs. On the other hand, using a demand determined model Hanson (1983) shows that depending on the values of price elasticities of demand for imported consumer goods and of derived demand for imported inputs, devaluation may be contractionary.

Among the multi-sector general equilibrium analyses, Brecher (1974) demonstrated that in a standard two-sector model of trade with minimum *real wage* restriction, trade liberalization raises aggregate employment if the trade pattern is Heckscher-Ohlin. Helpman (1977) considered a short run model of an economy producing traded and non-traded goods with sectorally mobile labour but sector-specific capital, and showed that under the assumption of downward rigidity of real wage, currency devaluation would raise aggregate employment of labour unambiguously. There are also the dual-economy approaches that consider open economy extensions of the Harris-Todaro framework (Khan (1980, 1982), Hazari and Sgro (1991), Hazari, Jayasuriya and Sgro (1992), Chao and Yu (1993), Gupta (1994, 1995) and Beladi and Marjit (1996)). An early survey of the literature on trade and employment has been presented in Marjit and Acharyya (2003, Ch. 6).[4]

1.3 Research Objectives

From the review of existing literature of trade policy and export-quality emerges several research gaps and limitations of existing analyses to explain the low-quality phenomenon in the developing countries. First of all, despite some of the theoretical works highlighting the scarcity of domestic factors like skilled labour and/or capital underlying poor quality of exports as mentioned above, and a few subsequent empirical studies substantiating importance of such domestic factors (Bas and Paunov (2021), Brambilla et al. (2012, 2014), Brambilla and Porto (2016)), a large and growing number of studies

[4] Of late, in the context of competitive-general equilibrium production structure of a small open economy, Marjit, Ganguly and Acharyya (2019) have derived conditions under which an increase in the minimum unskilled wage raises the aggregate employment of unskilled workers.

consider imported inputs as the essential element for export-quality upgrading and accordingly focus on input-tariff reduction as a potential export-promotion policy. While better quality of imported input may certainly be important, the problem with such an approach is that input-tariff reduction should unambiguously improve the quality of export goods across the board. Only the extent of quality-upgrading of different export-goods will differ depending on their import intensities. However, the observed asymmetric movements in quality indices of different export product groups does not corroborate with this prediction. But, once the skill and capital intensities of high-quality varieties of exports goods are taken into account, with such intensities varying across different product groups, then not only input-tariff reduction but also reduction of tariff on import of some final consumption goods can have asymmetric effects and explain the observed asymmetric quality variations. This follows from the predictions of the standard trade theory that tariff reductions on final imported goods will asymmetrically change the skilled wage and the rate of return to capital. So, for example, in case of pharmaceutical products, chemical elements, Software, ITeS, for which quality upgrading would be relatively more skill intensive than capital, the marginal cost of quality upgrading would respond in a completely opposite way to how it would in case of product groups like transport equipments, data processing equipments, electrical machinery, appliances which are relatively more capital intensive than skilled labour. Note that despite Falvey and Kierzkowski (1987) and Acharyya and Jones (2001) emphasizing upon domestic factors essential for quality upgrading, yet their analysis cannot explain the asymmetric quality variations due to the restrictive assumption that higher-quality varieties are relatively capital intensive, and thus needs generalization with respect to the production technology. At the same time, to the best of my knowledge, theoretical explanations for the observed asymmetric quality variations across export product groups that vary in their relative intensities of domestic factors (skill and capital) required for quality upgrading, are largely lacking in the existing trade literature. *Thus, re-examination of trade policy impacts on export-quality when quality upgrading requires intensive use of domestic factors like skilled labour and capital is the first research question or issue that is addressed in this dissertation.*

The second relevant issue that has not been explored in the literature on export-quality promotion policies also arises from the domestic-factor-cost dimension of quality upgrading. Since better infrastructure – both hard infrastructure and soft infrastructure – can augment productivity of skilled workers, it can thereby improve quality of export-goods. For example, better ICT infrastructure may improve quality of IT-enabled service (ITeS) exports by augmenting the productivity of skilled workers necessary to produce and export such services. Similar factor-productivity augmenting effects of hard infrastructure like paved roads, uninterrupted power generation and improved port efficiency may have favourable impacts on quality of manufactured exports whose production is contingent upon the provision of these infrastructure facilities. Put alternatively, besides scarcity of skilled workers, poor infrastructure in the developing countries that adversely affects productivity of skilled workers can also be a plausible explanation for low export-quality. This opens up the role of fiscal policy or government expenditure on infrastructure development to promote exports at the extensive margin. There is a sizeable empirical literature that examines the role of improved port efficiency, larger length of paved roads, and better telecommunication facilities on price competitiveness of exports and thereby gains at the intensive margin (Calderon and Severn (2005), Égert, Koźluk and Sutherland (2009), Esfahani and Ramirez (2002), Fernald (1999), Ismail and Mahyideen (2015), and Xing (2018)). But none of these analyses, to best of my knowledge, examines how better infrastructure promotes exports at the extensive margin. This research question is important in yet another respect. Since development of infrastructure competes for the same scarce resources that are used for production of other traded and non-traded goods and services in the economy, it raises domestic factor costs, which may adversely affect the choice of export qualities. That is, infrastructure development has both favourable productivity-augmenting effect and adverse cost-cascading effect, and accordingly its impact on export-quality choice is ambiguous. The existing literature does not take into account this cost-cascading effect either with the notable exception of Acharyya (2014). In the context of the Ricardian continuum goods model with transport cost, his focus was, however, not on promotion of export-quality but on how the set of traded goods expands through development of road infrastructure. Given these gaps in the existing literature, *examination of the role of fiscal* *policy of infrastructure development for upgrading export-quality by taking into account both the skilled-labour augmenting effect and cost-cascading effect of better infrastructure constitutes the second major research question that I intend to address in this dissertation.*

The third aspect of the present dissertation is in regard to examining whether a monetary policy can favourably affect export-quality choice by the domestic producers in a developing country. This issue assumes relevance due to two primary reasons. First, while exchange rate changes also cannot explain asymmetric quality variations across different product groups without taking into account domestic factors essential, for quality-upgrading, more importantly, exchange rate changes are not exogenous as is considered by Yu (2013), Chen and Juvenal (2016), and Hu, Parsely and Tan (2017). Rather, these are "managed" outcomes of monetary policies. That is, under a managed float exchange rate regime, which is being widely adopted by countries across the globe, the effects of exchange rate changes on the quality of exports are, in essence, the consequences of monetary policies pursued by the central banks of the developing countries. Accordingly, a more appropriate focus of analysis should be on how monetary policies affect export-quality. Second, monetary policies can also affect export-quality by changing domestic factor prices through capital formation and consequent change in the composition of aggregate output due to scarcity of some commonly used resources. However, to what extent an expansionary monetary policy will generate general-equilibrium effects on the export-quality through changes in the domestic factor costs due to the output-composition effect remain unexplored in the literature. Thus, *examination of the role of monetary policy for export-quality is a much broader research question than what the existing literature on the exchange rate and export-quality addresses, and this constitutes the third major research question that I address in this dissertation*.

Fourth major research question that I address is whether export-promotion trade, fiscal and monetary policies accentuate the wage inequality between skilled and unskilled workers; or, whether these policies lower the aggregate level of employment of the unskilled workers when unskilled money wage is rigid everywhere in the economy. This research question assumes relevance because though the wide range of existing theoretical analyses merit attention for identifying plausible channels through which liberal trade policies may accentuate wage inequality, none of these have accounted for quality variations in skill-based exports induced by such policies as a plausible source and cause of the observed increase in wage inequality. To the extent to which quality variations per se accentuate wage inequality, the effects of trade, fiscal or monetary policies on wage inequality will be an underestimation if quality variations induced by it are not considered. Ma and Dei (2009) have analyzed the implications of quality upgrading on wage inequality extending the analysis of Acharyya and Jones (2001). But, in contrast to their study of implications of quality upgrading of a domestically produced non-traded good, my focal point is quality-differentiated export goods. Analyzing wage inequality among unskilled workers through informalization in the context of segmented labour markets is another major point of departure of the present analysis from that of Ma and Dei (2009). Consequently, the aim and nature of policy analysis are significantly different. On the other hand, despite existence of a large literature on how monetary policy affects the employment levels in an economy with large number of workers being unemployed, it largely overlooks the concern I raise here. In fact, most of the macroeconomic analyses made no distinction between different types of consumption goods in terms of their factor intensities and product quality, or even between different types of labour in terms of their skill levels. This limits the scope for discussion on sectoral allocation of (unskilled) labour and implication of such reallocations on the aggregate level of employment. The multi-sector general equilibrium analysis by Acharyya (1994), Beladi and Marjit (1996), Brecher (1974), Chao and Yu (1993), Gupta (1994, 1995), Hazari and Sgro (1991), Hazari, Jayasuriya and Sgro (1992), Helpman (1977) and Khan (1980, 1982), shed no light on the policy conflict that may arise due to policy-induced quality upgrading of the export goods.

To summarize, by focusing on the intensity of domestic factors like skilled labour and capital – along with imported inputs in some instances – and therefore on the domestic factor-costs, this dissertation examines the role of trade policy, fiscal policy and monetary policy in upgrading qualities of export goods and services. It also provides plausible alternative explanations for asymmetric quality variations across different product groups, and draws labour market implications of such policy-induced quality variations. These issues are analyzed theoretically in a competitive general equilibrium framework of a small open economy in the three core chapters of this dissertation, as outlined in Section 1.4 below.

As a further motivation of my theoretical analysis, I have undertaken a preliminary empirical exercise to reflect upon the relative importance of these three key variables, that these policies impact upon: globalization index, infrastructure index, and real effective exchange rate. Using panel data of 103 countries for the period 1996-2010, I have run fixed effects static panel regression to estimate the significance and magnitude of effectiveness of the policy variables mentioned in determining the choice of product quality. This also provides a preliminary and more general cross-country evidence on such impacts on export performance in contrast to the existing country specific studies using firm-level data carried out for short periods of time and few product varieties (Khandelwal (2010), Kugler and Verhoogen (2012), Manova and Zhang (2012), Piveateau and Smagghue (2019) and Verhoogen (2008)). For cross-country comparisons, including developing countries, I have used the quality dataset developed by Henn et al. (2013) as an IMF-DFID research collaboration. They provide us with the most extensive quality indices for 200 countries for the period 1962-2014 and for each of the 851 number of products at the SITC 4 digit level, which is a significantly extended version of the UN–NBER data set. However, I limit my study period to 1996-2010 due to the limited availability of data on the Infrastructure index, which is available for 1990-2010 only. The choice of the starting year in my time period is, however, in line with establishment of the WTO. I estimate the following structural form specification:

$$\exp qua_{i,t} = \beta_1 + \beta_2 Dkoftrgi_{i,t} + \beta_3 \ln \inf_{i,t} + \beta_4 \ln reer_{i,t} + \sum_{j=1}^{J} \alpha_j CON_{j,i,t} + \beta_5 v_i + \beta_6 \theta_t + \varepsilon_{it} \qquad (1.1)$$

The three key variables of interest, the impacts of which I estimate here, are *trade liberalization, exchange rate, and infrastructure index*. The panel is set where *i* denotes country and t denotes year for ech of the variables. Trade liberalization measures is captured as $koftrgi_{i,t}$, which is the KOF Trade Globalization Index[5] that computes globalization by applying principal component analysis over the trade variables such as the prevalence of non-tariff trade barriers and compliance costs of importing and exporting, income from taxes on international trade as percentage of revenue and unweighted mean of tariff rates[6]. Data is taken from the KOF Swiss Economic Institute database[7]. For exchange rate, denoted as $reer_{i,t}$, I consider the standard measure of real effective exchange rate provided by the International Monetary Fund (International Financial Statistics database). Note that by the IMF conventional measure, a rise in the REER denotes appreciation. The third policy variable $\ln \inf_{i,t}$ is the Infrastructure (aggregate) index, as constructed by Donaubauer et. al (2016)[8]. Different infrastructural facilities can augment trade through different channels. For example, while improved port efficiency and higher density of smooth paved roads, lower transaction costs and promote efficient export of commodities that require physical transfer, infrastructural facilities like better telecommunication, augments factor productivity and thus pronounce the quality of exports of ITeS and the like. So I use a comprehensive index of infrastructure that takes into consideration all relevant components of economic infrastructure in its composition. Specifically, based on a broad annual data-set of 30 indicators of the quantity and quality of infrastructure, the index comprises of four sub categories: transport (via air, land and sea), information and communications technology (ICT), energy, and finance.

[5]An alternative and direct, albeit a narrow, measure of trade liberalization policy would have been weighted mean applied tariff of each country. However, due to the irregularity of the tariff data available in TRAINS, a lot of data points would have been lost and so this measure is not used in our study.

[6]Economic globalization is composed of trade and financial globalization, (each with weight of 50 percent. There are indices of other types of globalization like social and political globalization. The overall KOF Globalization Index for each country is calculated as the average of the de facto and de jure of all these Globalization Indices.

[7]These data are available on an annual basis from 1970 till date. For a detailed discussion on the literature and procedure of developing these indices, refer to https://doi.org/10.1007/s11558-019-09344-2

[8]For more information on the components of the indices and method of construction and data refer to Donaubauer, J., Meyer, B. and Nunnenkamp, P. (2016) A New Global Indexof Infrastructure: Construction, Rankings and Applications. WorldEconomy, 39(2), 236-259. I am thankful to the authors for allowing me to access their data set.

I consider a set of control variables based on the determinants of product quality that the existing theoretical literature emphasizes upon as plausible causes for cross-country variations in product qualities. As a supply side determinant, I have taken composition of export basket, captured through share of high technology exports in total exports (World Bank). I also control for the effect of economic institutional quality using indices from the dataset developed by Kuncic (2014). Institutions, like quality of contract enforcement, property rights, efficient rule of law and a good endowment of informal institutions have also been found to augment trade flows in many studies (de Groot, Linders, Rietveld, and Subramanian (2004)). Export diversification index at the intensive margin is also considered (Henn et. al. (2013)). The reason behind this is the observation made by Henn et. al. (2013) that the developing countries, that already have relatively higher average export quality, may benefit from diversifying into sectors with opportunity for quality upgrading still existing. At the same time, too much of diversification of the export basket may lead to an increase in capital cost and skilled-labour cost due to scarcity of these resources in the developing counties, and accordingly may adversely affect quality choices there. Among the demand side factors, the home market (domestic demand) effect or the level of development of countries is captured through a country's share in world GDP using data from the UNCTAD database. Share of industry, and in alternatives to the baseline specification, share of services in a country's GDP is considered to capture the effect of sectoral contributions in the development of a country. Data are taken from World Development Indicators (WDI) database. Among country specific characteristics, the relative size of the economy is taken as the share of its population in world population with data from the UNCTAD database and landlockedness of a country is considered as a dummy, that takes value 1 if landlocked and zero otherwise. Finally, γ_i and θ_t in (1.1) stand for country fixed and time fixed effects, respectively, while ϵ_{it} represents the idiosyncratic error terms. The specifications in the panel fixed effects are chosen after conducting Hausman test. The level at which the variables are considered in the model specification are based on the stationarity of the variables that I have checked by applying unit root test (ADF) which are reported in Table 1.2.

Table 1.2: ADF Test of unit root

Variable	Stationary at --
exqua100	level I(0)
D.kof	difference stationary I(1)
lninfra	level I(0)
lnreer	first-difference I(1)
Expdivintensive	trend-stationary I(0)
shworldgdp	trend-stationary I(0)
hteshte	level I(0)
sharindusgdp	trend- stationary I(0)

Table 1.3 presents the results on the impact of the key policy variables and the set of controls on product quality using panel fixed effects. The baseline analysis establishes the following results. All the core policy variables have significant influence on choice of export quality. For example, specification 1 states that the growth in KOF trade globalization indicator reduces export quality and this is consistent for all variations with statistical significance at 1%. Subsequent theoretical analysis will provide some plausible explanations for this negative significant impact in terms of domestic factor cost effect. As expected, improvement in infrastructure facilities incentivises quality upgrading. An increase in the real effective exchange rate, implying appreciation of the domestic currency vis-à-vis USD by the definitions of IMF, on the other hand, has a favourable impact on the export quality. A positive change in the first difference of REER raises export quality by almost 4 times in the baseline model (first column) with statistical significance at 10%. However, its effects become insignificant when other control variables are taken into account.

Of course, the static panel estimation may be biased due to endogeneity problem and possibility of omitted variables among others. Also, disaggregation of the product categories and country groups may be needed to check robustness of these results. However, notwithstanding these limitations, the baseline results give us some preliminary reflections on the significance of the three target variables of interest and thus provide some empirical relevance and motivation for our theoretical analyses. On the other hand, the insights gained from theoretical analyses carried out in this dissertation regarding how the policies affect the choice of export-quality will enable me to set up appropriate specification of our dynamic panel regression analysis (such as, system GMM) to estimate the policy impacts on export quality in a more robust way in a future extension of this preliminary empirical analysis.

Table 1.3: Impact of Policy Variables on Export Quality: Panel Fixed Effects

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
VARIABLES	exqua100	exqua100	exqua100	exqua100	exqua100	exqua100	exqua100
D.koftrgi	-0.242***	-0.255***	-0.172***	-0.174***	-0.177***	-0.180***	-0.170***
	(0.0588)	(0.0606)	(0.0504)	(0.0503)	(0.0501)	(0.0493)	(0.0491)
Lninfra	0.617***	0.649***	0.376**	0.357*	0.356*	0.347*	0.345*
	(0.217)	(0.219)	(0.182)	(0.182)	(0.181)	(0.178)	(0.177)
D.lnreer	4.907*	4.915*	1.350	1.320	1.748	1.751	1.038
	(2.526)	(2.555)	(2.128)	(2.124)	(2.117)	(2.085)	(2.078)
Shindusgdp		-0.320***	-0.510***	-0.518***	-0.515***	-0.503***	-0.518***
		(0.0873)	(0.0730)	(0.0730)	(0.0726)	(0.0714)	(0.0710)
Expdivint			13.47***	13.41***	13.37***	7.978***	8.388***
			(0.572)	(0.572)	(0.569)	(0.999)	(0.997)
Ecoinstqua				8.732**	8.438**		
				(3.861)	(3.842)		
Hteshte					0.173***	0.163***	0.154***
					(0.0475)	(0.0468)	(0.0466)
Ecoinsdiv						8.509***	7.973***
						(1.291)	(1.289)
shwPcgdp							3.236***
							(0.776)
Constant	84.36***	93.88***	64.18***	59.36***	57.59***	63.71***	58.13***
	(0.330)	(2.545)	(2.462)	(3.253)	(3.273)	(2.474)	(2.799)
Observations	1,376	1,337	1,337	1,337	1,337	1,337	1,337
R-squared	0.021	0.032	0.332	0.335	0.342	0.362	0.371
Number of countrycode	100	99	99	99	99	99	99

Standard errors in parentheses
*** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$

Source: Author's calculations using Stata 13 software

1.4 Outline of the Dissertation

The dissertation comprises of three core chapters followed by a Conclusion chapter that summarizes the results obtained in the three core analyses and then outlines my future research agenda. The outline of the core chapters are as follows.

Chapter 2: Trade Liberalization, Export Quality and Wage Inequality

This Chapter examines whether and how reduction of tariffs on final imported goods and on imported inputs may improve the quality of quality-differentiated export products; and whether it can provide a theoretical explanation for the asymmetric quality variations across different export product groups as observed in the data.

In Section 2.1, I discuss the perspectives and motivation of my analysis, review the relevant literature on tariff as an (indirect) export-promotion policy, and accordingly contextualize my research question. In Section 2.2, extending the Acharyya and Jones (2001) by considering a more general production technology for quality-upgrading and incorporating two types of quality-differentiated export goods, I examine how a reduction of tariff on import of a homogeneous final consumption good affects choice of quality for these two export-goods. In the context of formal-informal segmentation of the unskilled labour market, I then draw implications of tariff-induced quality variations for three dimensions of wage inequality (as defined in Chapter 2) through reallocations unskilled workers across the formal and informal sectors. Section 2.3 examines the efficacies of sector-specific or targeted subsidies financed by an income tax as concurrent policy measures in mitigating the adverse effects that tariff reduction may generate for quality choice of some export product groups. In section 2.4, I include imported inputs in production of the two quality-differentiated export goods to study implications of input tariff reduction. Finally, in Section 2.5, I study the role of a non-traded good. Example of non-traded goods and services produced by an economy is abounding, which include freshly prepared food, highly perishable consumption goods, major components of construction, and services like haircut and nursing. The role of non-traded goods in altering some of the properties of the standard trade models and explaining phenomenon like Dutch Disease are also well recognized in the literature.[9] The most important is the influence of domestic demand for non-traded goods on the domestic factor prices. So, by including production of a non-traded good, after appropriately modifying – and to some extent, simplifying – the benchmark model, I study whether and how the results derived in the earlier sections get altered.

Chapter 3: Infrastructure Development, Export Quality and Labour Market Implications

In this chapter, I examine the role of infrastructure development for upgrading export quality and thus promoting exports at the extensive margin. In the benchmark exercise in Section 3.2, I consider a situation where quality of an ITeS exports depends on the quality of the ICT infrastructure, which is provided by the government. Better quality of ICT infrastructure and service has a favourable impact on the quality of the ITeS exports both due to augmentation of skilled-labour productivity and lesser ICT usage time. But, by incentivizing quality-upgrading of ITeS exports, better quality of the ICT infrastructure also raises the skilled wage as their demand increases in the ITeS sector. This cost-cascading effect of better ICT infrastructure makes quality improvement for ITeS exports uncertain. In Section 3.3, I introduce provision and development of a hard infrastructure like better paved road, in addition to the soft infrastructure like ICT. To capture sector-specificity of these two types of infrastructures, I also consider a quality-differentiated manufactured export-good for which this hard infrastructure generates benefits in the sense that better roads enables smoother and faster travel and transportation for skilled workers there (as well as unskilled workers employed in rest of the economy) to their workplaces and consequently improves their productivity. There is, on the other hand, a cost-cascading effect of better roads – like the cost-cascading effect of better quality ICT – because same scarce resources are used to develop roads as are used in production sectors in rest of the economy. Better roads, however, do not improve productivity of skilled workers engaged in the ITeS sector because of the scope

[9] See Caves, Frankel and Jones (1999, for example,) for textbook presentations of some of these results.

of work-from-home from such a service exports. The main purpose that consideration of these two types of infrastructure serves is to capture a potential trade-off between them that may arise due to cost-cascading effect of each of these as well as due to budget constraint for the government, draw implications of such a trade-off for choice of export qualities of the ITeS exports and manufactured export-good. In such a scenario, I investigate how variations in the budgetary allocations between the two types of infrastructures would affect the export quality choices of the two quality-differentiated export good and services through domestic factor cost effects. Then I look into the implications of the same for wage inequality between the skilled and unskilled workers. Finally, Section 3.5 concludes the current Chapter with an informal discussion on a balanced-budget method financing of infrastructure development through revenues collected from a tariff on an imported input.

Chapter 4: Export Quality and Labour market under Managed Float: Role of Monetary Policies

In this chapter, I examine whether and how an expansionary monetary policy affects the quality of exports in the basic framework of earlier chapters with only one type of quality-differentiated export good, a homogeneous composite traded good and a homogeneous non-traded good, by incorporating a money market, a portfolio-choice by wealth-holders for liquid-cash, domestic assets and foreign assets, and commercial banks channelizing supply of loanable funds to potential investment-firms. The other concern is once again, the domestic labour market implications. In Section 4.2, I set up the analytical framework under fully flexible wages for unskilled labour in each and every sector of the economy. This enables me to examine implications of monetary-policy-induced quality variations for the skilled-unskilled wage gap. In Section 4.3, I introduce a formal-informal segmentation of the unskilled labour market and recast the benchmark analysis to study the effect on wage inequality through labour allocation across these sectors. Finally, in Section 4.4, I consider implications of a minimum (and rigid) unskilled money wage in all relevant sectors. Whereas the justification of implementation of such uniform minimum wage for the unskilled workers can be put forward as ensuring at least the subsistence level of earnings for the unskilled workers, the flip side of this policy is that all workers will not be employed now. An obvious question that crops up in such a context is how a monetary expansion affects the aggregate level of employment of unskilled workers through its effects on the composition aggregate output and variations in the export-quality. While implications of inflation-targeting by the foreign country is analyzed in Section 4.5, informal discussions are presented in Section 4.6 regarding how inclusion of a transaction demand for money and relaxation of the assumption of perfect substitutability between domestic and foreign assets may alter my results.

Chapter 2

Trade Liberalization, Export Quality and Wage Inequality

2.1 Introduction

Since the late 1980s many developing countries, including India, have implemented a host of trade reforms as part of their globalization efforts and subsequently for meeting the requirements for accession to the World Trade Organization (WTO) membership. Conversion of quantitative restrictions into (equivalent) tariffs and subsequent phasing out of tariff rates have been the major components of such trade reforms. A major benefit that reduction in tariff rates is popularly believed to bring about is boosting exports by freeing up scarce resources from the import-competing sectors. This not only generates real income gains through efficient reallocations of resources in the short run, but also creates scope for export-led growth in the long run. The rapid export upgrade from low-technology textiles to high-technology electronics by China over the last three decades bears the biggest testimony to how liberalization has facilitated spectacular trade performance and the quick integration into the global trade network (Rodrik (2006), Schott (2008)). However, a strong favorable influence of a liberalized trade policy regime on export performance has remained largely unresolved in the literature. While some studies, such as Joshi and Little (1996), Dijkstra (1997), Michaely et. al (1991), Niemi (2001), Santos-Paulino (2000), Edwards (1993) to name a few, have found a positive association; some other studies have found little empirical evidence to support the link (Agosin (1991), Clarke and Kirkpatric (1992), Greenaway and Sapsford (1994), Morrissey and Mold (2006), Shafaedin (1994), Moon (1998)). These studies have highlighted on different ways trade liberalization promotes exports. The standard argument for the beneficial effects of trade liberalization have been primarily based on arguments of resource reallocation, and the main proponents of this are Bhagwati (2004), Krueger (1998), Papageorgiou et al. (1991), among others. Another argument highlights on trade liberalization creating a more competitive domestic environment, and attracting foreign capital to improve the export performance. Empirical explorations such as

Kassim (2013) also conclude that trade liberalization increases the growth of exports by looking at the interaction between the rate of change of the terms of trade and trade liberalization dummy. Further, trade liberalization is found to significantly raise the price elasticity of demand for exports. On the other side of the story, Chang (2005) and Lall (2003) have stressed upon the infant industry argument when liberal trade policies repress beneficial structural change and therefore have a negative long-term effect on export and, as a consequence, on export led growth. Santos-Paulino (2002) and Santos-Paulino and Thirlwall (2004) analyzed panel data for the 1972-1997 period for a sample of 22 developing countries in which trade policies were liberalized in the mid-1970s and both Fixed Effects (FE) and Generalized Methods of Moments (GMM) showed that though liberalisation stimulated export growth, it raised import growth more than proportionately. The consequent worsening of the balance of trade and payments has significantly constrained the growth of output and living standards.

However, the quality dimension of the alignment problem discussed in Chapter 1 suggests that tariff reductions as indirect export-promotion policies may not work unless they incentivize upgrading of qualities of exported goods and services. This possibility of tariff reductions adversely affecting export-qualities arises due to two reasons. First, recent evidences reveal that domestic inputs like skilled-labour and capital are often the critical components for higher quality varieties of exported goods and services. Second, tariff reductions may asymmetrically affect prices of these scarce domestic inputs through their reallocation from import-competing sectors to the export sectors. Such asymmetric effects on domestic-input costs may arise even when tariffs on imported-inputs used in the quality-differentiated exported goods are lowered. Thus the marginal cost of quality may go either way and accordingly it is quite plausible that quality of exported goods may actually deteriorate. The observed asymmetric quality variations across different product groups reported in the previous Chapter is a point in case for such a possibility.

The existing literature that discusses effects of input-tariff reductions on export quality falls short of explaining this observed phenomenon of asymmetric quality-variations (Bas and Strauss-Khan (2013), Hu, Parsely and Tan (2017), Kugler and Verhoogen (2012), Manova and Zhang (2012), Verhoogen (2008)). On a study of Chinese exporting-firms, Bas and Strauss-Khan (2013), for example, find that those firms who were importing high-quality inputs from the developed countries could upgrade quality of products they were exporting to the high-income countries. They also find that firms increase both the number of input varieties they import and the price of their imported-varieties after input-trade liberalization. This suggests a within-firm quality upgrading of imported inputs. While these observations are certainly important and merit attention of researchers, at the same time, these do not shed any light on whether quality-upgrading effect of input-trade liberalization is uniform for firms across different industries. In general, this set of studies fails to provide any plausible explanation for the asymmetric quality-variations phenomenon for two reasons. One is their overwhelming focus on availability of better-quality imported-inputs as the essential element for quality-upgrading. The other is total disregard of importance of domestic inputs like skilled-labour and capital for quality-upgrading, notwithstanding early theoretical analyses and recent empirical evidences on export performances revealing their roles (Acharyya and Jones (2001), Brambilla et al. (2012), Brambilla et al. (2014), Brambilla and Porto (2016), Falvey and Kierzkowski (1987), Flam and Helpman (1987), Murphy and Shleifer (1997), Schott (2004)). A very recent study by Bas and Paunov (2021) in fact reveals the joint role of imported-input quality and skilled-labour for quality-upgrading.

In this backdrop, I focus in this Chapter on the domestic-factor cost and its joint role with imported-input to demonstrate that if different export products vary from each other with respect to the relative domestic-factor intensities for their respective higher qualities, then quality variations induced by tariff reductions – be it on imports of final consumption good or of inputs – will indeed be non-uniform across these product groups. For the purpose, in Section 2.2, I consider two quality-differentiated export products along with a homogeneous export-good and a homogeneous import-competing good. I also explore how tariff-reduction induced asymmetric export-quality variations affect wage inequality among skilled and unskilled workers, as well as among the unskilled workers themselves, by taking into account formal-informal segmentation of the labour market. Motivation for examining such labour market implications comes from a potential policy conflict that policymakers in developing countries may face. Quality upgrading induced by export-promotion strategies like tariff reductions may draw upon scarce resources like capital from other sectors that use unskilled workers along with capital for production. Consequent contraction of scale of operation in such sectors lowers the demand for unskilled labour. On the other hand, unskilled workers are not directly used in quality upgrading. Hence, overall, quality-upgrading would lower the unskilled wage and thereby accentuate wage inequality. In large democracies, such adverse labour market implications may make it difficult for policymakers to continue with quality-upgrading export-promotion policies.

Asymmetric quality-effects of reduction of tariff on an imported final consumption good call for adoption of some concurrent policies targeted for those export-product groups whose quality is downgraded. In Section 2.3, I examine effectiveness of two such sector-specific policies. One is a quality-content production subsidy, and the other is input-subsidy for use of capital and/or skilled labour to lower. I also discuss financing of these subsidies through a quality-neutral income tax policy. In Section 2.4, I evaluate the robustness of these results by allowing the same and mobile capital used in both the formal and informal sectors of production.

Section 2.5 examines the joint role of imported-input and domestic-inputs in explaining the asymmetric quality-variation phenomenon. The purpose of this exercise is to highlight on the fact that input-tariff reductions can also be a plausible explanation provided intensive use of domestic inputs are also considered along with imported-inputs for quality-upgrading. This also provides a theoretical explanation for the observation of Bas and Paunov (2021) mentioned above.

In the penultimate section, Section 2.6, I examine the implications of non-traded goods being produced in the economy for the results derived in the earlier sections. Existence of non-traded goods and their roles in altering some of the properties of the standard trade models and explaining phenomenon like Dutch Disease are well recognized in the literature (Dornbusch (1980), Dornbusch, Fisher and Samuelson (1977), Helpman (1976), Jones (1976), Jones and Corden (1976), Komiya (1967), Sanyal and Jones (1982), Xu (2003)). The most important and relevant in my context is that the domestic demand for such non-traded goods now matter even for a small open economy, as changes therein impact the domestic factor prices through changes in domestic price of non-traded goods. Finally, Section 2.7 summarizes the results and concludes the current Chapter.

2.2 Tariff Reduction, Asymmetric Export-Quality Variation and Wage Inequality[10]

In this Section I show how reduction in tariff on final import goods asymmetrically affects the quality of skill-based export goods that differ with respect to the relative skill intensity of their higher-quality varieties. This offers a plausible explanation for asymmetric quality variations across product groups. I also show that on the contrary, tariff-reduction-induced quality variations, regardless of their asymmetry, accentuate wage inequality in all dimensions by depressing the informal unskilled wage through displacement of unskilled workers from the formal sector and the consequent *informalization* of the economy.

2.2.1 Analytical structure

I consider a small open economy that produces four goods: a homogeneous agricultural export good (X); a homogeneous import competing manufacturing good (Y); and two quality-differentiated export goods Z_1 and Z_2, whose qualities are observable and indexed by $Q_m \in [0, \overline{Q}]; m = 1,2$.[11] Good Y uses unskilled labour and a specific type of capital (K_1) – which I label as type-1 capital – while good X is produced using land (T) and unskilled labour (L). Production of Y is organized in the formal sector and production of X in the informal sector of the economy. This assumption is made in parity with what we typically observe in many developing countries. The import-competing manufacturing sectors mostly consist of medium and large enterprises that hire unskilled workers on the basis of formal contracts. On the other hand the agriculture (as well as many low-skill intensive exports like leather and leather manufacture) is largely informal in nature. Of course,

[10] This Section is based on Ganguly and Acharyya (2021a).

[11] Note that observable quality rules out any information externality and associated moral hazard and adverse selection problems.

there are goods produced in the formal sectors which are also exported by the developing countries, and I shall consider such a specification later in this Chapter. The distinction between formal and informal sectors in terms of unskilled-wage formation follows the standard literature (Kar et al. (2019), Marjit (2003), Marjit and Kar (2011)). The unskilled workers in the formal sector are paid a minimum, and fixed, wage, $\overline{w}$, whereas those engaged in the informal sector are paid the competitive market-determined wage (without any floor), *w*. Production technologies for X and Y follow constant returns to scale (CRS), and allow per unit input requirements $(a_{hj}, h = L, K, T; j = X, Y)$ to vary with relevant wage-rental ratios. The small country faces given world prices of all the traded goods, $P_j^W, j = X, Y, Z_{1.}, Z_2$. With exchange rate normalized to unity and an ad valorem tariff at the rate $0 < t < 1$ imposed on imports of Y, perfect competition in all domestic markets gives us the following zero-profit conditions:

$$P_X^W = a_{LX} w + a_{TX} R \tag{2.1}$$

$$P_Y = (1+t) P_Y^W = a_{LY} \overline{w} + a_{KY} r_1 \tag{2.2}$$

where, *R* is the rate of return to land; r_1 is the rate of return to type-1 capital, and w and $\overline{w}$ are as specified above. Least-cost choice of per unit requirement of factor-*h* in producing the homogeneous traded good j depends on the relevant factor price ratio:

$$a_{hX} = a_{hX}(w/R), a_{hY} = a_{hY}(w/r_1), \; (h = L, K \;\; for\ Y\ and\ h = L, T \;\; for\ X) \tag{2.3}$$

The quality-differentiated goods Z_1 and Z_2 require skilled labour (*S*) along with capital, but of two different types. The export-good Z_1 can be thought of as a quality-differentiated manufacturing good, such as data processing equipment, and thus is assumed to use the same type-1 capital that the import-competing good Y uses for its production. On the other hand, production of the export-good Z_2, which can be thought of software or Information-technology enabled service (ITeS) exports, requires an altogether different type of capital – which I call type-2 capital (K_2). These two skilled-labour based quality-differentiated export goods and services are produced usually in structured and organized set ups, where workplace norms and regulations are strictly enforced, with a few exceptions of self-employed skilled workers offering ITeS or consultancy services. I assume that per unit requirement of *S* and K_i (*i* =1,2) are fixed *for any given* Q_m, *m* = 1, 2, but increases at an increasing rate with quality upgrading that reflect diminishing returns to each factor:

$$a_{iZ}^{m} = a_{iZ}^{m}(Q_m), a_{iZ}^{m\prime}(Q_m) > 0, a_{iZ}^{m\prime\prime}(Q_m) > 0,\ i = K_1, K_2, S\ and\ m = 1,2 \qquad (2.4)$$

The relative skill intensity of higher quality varieties of export-good Z_m , m = 1,2, defined as, $s_Z^m = a_{SZ}^m(Q)/a_{KZ}^m(Q)$, is increasing or decreasing with quality upgrading according to the technological requirements. In particular, if quality upgrading of Z_m requires relatively more capital than skilled labour per unit, then s_Z^m is decreasing in higher qualities. Algebraically, for such an export-good, $\hat{s}_Z^m = \left(\gamma_{SZ}^m - \gamma_{KZ}^m\right)\hat{Q}_m < 0$, where $\gamma_{iZ}^m = \dfrac{\partial a_{iZ}^m}{\partial Q}\dfrac{Q}{a_{iZ}^m} > 0, i = K, S; m = 1,2$, denote the quality-elasticity of per unit requirements of input i in production of Z_m and hat over a variable denotes its proportional change, e.g., $\hat{s}_Z = \dfrac{ds_Z}{s_Z}$. Higher quality of goods like aerospace, scientific instruments, defence equipments, household and office equipments, electrical appliances, agro based products, are relatively more capital intensive. Let Z_1 denote these types of manufacturing goods for which $\gamma_{KZ}^1 > \gamma_{SZ}^1$. On the other hand, Z_2 represents goods and services like software, jewelry, diamond cutting and polishing, ITeS, and financial services, higher qualities of which are relatively more skill intensive, such that $\gamma_{KZ}^2 < \gamma_{SZ}^2$. In rest of the analysis this is the difference in the relative skill requirement to upgrade respective qualities of Z_1 and Z_2 that will be assumed:

$$\gamma_{KZ}^1 > \gamma_{SZ}^1,\ \gamma_{KZ}^2 < \gamma_{SZ}^2 \qquad (2.5)$$

Before proceeding further it may be worthwhile to mention that these production technologies for quality-differentiated export goods are generalizations of production technologies considered in Flam and Helpman (1987), Falvey and Kierzkowski (1987) and Acharyya and Jones (2001). Similar to the Ricardian continuum of goods model a la Dornbusch et al. (1977), Flam and Helpman (1987) considered a continuum of quality-differentiated goods which differ from each other in terms of their per-unit requirements of (homogeneous or same-skill) labour. In Falvey and Kierzkowski (1987), the *single* quality-differentiated good uses both capital and labour. But, a higher quality of the good requires larger units of capital only per unit of output, with the same units of labour as a lower quality of the good. Thus, the capital-labour ratio is fixed for any given quality though increasing in higher quality varieties. Acharyya and Jones (2001) also considered that the higher quality varieties of the export-good is more intensive to capital, but they considered it as a skill-based good in contrast to the other homogeneous traded goods which they assumed to be produced by unskilled (and homogeneous) labour. However, they did not allow intensity of skilled labour to vary across different qualities of the export-good and thus could not explain the possibility of asymmetric quality variations through their theoretical analysis. In contrast to all these theoretical analyses, I consider a technological specification that requires larger units of *both* capital and skilled-labour for quality-upgrading but at different proportions so that the capital to skilled-labour ratio varies across higher qualities. However, this ratio moves in opposite directions for the two types of quality-differentiated goods that I consider here.

The world prices of $Z_{1.}$ *and* Z_2, denoted by P_{Z1}^W and P_{Z2}^W respectively, rises with rise in their quality levels, which reflects foreign buyers' willingness to pay for higher qualities: $P_{Zm}^{W\prime}(Q_m) > 0$, $P_{Zm}^{W\prime\prime}(Q_m) > 0$. This assumption of marginal willingness to pay increasing with the quality level is consistent with the standard (partial equilibrium) literature on quality choice (Mussa and Rosen (1978), Tirole (1984), Shaked and Sutton (1982)). However, following Acharyya and Jones (2001), I assume that all foreign buyers have the same marginal willingness to pay due to their identical tastes (or incomes), which is a simplifying assumption.

So the zero-profit conditions in the two Z sectors can be written as follows:

$$P_{Zm}^W(Q_m) = a_{KZ}^m(Q_m)r_i + a_{SZ}^m(Q_m)w_S\ ,\ m = 1, 2;\ i = 1,2 \tag{2.6}$$

where, r_i (i =1,2) is the rate of return to type-i capital and w_S is the skilled wage.

Profit maximising export quality Q_m^0 of the export good Z_m is given by the following marginal condition:

$$P_{Zm}^{W\prime}(Q_m^0) = a_{KZ}^{m\prime}(Q_m^0)r_i + a_{SZ}^{m\prime}(Q_m^0)w_S\ ,\ m = 1,2\ ;\ i = 1,2 \tag{2.7}$$

Finally, the full employment conditions of the two types of capital, skilled and unskilled labour and land which are ensured by flexibility of rates of return to different types of capital, skilled wage, informal unskilled-wage, and rate of return to land:

$$\tilde{K}_1(Q_1) \equiv \overline{K}_1 - a^1_{KZ}(Q_1)Z_1 = a_{KY}Y \tag{2.8}$$

$$\overline{K}_2 = a^2_{KZ}(Q_2)Z_2 \tag{2.9}$$

$$\overline{S} = \sum_{m=1}^{2} a^m_{SZ}(Q_m)Z_m \tag{2.10}$$

$$\overline{L} = a_{LX}X + a_{LY}Y \tag{2.11}$$

$$\overline{T} = a_{TX}X \tag{2.12}$$

where, X, Y and Z_m (m =1,2) are respectively output levels of the four traded goods; $\tilde{K}_1(Q_1)$ is the availability of type-1 capital for production of Y which is its total stock ($\overline{K}_1$) less what is required in production of Z_1 for any given quality of it; and $\overline{K}_1$, $\overline{S}$, $\overline{L}$ and $\overline{T}$ are the fixe endowments of the type-2 capital, skilled labour, unskilled labour and land respectively.

Above set of fifteen equations in (2.1) – (2.4), (2.6) – (2.12) determines the fifteen variables in our system: w_S , w, R, r_1, r_2, Q_1, Q_2 , X, Y, Z_1, Z_2, and four input coefficients a_{hj}. Note, I assume that those who cannot get employment in the formal sector are absorbed in the informal sector through competitive forces and consequent fall in the informal unskilled wage. This assumption of full absorption of displaced unskilled workers from the formal into the informal sector such that there is zero open unemployment in the economy has been largely motivated by the analyses of Carruth and Oswald (1981), Rauch (1991), Agenor and Montiel (1996), Marjit (2003), Marjit (2000), Marjit and Kar (2011) and Kar et al. (2019).[12]

[12]On the contrary, some researchers observe that all unskilled workers displaced from the formal sectors may not be fully absorbed in informal sectors the short run for various reasons (Douglas and Young (1995), Fields (1990), Rogers and Swinnerton (2004) and Swinnerton (1996)). In such a case, some unemployment may still exist. Here, I assume away such a possibility. Employment changes due to quality variations are examined in a latter Chapter.

Given the formal money wage and the world price of the import good, by the zero-profit condition (2.4), the ad valorem tariff rate determines the rate of return to capital r_1 used in (Y, Z_1) subsystem. This, in turn, determines the skilled wage for any given level of quality Q_1 – and corresponding world price $P_{Z1}^W(Q_1)$ – from the relevant zero-profit condition in (2.5). This skilled wage then determines r_2, the rate of return to capital specific to Z_2, for any level of quality Q_2 from the zero-profit condition for Z_2. On the other hand, for any given skilled wage and rates of return to the two types of capital, producers choose the quality levels of export-goods Z_1 and Z_2 that satisfy the relevant marginal conditions specified in (2.7). Since, by the pair of zero-profit conditions in (2.6), each rate of return to capital and the skilled wage are inversely related[13], so the profit maximizing quality levels are related to the cost of two types of capital in the following way (see appendix):

$$\hat{Q}_m = \frac{P_{Zm}^W}{\delta Q_m^2}\theta_{KZ}^m(\gamma_{KZ}^m - \gamma_{SZ}^m)\hat{r}_i\,,\, m = 1,2\,;\, i = 1,2 \qquad (2.13)$$

where, $\delta_m \equiv \left(P_Z^{W''}(Q_m) - w_S a_{SZ}''(Q_m) - r_i a_{KZ}''(Q_m) \right) < 0$ by the second order condition for profit maximization.

These relationships between the choice of export quality and the rates of return to capital are illustrated in Figure 2.1. The π_{Z1} curve and π_{Z2} curve reflect the relationship between the rate of return to capital and profit-maximizing choice of quality levels of Z_1 and Z_2 respectively. If producers of Z_1 face r_1^0 as the rate of return to type-1 capital for any given parametric configuration, they choose Q_1^0 as the profit-maximizing quality. Similarly, for r_2^0 as the rate of return to type-2 capital, producers of Z_2 choose Q_2^0 as the profit-maximizing quality. Note, by (2.5) and (2.13), whereas the π_{Z1} curve is downward-sloping, the π_{Z2} curve is upward-sloping.

Further note that a policy induced change in r_1 will change the rate of return to the other type of capital, r_2 in the same direction as itself but the skilled wage in the opposite direction. Thus, by (2.2), *at initial quality levels*, change in the relevant factor prices will

[13] By envelope theorem, the skilled wage will be invariant with respect to the quality variation.

asymmetrically affect marginal cost of quality upgrading of Z_1 and Z_2. More precisely, whereas a fall (or rise) in r_1 will raise (lower) quality of Z_1, for which quality upgrading requires more intensive use of capital than skilled labour, it will lower (raise) r_2 and thereby the level of quality of Z_2, since its quality upgrading requires less intensive use of capital than skilled labour.

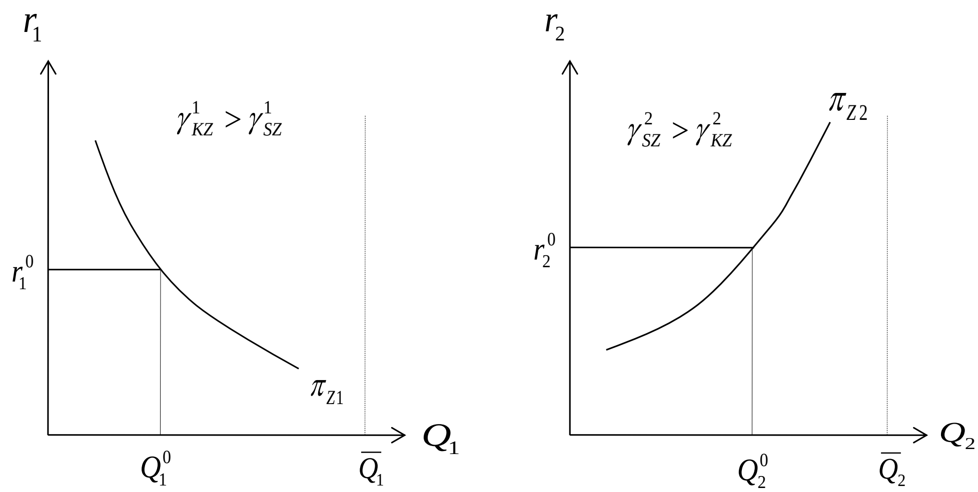

Figure 2.1: Profit-maximizing Choice of Quality

Lemma 2.1: *Quality Q_1 of good Z_1 varies inversely and quality Q_2 of good Z_2 varies positively with the rate of return to type-1 capital used in (Z_1, Y) subsystem.*

Proof: Follows from (2.5) and (2.13), given $\hat{r}_2 = -\dfrac{\theta^2_{SZ}}{\theta^2_{KZ}}\hat{w}_S = \dfrac{\theta^2_{SZ}}{\theta^2_{KZ}}\dfrac{\theta^1_{KZ}}{\theta^1_{SZ}}\hat{r}_1$. □

Thus, once a tariff rate determines the rate of return to type-1 capital (r_1) that is used in Y and Z_1, it correspondingly determines the profit maximizing quality levels of the two quality differentiated export goods. Though these quality choices are independent of the output levels and the informal wage, they will however, have a feedback effect on the informal wage by changing the availability of capital for production of the import-competing good Y (see (2.6)). This is because unlike the skilled wage and the rates of return to two types of capital, the informal wage and the return to the land specific to the informal sector cannot be determined independent of the resources available for production of goods X and Y. This follows from the specific factor structure of the (X, Y) subsystem. Thus, variations in quality of Z_1 and Z_2 affect the informal unskilled wage – and correspondingly the rate of return to land – through reallocation of type-1 capital across Z_1 and Y sectors, and consequently through reallocation of unskilled workers across formal and informal sectors.

Now, consider a ceteris paribus reduction in the tariff rate. With fixed formal wage this lowers the rate of return to type 1 capital:

$$\hat{r}_1 = \frac{1}{\theta_{KY}} \beta \hat{t} \qquad (2.14)$$

where, $\beta = \frac{t}{1+t}$, and θ_{KY} is the share of capital in unit cost of production of good Y.

Increased foreign competition as a consequence of tariff reduction forces the import-competing industry to contract, which lowers the demand for both unskilled labour and capital. With the unskilled money wage being fixed in this formal sector, the entire burden of adjustments fall on (type-1) capital and through a fall in its rate of return the domestic producers of Y break-even again at the lower tariff-inclusive domestic price.

Hence, I can write the following Proposition:

Proposition 2.1: *A reduction of tariff on import of good Y asymmetrically changes qualities of the export goods Z_1 and Z_2. More precisely, $\hat{Q}_1 > 0$ and $\hat{Q}_2 < 0$.*

Proof: Follows from (2.14) and Lemma 2.1.

As a reduction of tariff lowers the capital cost of producing Z_1 at its initial equilibrium quality, producers of Z_1 expand their production. At the initial equilibrium quality and production level of the other export-good Z_2, the demand for skilled workers and their wage thus rise. Consequent upon this fall in r_1 and rise in w_S, the marginal cost of quality falls since $\gamma^1_{KZ} > \gamma^1_{SZ}$. This induces producers of Z_1 good to upgrade the level of quality. On the other hand, at the initial Q_2, rise in the skilled wage lowers the production of Z_2, which in turn lowers the rate of return to type-2 capital specific to this sector. But, since $\gamma^2_{KZ} < \gamma^2_{SZ}$, the marginal cost of quality rises and producers respond by lowering the quality Q_2. Thus, tariff reduction on the final import competing good offers a plausible explanation of asymmetric quality variations across different product groups in terms of the differences in relative skill-intensity of their higher quality varieties.

Now, turning to the effect on wage inequality, firstly note that both the skilled and unskilled informal wage changes even at the initial quality levels. While the skilled wage rises, the informal unskilled wage declines on two counts. First, unskilled workers displaced from the formal sector due to tariff-reduction induced contraction of scale of production there move into the informal sector, which causes the marginal productivity of labour to diminish given the fixed amount of land to work with. The unskilled wage in the informal sector thus declines on this account. Second, a substitution of unskilled workers by capital per unit production of Y in face of lower r_1 (and fixed formal wage), which further reinforces the displacement of unskilled workers and decline in the informal unskilled wage. So at the initial quality levels, tariff reduction unambiguously lowers the informal unskilled wage through informalization.[14] Wage inequality thus worsens in all the three dimensions: between skilled workers and formal unskilled workers, which is captured through the rise in skilled wage; between skilled and informal unskilled workers, captured through $\hat{w}_S > 0 > \hat{w}$; and, among the unskilled workers themselves, that is, between formal and informal unskilled workers, which is captured through the decline in the informal wage along with the increase in the share of the informal sector in total employment of unskilled workers. In addition to these initial changes, tariff-reduction induced quality variations affect these dimensions of wage inequality further by changing the informal unskilled wage through reallocation of type-1 capital across Z_1 and Y sectors. Variations in quality levels change the requirement and overall usage of type-1 capital in the Z_1 sector to the following extent:

$$\hat{K}_Z^1 = (\gamma_{KZ}^1 - \gamma_{SZ}^1)\hat{Q}_1 - \frac{\lambda_{SZ}^2}{\lambda_{SZ}^1}(\gamma_{SZ}^2 - \gamma_{KZ}^2)\hat{Q}_2 \qquad (2.15)$$

where, λ_{SZ}^m, m =1,2, is the share of sector Z_m in total employment of skilled workers.

[14] Following Marjit (2003), by informalization I mean a contraction of the formal sector and corresponding expansion of the informal sector of the economy. This is akin to a larger share of the informal sector in aggregate value of output and aggregate level of employment.

The intuition is simple. A change in quality of good Z_1 changes the capital requirement in this sector and therefore its availability for the formal import-competing sector in two ways. Quality upgrading raises capital requirement per unit of output of Z_1 by the extent $\hat{a}^1_{KZ} = \gamma^1_{KZ}\hat{Q}_1$. In addition to this *technique* effect, capital requirement in Z_1 changes on account of a change in its scale of production in two ways. First, at the initial quality and production levels of good Z_2, larger requirement of skilled labour to upgrade quality of Z_1 would necessitate a fall in its production by $\gamma^1_{SZ}\hat{Q}$ at the margin. Demand for capital falls on this account, but by a magnitude that is smaller than that of the increase in capital demand due to quality upgrading (or the technique effect mentioned above) based on the assumption made in (2.5). This is captured by the first term in the parenthesis on the right-hand-side in (2.15). Second, downgrading of quality of the export good Z_2 releases some skilled labour which will cause production of Z_1 to increase. At the same time, since the demand for type-2 capital falls as well, and it is specific to this sector, consequently, the production of Z_2 must rise (through a fall in r_2) to accommodate the excess amount of K_2. This scale expansion in turn will raise the demand for skilled labour in this sector. But, this increase in demand for skilled labour in Z_2 sector will be smaller in magnitude than the fall in its demand due to quality downgrading by (2.5). That is, total skill requirement in Z_2 will indeed fall, causing production of Z_1 to increase further. Thus the demand for type-1 capital in the Z_1 sector rises further as well, which is captured by the second term in the parenthesis on the right-hand-side in (2.15). This result is summarized in the following Lemma:

Lemma 2.2: *Tariff reduction induced quality variations lead to a larger capital requirement for production of the quality differentiated export good Z_1 and correspondingly smaller availability of capital for the formal import competing sector.*

Proof: Follows from Proposition 2.1 and (2.15).

Thus, by Lemma 2.2, production of Y in the formal sector contracts due to quality variations. Some unskilled workers employed there are laid off, who move to the informal sector. Competition in the informal labour market pushes down the informal wage *further*. Algebraically, the overall fall in the informal wage is given as:

$$\hat{w} = \frac{1}{\bar{\lambda}} \frac{\lambda_{KY}\sigma_Y}{\theta_{KY}} \beta\hat{t} - \frac{\lambda_{KZ}^1}{\bar{\lambda}} \left[(\gamma_{KZ}^1 - \gamma_{SZ}^1)\hat{Q}_1 - \frac{\lambda_{SZ}^2}{\lambda_{SZ}^1} (\gamma_{SZ}^2 - \gamma_{KZ}^2)\hat{Q}_2 \right] \qquad (2.16)$$

where, $\bar{\lambda} = \lambda_{KY}\sigma_Y + \lambda_{KY} \frac{\lambda_{LX}}{\lambda_{LY}} \frac{\sigma_X}{\theta_{KX}} > 0$.

The first term on the right-hand-side of the expression in (2.16) is the initial effect of tariff reduction, whereas the second term captures the induced effect through quality variations of Z_1 and Z_2. Thus, wage inequality between skilled and informal unskilled workers, as well as between formal and informal unskilled workers, worsens even more. Therefore,

Proposition 2.2: *Quality variations of skill-based export goods induced by reduction of tariff on the imported final good Y accentuate wage inequality through informalization and consequent decline in the informal unskilled wage.*

Proof: Follows from Lemma 2.2 and (2.16). □

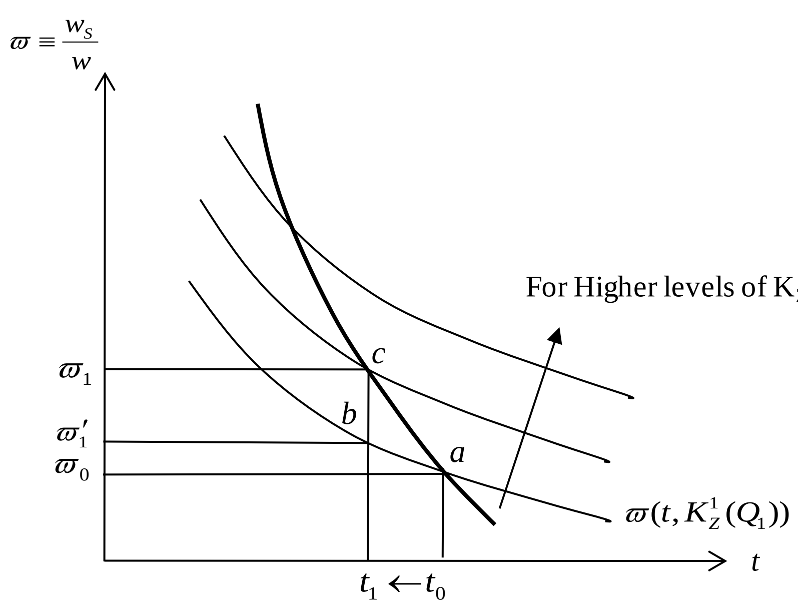

Figure 2.2: Overall effect of tariff reduction on skilled–unskilled wage ratio

Proposition 2.2 implies that when we account for quality variations of skill-based exports, the wage inequality worsens by a larger extent than when such quality variations are not accounted for. And this is regardless of the fact that quality variations are asymmetric across the two categories of quality-differentiated export goods. This brings out the relevance of accounting for quality variations induced by export promotion strategies like tariff reduction, in measuring the magnitude of changes in wage inequality. Figure 2.2 above illustrates this. The downward-sloping $\overline{\omega}$-curves capture the inverse relationship between the skilled-unskilled wage ratio and the tariff rate for any given $K_Z^1(Q_1)$ that corresponds to a given pair of (Q_1, Q_2). As explained above, a rise in the amount of capital used in Z_1 will lower the unskilled informal wage and raise the wage inequality. That is, a higher $\overline{\omega}$-curve will correspond to a larger $K_Z^1(Q_1)$ *for any given tariff rate*. When tariff is lowered from t_0 to t_1, the wage inequality accentuates at initial quality levels, from $\overline{\omega}_0$ to $\overline{\omega}_1'$ (corresponding to movement from point *a* to point *b*) along the initial $\overline{\omega}$ curve. But lower tariff raises Q_1 and lowers Q_2, which by Lemma 2.2 uses up more type-1 capital and thus raises $\overline{\omega}$ further to $\overline{\omega}_1$ (corresponding to movement from point *b* to point *c* on a higher $\overline{\omega}$ curve). So taking into account quality variations induced by a tariff reduction, the total change in wage inequality should be measured by the movement from *a* to *c* along the steeper bold curve. Thus, the effect of a tariff reduction on wage inequality would be an underestimation when induced quality variations are not accounted for.

2.3 Policy implications: Targeted subsidies as concurrent policies

The discussions in the above Section and the results summarised in Proposition 2.1 implies that tariff reduction is not an effective (indirect) export-promotion strategy for *all* types of quality-differentiated export goods. A reduction of tariff on the imported final good will cause downgrading of the quality of the export-good whose higher qualities are relatively more skill intensive than capital. An increase in the tariff rate would not help either, since it would again lead to asymmetric quality variations across different products but now in just the opposite way: quality of Z_1 would be downgraded and that of Z_2 would be upgraded. Moreover, tariff reductions being part of trade reforms that are committed to by the developing countries who have been given accession to the WTO, or are in the process of gaining such accession, reversals in policies are often no longer a feasible option. In such a context, concurrent policies in tandem with tariff reductions may be a more appropriate option for the policymakers in the developing countries to mitigate its adverse quality effects for export goods like Z_2. Sector-specific and targeted subsidies can be such concurrent policies. Two types of subsidies are relevant here: one is a production subsidy given to the producers of Z_2 linked to their choices of quality levels, which I call a quality-content production subsidy;[15] and, second, input-subsidies provided to the producers of Z_2 to mitigate the increase in the marginal cost of quality as a consequence of tariff reductions.

2.3.1 Quality-content production subsidy

Suppose the producers of the export-good Z_2 are given a production subsidy per unit, the rate of which increases with Q_2. This will raise the *effective* marginal revenue for quality and incentivize quality upgrading. But, the marginal cost of quality will rise as well. Quality upgrading induced by a production subsidy will raise the demand for both skilled workers and capital. Skilled labour can be drawn from the other export sector Z_1 at the given skilled wage (which is now tied to the tariff-inclusive domestic price of the import good Y through r_1). But higher demand for type-2 capital specific to this sector will raise its rate of return, at the post tariff-reduction lower level of quality of good Z_2 and its corresponding production level. This will disincentivise its quality upgrading. Thus, a quality-content production subsidy upgrading export quality is not a foregone conclusion, though it is quite plausible. To formalise, let me consider, for example, a unit subsidy $\psi(Q_2)$, that increases with quality upgrading at an increasing rate, such as,

$$\psi(Q_2) = \frac{1}{2} b Q_2^2 \quad \forall Q_2 \in [0,1] \tag{2.17}$$

It can be easily verified from the zero-profit and marginal conditions,

$$P_{Z1}^{W}(Q_2) = a_{KZ}^{2}(Q_2) r_2 + a_{SZ}^{2}(Q_2) w_S - \frac{1}{2} b Q_2^2 \tag{2.18}$$

$$P_{Z2}^{W'}(\tilde{Q}_2) + b\tilde{Q}_2 = a_{KZ}^{2\,\prime}(\tilde{Q}_2) r_2 + a_{SZ}^{2\,\prime}(\tilde{Q}_2) w_S \tag{2.19}$$

---

[15] In India, after the change in policy focus from inward-looking development strategy to outward-oriented development strategy in 1990s, the small exporting units were provided subsidies to obtain ISO 9000 series certificates – a certification for quality standards at par with minimum international standards – under the policy programme ASIDE.

that, given the (lower) tariff rate, the quality of Z_2 changes following an increase in the rate of subsidy (b) to the extent of:

$$\hat{Q}_2 = \frac{b}{2\delta}(\gamma_{KZ}^2 - 2)\hat{b} \qquad (2.20)$$

A one percent increase in the rate of subsidy raises the effective marginal revenue from quality upgrading by one percent. On the other hand, since one percent increase in the rate of return to type-2 capital r_2 raises the marginal cost by $\theta_{KZ}^2 \gamma_{KZ}^2$, so a one percent rise in the rate of production subsidy raises the marginal cost of quality upgrading by $\frac{\gamma_{KZ}^2}{2}$ percent by the quadratic form of the subsidy function. Thus, if $\gamma_{KZ}^2 < 2$, the marginal revenue from quality upgrading is larger than the marginal cost following a one percent increase in the rate of per unit production subsidy. And this will incentivise the producers to raise quality.

Following Lemma summarizes this result:

Lemma 2.3: *An increase in the rate of quality-content production subsidy will raise quality of good Z_2 if $\gamma_{KZ}^2 < 2$.*

Proof: Follows from (2.20) given $\delta < 0$. □

Interestingly, while the quality-content production subsidy may mitigate the adverse effect of a tariff reduction on Q_2, it can also *lower* wage inequality. Quality upgrading under the condition stated in Lemma 2.3 would lower the production of Z_2 due to scarcity and specificity of type-2 capital. So, while the demand for skilled labor increases due to quality upgrading, the same decreases due to fall in the output of Z_2. But overall, by (2.5), total skill requirement would be larger. Since production subsidy dores not change r_1 and correspondingly w_S , the quality of Z_1 remains the same. So, larger demand for skilled labour in Z_2 necessitates a fall in output of Z_1 to release some skilled labour for realization of upgrading of quality of Z_2. Some type-1 capital would also be released from the production of Z_1, which would now enable the formal import-competing sector to expand its production. This will draw some unskilled workers from the informal sector, and thereby raise the informal wage. Thus, wage inequality between skilled and informal unskilled workers, and between formal and informal workers (or, among the unskilled workers themselves) would decline.

2.3.2 Input Subsidies

Subsidies targeted at the inputs used for production of Z_2 are an alternative to this quality-content production subsidy. Two such relevant input-subsidies are subsidy for capital cost and subsidy for skilled-labour cost. These input-subsidy policies will be effective in mitigating the adverse effect of a committed tariff cut only if they can lower the marginal cost of quality. As higher qualities of Z_2 is relatively skill intensive and the relevant factor prices (skilled wage and the rate of return to capital) vary inversely, it seems that subsidizing the skilled-labour cost is a better option rather than subsidizing the capital cost. To explain further, suppose producers of Z_2 are offered an ad valorem subsidy at the rate s by the government for every unit of skilled wages they pay. Thus, the effective skilled wage that the producers of Z_2 has to pay to each skilled workers is $\tilde{w}_S = (1-s)w_S$. This means that the marginal cost of quality is now lower. As the skilled wage that is received by the skilled workers is tied down by the tariff rate, the producers of Z_2 are encouraged to expand the scale of production because of this wage subsidy. This raises the demand for K_2-type of capital that is specific to this sector and hence raises its rate of return to the following extent:

$$\hat{\tilde{w}}_S = -\phi\hat{s} < 0 \qquad (2.21)$$

$$\hat{r}_2 = -\frac{\theta_{SZ}^2}{\theta_{KZ}^2}\hat{\tilde{w}}_S = \frac{\theta_{SZ}^2}{\theta_{KZ}^2}\phi\hat{s} > 0 \qquad (2.22)$$

where, $\phi \equiv \frac{s}{1-s}$.

Thus, the marginal cost of quality upgrading rises on this account. Overall, however, the marginal cost declines since higher qualities of Z_2 are relatively more skill intensive. Thus, the skilled-wage subsidy is an effective targeted policy that will mitigate the adverse effect of the pre-committed tariff reduction by incentivizing the producers to upgrade the quality of Z_2 unconditionally. Algebraically,

$$\hat{Q}_2 = \frac{P_{Z2}^W}{\delta_2 Q_2^{\ 2}} \theta_{SZ}^2 \left(\gamma_{KZ}^2 - \gamma_{SZ}^2\right)\phi\hat{s} \tag{2.23}$$

Hence, by (2.5), $\hat{Q}_2 > 0$ for $\hat{s} > 0$.

Implications of this wage-cost subsidy in lowering wage inequality by raising the informal wage through expansion of the formal import competing sector is similar to that of the quality-content production subsidy.

In case of the subsidy to producers of Z_2 for the capital input, it will have no impact on their quality choice. An ad valorem subsidy for per unit capital cost raises the rate of return to K_2-type of capital just as in case of a wage subsidy. The rise is however now *proportionate to the rate of subsidy* since w_S remains unchanged. Hence, the effective capital cost per unit does not change at the initial level of quality:

$$\hat{r}_2 = \phi\hat{s} \Rightarrow \hat{\tilde{r}}_2 = 0 \Rightarrow \hat{Q}_2 = 0 \tag{2.24}$$

The capital-input subsidy thus cannot mitigate the adverse effect of the tariff reduction on the quality of Z_2. Assuming flexible coefficient production technology would have made no difference as with no change in the effective wage-rental ratio, the producers of Z_2 would have no incentive to substitute skilled labour by K_2-type capital for quality upgrading. [16]

2.3.3 Financing of the Subsidy

Subsidies have a related concern of how to finance them. Usually, taxes are imposed either on domestic agents or goods, or on imported goods, by the government under balanced budget financing of subsidies. But, this tax-policy itself may have some adverse effects on the choice of export qualities. Hence, a tax policy to finance the subsidies should be such as to be *quality- neutral*. In the present context, a proportional tax on skilled workers and capital owners can be such a desired way to finance the production

[16] Flexible coefficient production technology, however, leads to an interesting possibility as discussed in Ganguly and Acharyya (2021). Capital input subsidy given to the producers of Z_1 (the good that had been favourably affected by the tariff cut) now *may* work in favour of Z_2. I do not elaborate upon such a possibility here.

subsidy. Precisely, if the same proportional tax at the rate $0 < T < 1$ is applied, then under balanced budget:

$$T\left[w_S S + r_2 K_2 + r_1 K_1\right] = \frac{1}{2} b Q_2^2 Z_2 \quad (2.25)$$

Note that the tax rate is quality neutral in the sense that it only acts as an instrument to finance the subsidy under the assumption of a balanced budget. It does not have any direct impact on the quality choice as the factor prices are invariant with respect to the factor-income tax. That a higher rate of tax enables the government to increase the rate of subsidy and thereby incentivize quality is what matters.

If the government would have also taxed land-owners, then income tax-financed production subsidy would have caused the government to lower the subsidy rate due to fall in income of landowners (corresponding to the higher informal wage due to subsidy-induced quality upgrading) and thus revenue of the government. That is, for any given Q_2 and the tax rate τ , in case of land-owners also being taxed, the balanced budget constraint would have been:

$$T\left[w_S S + r_2 K_2 + r_1 K_1 + RT\right] = \frac{1}{2} b Q_2^2 Z_2 \quad (2.26)$$

such that the change in *b* would equal:

$$\hat{b} = \hat{T} + y\left[\theta_S \hat{w}_S + \theta_K^2 \hat{r}_2 + \theta_K^1 \hat{r}_1 + \theta_T \hat{R}\right] - (2 - \gamma_{KZ}^2)\hat{Q}_2 \quad (2.27)$$

where y is the reciprocal of proportion of non-unskilled labour income (or taxable income) in aggregate factor income.

Thus, if the rental rate to land falls, it will dampen the initial quality upgrading effect of production subsidy to some extent, for any given τ . This dampening effect of the income tax can be avoided by not taxing land-owners, as specified in the balanced budget constraint in (2.25).

Input subsidies can be similarly financed through selective income taxes. By analogous reasoning, for the skilled-wage subsidy, it would be reasonable to tax the skilled workers and type 1 capital owners.

2.4 Robustness: Homogeneous and Mobile capital

To check how far the results derived above depend upon the production structure for the homogeneous traded goods, suppose, instead of sector-specific factors of production – land to produce the export good and (type 1) capital to produce the import competing good – the same (type 1) capital is used to produce both these goods (along with in the production of the export-good Z_1). Moreover, this (type 1) capital is fully mobile across the formal and informal sectors producing these two homogeneous goods.[17] The zero profit conditions for goods X and Y and the full employment condition for type-1 capital, with the land constraint now dropping out, are thus rewritten as:

$$P_X^W = a_{LX} w + a_{KX} r \tag{2.28}$$

$$P_Y = (1+t) P_Y^W = a_{LY} \overline{w} + a_{KY} r \tag{2.29}$$

$$\overline{K}_1 - a_{KZ}^1 (Q_1) Z_1 = \widetilde{K}_1 (Q_1) = a_{KX} X + a_{KY} Y \tag{2.30}$$

The (X, Y) sub-system of the economy now displays HOS production structure, so that w and r_1 are now determined solely by world prices of X and Y, and thus are *independent of the endowment changes and availability of* (type 1) *capital and unskilled labour due to quality variations*.

Effects of tariff reduction on export-qualities remain the same, however. Tariff reduction once again lowers the rate of return to type-1 capital unambiguously and correspondingly raises the skilled wage and lowers the rate of return to type-2 capital. Thus, as in case of sector-specific factors of production in the formal and informal sectors, a reduction of tariff on the import of good Y improves the quality of export-good Z_1 and degrades the quality of export-good Z_2 under the assumption in (2.5). But, tariff reduction now unambiguously *raises* the informal wage. This is evident from the zero-profit conditions for X and Y. This difference in result is similar to the one derived in Marjit (2003). When

[17] Use of land as a specific-factor to produce the export-good X could be interpreted as either another type of capital, or the same type-1 capital which was immobile across the forms and informal sectors in the benchmark model. All the results derived in Section 2.3.1 hold regardless of how this specific factor in production of X is interpreted. That is why to check the robustness I assume not only the use of same type-1 capital of production but also mobility of it across the forma Y-sector and inform X-sector.

the informal sector uses land (or another type of capital) as a specific-factor, or the same capital as the formal sector but which is immobile across these sectors, workers who are displaced from the contracting import-competing Y-sector and move into the informal X-sector depress the marginal productivity there and accordingly cause the informal unskilled wage to fall as worked out in Section 2.3.1. But, in this case, as the capital released from the Y-sector can also move to the informal sector – at the initial level of quality of the export-good Z_1 and accordingly at the corresponding initial demand for the same type-1 capital there – so larger workers in the informal sectors can work with a larger availability of capital which raises their marginal productivities and hence raises the informal unskilled wage.

With the skilled wage rising as well, now the wage inequality may or may not rise. It is straightforward to work out the following:

$$\hat{w}_S - \hat{w} = \frac{1}{\theta_{KY}}\left[\frac{\theta_{KX}}{\theta_{LX}} - \frac{\theta^1_{KZ}}{\theta^1_{SZ}}\right]\beta\hat{t} \tag{2.31}$$

Hence, the wage inequality worsens under homogeneous and mobile capital if:

$$\frac{\theta_{KX}}{\theta_{LX}} < \frac{\theta^1_{KZ}}{\theta^1_{SZ}} \tag{2.32}$$

Validity of this condition, however, depends on the initial level of export quality, Q_1^e, because by the technology conditions defined earlier in (2.5) that quality upgrading of Z_1 requires relatively more capital than skilled labour, $\frac{\theta^1_{KZ}}{\theta^1_{SZ}}$ is larger for a higher initial quality level. More precise statement is made in Lemma 2.4 below:

Lemma 2.4: *Define* $\mu(Q_1) \equiv \frac{\theta^1_{KZ}(Q_1)}{\theta^1_{SZ}(Q_1)}$. *Then,* $\mu'(Q_1) > 0 \; \forall \, Q_1 \in [0, \overline{Q}_1]$ *since* $\gamma^1_{KZ} > \gamma^1_{SZ}$ *by the assumption* (2.5).

Proof: See appendix. □

Thus, I can write the following Proposition:

Proposition 2.3: *When capital is homogeneous and mobile, tariff reduction widens wage inequality between skilled and informal unskilled workers, (a) regardless of the initial equilibrium level of* Q_1 *if* $\frac{\theta_{KX}}{\theta_{LX}} < \mu(0)$; *(b)* $\forall Q_1^e > \tilde{Q}_1$ *if* $\mu(0) < \frac{\theta_{KX}}{\theta_{LX}} < \mu(\overline{Q}_1)$, *where* $\mu(\tilde{Q}_1) = \frac{\theta_{KX}}{\theta_{LX}}$.

Proof: See appendix.□

Figure 2.3 illustrates the alternative cases stated in Proposition 2.3.

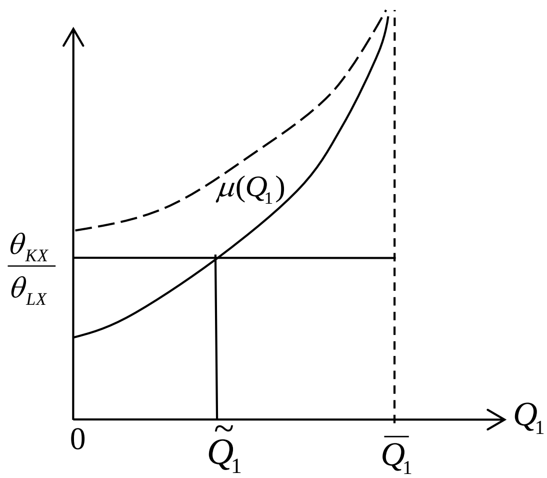

Figure 2.3: Initial Choice of Quality and Wage Inequality

Let us now turn to informalization. Since now the same capital is used in both X and Y and capital is mobile, so *both* formal and informal sectors adopt more capital intensive techniques as tariff reduction lowers the rate of return to capital. This, at initial level of export-quality, appears in essence as a fall in the supply of capital so that similar to the output magnification effect a la Jones (1965), informal sector will expand if it is labour intensive relative to the formal sector, which is more likely. In addition, by Lemma 2.2, quality variation induced by tariff reduction will lead to further informalization under the same factor intensity condition. Displacement of unskilled labour from formal sector due to technique effect will thus be reinforced by these scale effects causing accentuation of wage inequality among unskilled workers employed in formal and informal sectors *despite a rise in the informal wage*. This result is summarized in the following Proposition:

Proposition 2.4: *When capital is homogeneous and mobile across formal and informal sectors, tariff reduction induced quality variation causes further informalization if the informal production of export good X is labour intensive relative to the formal sector production of the import-competing good Y.*

Proof: Follows from the above discussion.

Note that in this case wage inequality *among* unskilled workers is ambiguous. As the informal wage now rises, those who were employed in the informal sector before the tariff reduction gains relative to the formal unskilled workers, both still employed there and those displaced there from. But those workers who are now displaced from the formal sector and move to the informal sector are now worse off as they now earn lower wage than the formal wage that they were earning before the tariff reduction.

Before proceeding further, it may be noted that if there had been no minimum wage in the import-competing sector, and unskilled wage had been market-determined everywhere, changes in export-quality would still have not affected the unskilled wage due to one-to-one correspondence between prices of the traded goods and the four factor prices. But, now the tariff reduction would increase the unskilled wage only if the import-competing good Y is capital-intensive relative to the homogeneous export-good X. The same condition, as for the segmented-laboir-market case, would also underlie larger informalization caused by tariff reduction.

2.5 Sector-specific Imported Inputs and Input-Tariff Reductions

In the spirit of the existing literature emphasizing imported inputs as essential requirement for quality-upgrading (Bas and Strauss-Khan (2013), Hu, Parsely and Tan (2017), Fan and Li (2013), Kugler and Verhoogen (2012)), and the joint role of imported inputs and skilled labour observed by Bas and Pavnov (2021), I consider in this section two specific imported inputs used in production of the two quality-differentiated goods, denoted by f_1 and f_2, in the above production structure with homogeneous and mobile (type 1) capital across Z_1, X and Y sectors. Purpose of this exercise is to examine whether input-tariff reductions can explain asymmetric quality variations.

Let the per unit requirement of the imported input f_m, denoted by $a_{fZ}^{m}, m = 1, 2,$ increases with the higher quality of the export-good Z_m, like the per unit requirements of skilled labour and type-*m* capital. The country under consideration being small, faces exogenously given world prices of the two imported inputs, which are normalized to unity. Imports of these inputs are, however, subject to ad-valorem tariff rates denoted by τ_m, m = 1, 2. Accordingly, I rewrite the zero-profit and marginal conditions for the two quality-differentiated export goods as:

$$P_{Zm}^{W}(Q_m) = a_{KZ}^{m}(Q_m)r_i + a_{SZ}^{m}(Q_m)w_S + (1+\tau_m)a_{fZ}^{m}(Q_m),\ m = 1,2;\ i = 1,2 \qquad (2.33)$$

$$P_{Zm}^{W\prime}(Q_m^0) = a_{KZ}^{m\prime}(Q_m^0)r_i + a_{SZ}^{m\prime}(Q_m^0)w_S + (1+\tau_m)a_{fZ}^{m\prime}(Q_m) \qquad (2.34)$$

As shown in the appendix, the quality changes due to reduction in the two tariff rates (with the rate of tariff t on import of good Y kept unchanged) are given as:

$$\hat{Q}_1 = \frac{P_{Z1}^{W}\theta_{fZ}^{1}}{\delta_1 Q_1^2}(\gamma_{fZ}^{1} - \gamma_{SZ}^{1})\rho_1\hat{\tau}_1 \qquad (2.35)$$

$$\hat{Q}_2 = \frac{P_{Z2}^{W}}{\delta_2 Q_2^2}\left[-\theta_{SZ}^{2}(\gamma_{SZ}^{2} - \gamma_{KZ}^{2})\frac{\theta_{fZ}^{1}}{\theta_{SZ}^{1}}\rho_1\hat{\tau}_1 + \theta_{fZ}^{2}(\gamma_{fZ}^{2} - \gamma_{KZ}^{2})\rho_2\hat{\tau}_2\right] \qquad (2.36)$$

where, $\rho_m \equiv \frac{\tau_m}{1+\tau_m}$, m = 1, 2.

Since the tariff on final imported good Y is not changed in this exercise, so the rate of return to type-1 capital, r_1, remains unchanged. Thus, lower τ_1 raises only the skilled wage: Lower imported input-cost incentivizes expansion of production of Z_1, which raises the demand for skilled labour and its wage. Accordingly, intensity of imported input f_1 relative to skilled labour for higher quality of Z_1 now matters. In particular, a ceteris paribus reduction of input-tariff τ_1 raises the quality of Z_1 if higher quality varieties are relatively imported-input intensive, $\gamma_{fZ}^{1} > \gamma_{SZ}^{1}$. The reduction of τ_1 also matters for Q_2 because by raising the skilled wage it lowers r_2. But, now the capital-intensity relative to skill-intensity of higher quality varieties of Z_2 matters, and since $\gamma_{KZ}^2 < \gamma_{SZ}^2$ by the assumption (2.5), so a ceteris paribus reduction of input-tariff τ_1 lowers the quality of Z_2. Thus, input tariff reduction in this instance can generate asymmetric quality variations provided of course domestic factors like skilled labour and capital are also relevant for quality-upgrading.

A ceteris paribus reduction of τ_2, on the other hand, raises r_2 but does not affect the skilled wage since both r_1 and τ_1 remain unchanged. Thus, quality of Z_2 improves if higher quality varieties are imported-input intensive relative to capital, $\gamma_{fZ}^2 > \gamma_{KZ}^2$. But the reduction of τ_2 does not affect Q_1, since, fall in r_2 is inconsequential for the choice of Q_1.

Thus, I can write:

Proposition 2.5: *(a) A ceteris paribus reduction of input-tariff τ_1 raises the quality of Z_1 if higher quality varieties are relatively imported-input intensive, $\gamma_{fZ}^1 > \gamma_{SZ}^1$; and lowers the quality of Z_2 since $\gamma_{KZ}^2 < \gamma_{SZ}^2$ by the assumption (2.5).*
(b) A ceteris paribus reduction of τ_2 does not affect the quality of Z_1; and raises the quality of Z_2 if its higher quality varieties are imported-input intensive relative to capital, $\gamma_{fZ}^2 > \gamma_{KZ}^2$.

Proof: Follows from (2.35), (2.36) and (2.5).□

Before proceeding further, it may be noted that the quality changes due to input-tariff reductions would have been the same as above even if I had incorporated imported inputs in the benchmark model with sector-specific land and (type-1) capital in the production of X and Y.

Regarding wages, as mentioned above, while reduction of τ_1 raises the skilled wage, reduction of τ_2 leaves it unchanged. The magnitude of increase in the skilled wage is given by (see appendix):

$$\hat{w}_S = -\frac{\theta^1_{fZ}}{\theta^1_{SZ}}\rho_1\hat{\tau}_1 \qquad (2.37)$$

The informal unskilled wage, on the other hand, is not affected by the input tariff reductions. Note that the property of wages being invariant to the quality changes still holds. Thus, though tariff reductions affect the quality choice, consequent quality variations do not affect the wages. Hence, the wage inequality between skilled and unskilled workers unambiguously worsens for reduction of τ_1, but remains the same for reduction of τ_2.

But, quality changes re-allocate unskilled workers across formal and informal sectors and thus change the wage-inequality among the unskilled workers themselves. The direction of re-allocation depends on the type-1 capital requirement in quality-differentiated Z_1 sector. Recall from (2.15) that $\hat{K}^1_Z = \left[(\gamma^1_{KZ} - \lambda^1_{SZ})\hat{Q}_1 - \frac{\lambda^2_{SZ}}{\lambda^1_{SZ}}(\gamma^2_{SZ} - \lambda^2_{KZ})\hat{Q}_2\right]$. Suppose, $\gamma^1_{fZ} > \gamma^1_{SZ}$. Thus, Q_1 rises for a reduction in τ_1. So under the earlier assumption that $\gamma^1_{KZ} > \lambda^1_{SZ}$, the first term in the parenthesis on the right-hand side is positive. On the other hand, under the earlier assumption that $\gamma^2_{KZ} < \lambda^2_{SZ}$, a reduction in τ_1 lowers Q_2, so that the second term is negative. Thus, a reduction in τ_1 raises demand for type-1 capital in Z_1-sector, and correspondingly lowers the availability of the same for production of X and Y. Through the output-magnification effect, the production of Y in the formal sector contracts and that of X in the informal sector expands as long as Y is relatively capital intensive sector. Thus, just as the case of reduction of *t* on import of Y, a reduction in τ_1 leads to an infomalization of the economy through quality variations and thus worsens the wage-inequality among the unskilled workers. But, if $\gamma^1_{fZ} < \gamma^1_{SZ}$, then the wage inequality among the unskilled workers may worsen or decline depending on the parametric configurations.

By similar reason, a reduction in τ_2 causes an expansion of the formal sector – contrary to the above results – and thus lowers the wage-inequality among the unskilled workers if

$\gamma_{fZ}^2 > \gamma_{KZ}^2$. Note that while $\hat{Q}_1 = 0$ for $\hat{\tau}_2 < 0 = \hat{\tau}_1$, $\hat{Q}_2 > 0$ under such a condition so that now $\hat{K}_Z^1 < 0$. But, if $\gamma_{fZ}^2 < \gamma_{KZ}^2$, then $\hat{Q}_2 < 0$ and so $\hat{K}_Z^1 < 0$. Consequent re-allocation of type-1 capital causes the formal sector to contract and the wage inequality among the unskilled workers to worsen.

These results are summarized as follows:

Proposition 2.6: *With homogeneous and mobile type*-1 *capital in Z_1, X and Y sectors,*
(a) a reduction of the rate of tariff on the imported input used in Z_1 unambiguously worsens wage-inequality between skilled and unskilled workers, informal as well as formal; and worsens the wage inequality among the unskilled workers due to greater informalization if $\gamma_{fZ}^1 > \gamma_{SZ}^1$, but may lower it for $\gamma_{fZ}^1 < \gamma_{SZ}^1$.
(b) a reduction of the rate of tariff on the imported input used in Z_2 does not change wage inequality between skilled and unskilled workers; and worsens the wage inequality among the unskilled workers due to greater informalization if $\gamma_{fZ}^2 > \gamma_{KZ}^2$, but lowers it for $\gamma_{fZ}^2 < \gamma_{KZ}^2$.

Proof: Follows from the above discussion.□

2.6 Non-Traded Good and Role of Domestic Demand

So far I have considered all goods produced by the small country as traded goods. But, there are lots of goods and services that an economy produces which cannot be traded either due to high transport costs or perishable nature of such goods, or due to contact-based nature of some services. Examples include freshly prepared food, highly perishable consumption goods, major components of construction, and services like hair cut and nursing. The role of non-traded goods in altering some of the properties of the standard trade models and explaining phenomenon like Dutch Disease are well recognized in the literature.[18] The most important and relevant in my context is that the domestic demand for such non-traded goods now matter even for a small open economy, as changes therein impact the domestic factor prices through changes in domestic price of non-traded goods. So, it will be worthwhile to examine whether and to what extent impacts of tariff

[18] See Caves, Frankel and Jones (1999, for example) for textbook presentations of some of these results.

reductions on export-qualities and wage inequality get altered when production of non-traded goods are considered.

For the purpose, however, without any loss of generality, I modify and simplify the analytical structure of Sections 2.4 and 2.5 as follows. First, the homogeneous export and import-competing goods of previous Sections are clubbed together into a *composite traded good*, denoted by T, following Jones (1976). Second, to simply the algebraic details, I shall now consider only on type of quality-differentiated export good Z, and accordingly drop the subscript and superscripts that have been used to distinguish between the two types of Z goods. As we will see, despite the price of the non-traded good influencing the factor prices, the relative skill-intensity of higher-quality varieties of Z-good(s) will still underlie the condition for a quality improvement following tariff reduction(s). This will essentially reflect asymmetric quality variations across export-goods with different skill intensities. Both the composite traded good (T) and a non-traded good (denoted by N) are produced by unskilled labour and the same type of capital (as is used by the single quality-differentiated good Z). As a further simplification, I assume fixed-coefficients production technologies for T and N; that is, per unit input requirements a_{ij}, $i = L, K, j = T, N,$ are technologically given. I start with the segmented labour market specification, and subsequently shall allow flexible unskilled money wage in every relevant sector of the economy.

2.6.1 Segmented Labour Market

The composite traded good is assumed to be produced in the formal sector, with rigid unskilled money wage, whereas the non-traded good is assumed to be produced in the informal sector with market-determined wage without any wage-floor. There is another important change that is being made is inclusion of an imported input in production of the composite traded good, denoted by f_T. This is to capture the effect of trade liberalization for the homogeneous traded goods, since the clubbing of export and import goods (X and Y in the earlier specification) leaves no scope for a reduction of tariff on import of final good Y. The example of petroleum being the same imported input that is used to produce many export as well as import-competing goods provides a motivation and justification of including an imported input in the composite traded good (T).[19]

Given these modifications of the analytical structure of Section 2.5, I write down the equation structure of the model in the following:

$$P_T^W = a_{LT}\overline{w} + a_{KT}r + a_{fT}(1+\tau_T) \tag{2.38}$$

$$P_N = a_{LN}w + a_{KN}r \tag{2.39}$$

$$P_Z^W = P_Z^W(Q),\ P_Z^{W'}(Q) > 0,\ P_Z^{W''}(Q) > 0 \tag{2.40}$$

$$a_{iZ} = a_{iZ}(Q), a'_{iZ}(Q) > 0, a''_{iZ}(Q) > 0, i = S, K, f \tag{2.40a}$$

$$P_Z^W(Q) = a_{KZ}(Q)r + a_{SZ}(Q)w_S + a_{fZ}(Q)(1+\tau) \tag{2.41}$$

$$P_Z^{W'}(Q_0) = a'_{KZ}(Q_0)r + a'_{SZ}(Q_0)w_S + a'_{fZ}(Q_0)(1+\tau) \tag{2.42}$$

$$\overline{K} - a_{KZ}(Q)X_Z = \widetilde{K}(Q) = a_{KT}X_T + a_{KN}X_N \tag{2.43}$$

$$\overline{L} = a_{LT}X_T + a_{LN}X_N \tag{2.44}$$

$$\overline{S} = a_{SZ}(Q)X_Z \tag{2.45}$$

All these conditions are self-explanatory as I have already elaborated upon in Section 2.3. τ_T denotes the ad valorem rate of tariff on the imported input used in production of the composite traded good.

In addition to these supply side conditions, I need to define domestic demand and introduce a market-clearing condition since by definition the market for the non-traded must clear locally. I assume that the identical domestic consumers consume only the composite traded good and the non-traded good, and they have homothetic preferences for these goods. This enables me to neglect income effects as the relative demand for the non-traded good will depend only on the relative price. Given this assumption of homothetic preferences, I write down the market-clearing condition in terms of relative demand equating with relative supply of the non-traded good:

[19] In contrast, Acharyya and Jones (2001) considered an imported input in production of the non-traded good to examine the impact of (input) trade liberalization on the export-quality.

$$\frac{D_N}{D_T} = f\left(\frac{P_N}{P_T^W}\right) = \frac{X_N}{X_T} \tag{2.46}$$

Given this structure, some important properties of the model deserve attention. First, as in Section 2.5 with no non-traded good, the rate of return to the mobile capital is still determined by the world price of the (composite) traded good, the minimum wage policy, and now by the input tariff rate τ_T. Quality variation still does not matter for the rate of return to capital. Second, the skilled wage still being affected only by the rate of return to capital, does not depend on the quality of Z either. Third, the informal unskilled wage is now affected by the quality of Z, and herein comes the role of the non-traded good. Quality variation changes the composition of output in the (T, N) nugget for reasons similar to the one discussed in Section 2.6 and consequently changes the price of the non-traded good. This in turn affects the informal unskilled wage. Therefore, change in the wage inequality due to input-tariff reduction now depends on how it affects the export-quality.

As shown in the appendix, change in export-quality consequent upon reductions in input tariffs is given as:

$$\hat{Q} = \frac{P_Z^W}{\delta Q^2}\left[\frac{\theta_{KZ}\theta_{fT}}{\theta_{KT}}(\gamma_{SZ} - \gamma_{KZ})\beta_f \hat{\tau}_T + \theta_{fZ}(\gamma_{fZ} - \gamma_{SZ})\rho\hat{\tau}\right] \tag{2.47}$$

Thus, a ceteris paribus reduction in the rate of tariff on imported input f_T used to produce the composite traded good raises the export-quality if $\gamma_{SZ} > \gamma_{KZ}$ and lowers it if $\gamma_{SZ} < \gamma_{KZ}$. However, earlier I have assumed in (2.5) that higher-quality varieties of the export-good Z_1 that uses the same capital as the formal sector producing the import-competing good is relatively capital intensive ($\gamma_{SZ} < \gamma_{KZ}$). So keeping parity with that condition, it follows that input tariff reduction lowers the quality of this export-good. For a reduction of tariff on the imported input used in production of the quality-differentiated export-good, on the other hand, the export-quality improves if $\gamma_{fZ} > \gamma_{SZ}$ for the same reasons as spelled out in Section 2.5 above.

Two comments are warranted at this point. First, these results again suggest asymmetric effects of input-tariff reductions across product groups. In fact, it can be easily verified that even if I consider two quality-differentiated goods, the effects of input-tariff reductions on their qualities would have been driven by the same set of conditions as I had derived in Section 2.5 without the non-traded good. That is, the non-traded good does not make any difference as far as the effects on export qualities are concerned. However, as I shall show later, this invariance result is due to segmented labour markets, that is, due to minimum (and rigid) money wage in the composite traded sector.

Second, for the same product group, reduction of tariff on a homogeneous final import good (as considered in Section 2.4) and reduction of tariff on the imported input that it would have used (or, which the composite traded good uses here in this section) have contrasting effects. More precisely, while the former raises the quality of the export-good if higher quality varieties of the good is more capital intensive ($\gamma_{SZ} < \gamma_{KZ}$), the latter degrades its quality. These contrasting effects are not surprising because the former lowered the domestic price of the import-competing good in the earlier section, whereas input tariff reduction here raises the *effective* price of the composite traded good. Hence, the rate of return to capital (and correspondingly the skilled wage) responds in a contrasting fashion to these two types of tariff reductions.

Turning now to the factor prices, from the zero profit conditions for the export-good Z, composite traded good *T* and the non-traded good *N*, I obtain the following proportional changes:

$$\hat{r} = -\frac{\theta_{fT}}{\theta_{KT}}\beta_f \hat{\tau}_T \tag{2.48}$$

$$\hat{w}_S = \frac{\theta_{KZ}}{\theta_{SZ}}\frac{\theta_{fT}}{\theta_{KT}}\beta_f \hat{\tau}_T - \frac{\theta_{fZ}}{\theta_{SZ}}\rho\hat{\tau} \tag{2.49}$$

$$\hat{w} = \frac{\hat{P}_N}{\theta_{LN}} - \frac{\theta_{KN}}{\theta_{LN}}\hat{r} \tag{2.50}$$

Thus, as mentioned earlier, the changes in the rate of return to capital and skilled wage are solely determined by the changes in the tariff rates, and independent of the quality variations as before. But, the informal unskilled wage being driven by the price of the non-traded good – the unskilled wage is lowered if price of the non-traded good falls –

along with the tariff on imported input f_T, now depends on the quality variation. As shown in the appendix, the price of the non-traded good varies with the quality level in the following manner:

$$\hat{P}_N = -\frac{\lambda_{KZ}}{\varepsilon_N |\lambda|}(\gamma_{SZ} - \gamma_{KZ})\hat{Q} \tag{2.51}$$

where, ε_N is the absolute value of the price elasticity of (relative) demand for the non-traded good; and $|\lambda|$ is the determinant of the employment-share matrix in the (T, N) nugget.

Substitution of (2.47), (2.48) and (2.51) in (2.50) yields the change in the informal unskilled wage as:

$$\hat{w} = \left[-\frac{P_Z^W}{\delta Q^2} \frac{\lambda_{KZ}\theta_{KZ}\theta_{fT}}{\varepsilon_N |\lambda| \theta_{LN}\theta_{KT}}(\gamma_{SZ} - \gamma_{KZ})^2 + \frac{\theta_{KN}\theta_{fT}}{\theta_{LN}\theta_{KT}} \right] \beta_f \hat{\tau}_T - \frac{P_Z^W}{\delta Q^2} \frac{\theta_{KZ}\theta_{fZ}}{\varepsilon_N |\lambda| \theta_{LN}}(\gamma_{SZ} - \gamma_{KZ})(\gamma_{fZ} - \gamma_{SZ})\rho\hat{\tau} \tag{2.52}$$

First of all, as mentioned earlier, *now* reduction of tariff on imported input used in production Z affects the informal unskilled wage through change in the export-quality and consequent re-allocation of capital across the Z-sector and the (T, N) nugget, in contrast to the no-impact result in absence of the non-traded good. This brings out the role of the non-traded good. The direction of the change in the informal unskilled wage depends on whether quality is raised or lowered. Note that for reason mentioned above, $\gamma_{SZ} < \gamma_{KZ}$. So, if $\gamma_{fZ} > \gamma_{SZ}$ and thus the export-quality is raised, then given the assumption that the composite traded good is capital-intensive relative to the non-traded good ($|\lambda| < 0$), the informal unskilled wage falls. The reason is simple. When input-tariff reduction raises the export-quality, the capital requirement in the Z-sector rises:

$$\hat{K}_Z = (\gamma_{KZ} - \lambda_{SZ})\hat{Q} \tag{2.53}$$

Consequent fall in the availability of capital for the (T, N) nugget lowers the output of the composite traded good and raises the output of the non-traded good. The non-traded market now clears at a lower price, which in turn lowers the unskilled wage through larger informalization. In general, I can write the following result:

Lemma 2.6: *A reduction of tariff on the imported input used in production of the quality-differentiated export good lowers the informal unskilled wage if* $(\gamma_{SZ} - \gamma_{KZ})(\gamma_{fZ} - \gamma_{SZ}) < 0$.

Proof: Follows from (2.52) and the above discussion. □

Corollary 2.1: *Given the assumption that* $\gamma_{KZ} > \gamma_{SZ}$*, the condition stated in Lemma 2.6 is satisfied if* $\gamma_{fZ} > \gamma_{KZ} > \gamma_{SZ}$ *or if* $\gamma_{KZ} > \gamma_{fZ} > \gamma_{SZ}$.

But, the change in the informal unskilled wage is ambiguous following a reduction of tariff on the imported input used in production of the composite traded good. Tariff reduction raises the *effective* domestic price of the composite traded good, which incentivizes domestic producers to expand their output levels. The demand for capital increases, which raises its rate of return. But, at the initial equilibrium export-quality, and correspondingly at the initial availability of capital for the (T, N) nugget, output of the composite traded good cannot increase in response to such an increase in the effective price for the domestic producers. Thus, the rate of return to capital must rise to the extent to fully offset the fall the input-tariff rate to bring back the total average cost at the initial level. [20] At the initial equilibrium level of P_N, this increase in the rate of return to capital lowers the informal unskilled wage: the competitive market forces cause the wage to fall and thereby enable the producers to break-even. This initial adverse effect of input-tariff reduction on the informal unskilled wage is captured through the second term in the parenthesis in (2.52). There is also a secondary or indirect effect. As the input tariff reduction changes the export-quality, it re-allocates capital across the sectors and the output levels change in the similar way as before in Section 2.5 without any non-traded good. And, now with P_N adjusting to such output changes, the unskilled wage changes too. This quality-effect on the informal unskilled wage again brings out the role of the non-traded good. However, as in case of the benchmark model of Section 2.3 (without the non-traded good, sector-specific land, and homogeneous traded goods *not* being clubbed into the composite traded good), regardless of whether reduction of tariff on the

[20] Also, with the relative domestic price of the composite traded good (or, conversely, the relative domestic price of the non-traded good) faced by the consumers remaining unchanged, there will be no change in the relative demand either.

imported input used in production of the composite traded good raises or lowers the export-quality, the capital requirement in the Z sector falls. This can also be checked from (2.53) and the expression for $\hat{Q}$. Thus, now larger availability of capital raises the output of the composite traded good and lowers the output of the non-traded good. Consequent rise in P_N (and smaller informalization) cause the unskilled wage to rise. Overall, whether the unskilled wage rises or falls is ambiguous. From (2.52), the condition for a *fall* in the informal unskilled wage can be worked out as:

$$\varepsilon_N > \bar{\varepsilon}_N \equiv \frac{P_Z^W}{\delta Q^2} \frac{\lambda_{KZ}\theta_{KZ}}{|\lambda|\theta_{LN}\theta_{KN}} (\gamma_{SZ} - \gamma_{KZ})^2 \tag{2.54}$$

The intuition behind this condition is simple. As the quality variation lowers the output of the non-traded good through re-allocation of capital, the extent to which P_N must rise to wipe out the consequent excess demand is smaller, the larger is its price elasticity of demand. Hence, for a sufficiently large value of ε_N as defined in (2.54), the rise in the informal unskilled wage is so small that the initial magnitude of the fall in the wage is only dampened but not reversed. Hence:

Lemma 2.7: *A reduction of tariff on the imported input used in production of the composite traded good lowers the informal unskilled wage if* $\varepsilon_N > \bar{\varepsilon}_N$.

Proof: Follows from the above discussion.□

Finally, subtracting (2.52) from (2.49), the algebraic expression for change in wage inequality between skilled and informal unskilled workers can be obtained as:

$$\hat{w}_S - \hat{w} = \left[\frac{\theta_{KZ}\theta_{fT}}{\theta_{SZ}\theta_{KT}} - \frac{\theta_{KN}\theta_{fT}}{\theta_{LN}\theta_{KT}} + \frac{P_Z^W}{\delta Q^2}\frac{\lambda_{KZ}\theta_{KZ}\theta_{fT}}{\varepsilon_N|\lambda|\theta_{LN}\theta_{KT}}(\gamma_{SZ}-\gamma_{KZ})^2\right]\beta_f\hat{\tau}_T - \left[\frac{\theta_{fZ}}{\theta_{SZ}} - \frac{P_Z^W}{\delta Q^2}\frac{\theta_{KZ}\theta_{fZ}}{\varepsilon_N|\lambda|\theta_{LN}}(\gamma_{SZ}-\gamma_{KZ})(\gamma_{fZ}-\gamma_{SZ})\right]\rho\hat{\tau} \tag{2.55}$$

It is straightforward to check that by Lemma 2.7, $\hat{w}_S - \hat{w} > 0$ for $\hat{\tau} < 0 = \hat{\tau}_T$. But, if $(\gamma_{SZ} - \gamma_{KZ})(\gamma_{fZ} - \gamma_{SZ}) > 0$, then $\hat{w}_S - \hat{w} > 0$ if

$$\varepsilon_N > \tilde{\varepsilon}_N \equiv \frac{P_Z^W}{\delta Q^2} \frac{\theta_{KZ}\theta_{SZ}}{|\lambda|\theta_{LN}} (\gamma_{SZ} - \gamma_{KZ})(\gamma_{fZ} - \gamma_{SZ}) \tag{2.54a}$$

On the other hand, $\hat{w}_S - \hat{w} < 0$ for $\hat{\tau}_T < 0 = \hat{\tau}$ regardless of the value of ε_N if ,

$$\frac{\theta_{KZ}}{\theta_{SZ}} > \frac{\theta_{KN}}{\theta_{LN}} \tag{2.56}$$

It may be noted that the value of ε_N determines whether w rises or falls. $\frac{\theta_{KZ}}{\theta_{KZ}} > \frac{\theta_{KN}}{\theta_{LN}}$ means that even if w falls in case of $\varepsilon_N > \bar{\varepsilon}_N$, it will be smaller than the fall in the skilled wage. However, this is only a sufficient condition. Even if this condition is not satisfied, $\hat{w}_S - \hat{w} < 0$ if $\varepsilon_N < \bar{\varepsilon}_N$ (in which case *w* rises). In fact, if $\frac{\theta_{KZ}}{\theta_{SZ}} < \frac{\theta_{KN}}{\theta_{LN}}$, then wage inequality declines when

$$\varepsilon_N < \bar{\bar{\varepsilon}}_N \equiv \frac{P_Z^W \lambda_{KZ}\theta_{KZ}}{\delta Q^2 |\lambda| \left(\theta_{KN} - \frac{\theta_{LN}\theta_{KZ}}{\theta_{SZ}} \right)} (\gamma_{SZ} - \gamma_{KZ})^2 \tag{2.54b}$$

Note that $\bar{\bar{\varepsilon}}_N > \bar{\varepsilon}_N$.

From Lemma 2.6, Lemma 2.7, Corollary 2.1 and conditions (2.54a), (2.54b) and (2.56), I can write the following Proposition regarding wage inequality:

Proposition 2.6:

(a) If $\gamma_{fZ} > \gamma_{KZ} > \gamma_{SZ}$ or if $\gamma_{KZ} > \gamma_{fZ} > \gamma_{SZ}$, a ceteris paribus reduction of tariff on the imported input used in production of the quality-differentiated export good ($\hat{\tau} < 0 = \hat{\tau}_T$) raises the wage inequality between skilled and informal unskilled workers as well as among the unskilled workers. For other intensity rankings, wage inequality worsens between skilled and unskilled workers but is lowered among the unskilled workers, if $\varepsilon_N > \tilde{\varepsilon}_N$.

(b) A reduction of tariff on the imported input used in production of the composite traded good ($\hat{\tau}_T < 0 = \hat{\tau}$) lowers the wage inequality between skilled and unskilled workers as well as among the unskilled workers the informal unskilled wage if $\varepsilon_N < \bar{\varepsilon}_N$. If $\varepsilon_N > \bar{\varepsilon}_N$, then wage inequality among unskilled workers worsens, but still the wage inequality between skilled and unskilled workers can decline, and a sufficient condition for this is that $\frac{\theta_{KZ}}{\theta_{SZ}} > \frac{\theta_{KN}}{\theta_{LN}}$. If this condition does not hold, the wage inequality declines as long as $\varepsilon_N < \bar{\bar{\varepsilon}}_N$.

Proof: (a) First part of the proof follows from rise in the skilled wage as in (2.49) and fall in unskilled wage by Lemma 2.6 and Corollary 2.1.□

(b) For the first part, note that in this case by Lemma 2.7, w rises. So given that w_S falls by (2.49), wage inequality between skilled and unskilled workers declines. The rise in w also means wage inequality among unskilled workers declines. Rest follows from the above discussion.□

Feasibility of the sufficient condition $\frac{\theta_{KZ}}{\theta_{SZ}} > \frac{\theta_{KN}}{\theta_{LN}}$ for wage inequality to decline depends on the initial equilibrium level of quality for similar reasons as spelled out in Proposition 2.3 in Section 2.4. More precisely, since $\gamma_{KZ} > \gamma_{SZ}$, so $\mu(Q) \equiv \frac{\theta_{KZ}}{\theta_{SZ}}$ is increasing in the quality level. Hence the condition $\frac{\theta_{KZ}}{\theta_{SZ}} > \frac{\theta_{KN}}{\theta_{LN}}$ may be satisfied if $\frac{\theta_{KN}}{\theta_{LN}} < \mu(0)$; or, for $Q^e > \tilde{Q}$ *if* $\mu(0) < \frac{\theta_{KN}}{\theta_{LN}} < \mu(\overline{Q})$, where $\mu(\tilde{Q}) = \frac{\theta_{KN}}{\theta_{LN}}$.

Finally, note that by (2.49), wage inequality between skilled workers and formal unskilled workers unambiguously falls for a reduction of tariff on the imported input used in production of the composite traded good, but rises for reduction of tariff on the imported input used in production of the quality-differentiated export good.

2.6.2 Flexible unskilled wage and two-way causality

Suppose, instead of formal-informal segmentation of the unskilled labour market, unskilled workers get market-determined wages (with no floor or lower bound on it) everywhere in the economy. Q and r (or, P_N) are now inter-dependent. And this two-way causality between export-quality and domestic factors costs brings out the role of the non-traded good further. Consequent upon this two-way causality, the skilled wage will also depend on quality variations induced by these policies. That is, now both the skilled and unskilled wages are affected by tariff-induced quality variations in contrast to only the unskilled wage being affected by quality variations in case of labour-market segmentation. Furthermore, since such wage effects may be asymmetric, so the wage inequality between skilled and unskilled workers may not only be different in magnitude but also may get reversed compared to the case under segmented labour-market and one-way causality between quality and P_N.

The only change in the equation system (2.38)–(2.46) describing the small economy is the zero-profit condition for the composite traded good:

$$P_T^W = a_{LT}w + a_{KT}r + a_{fT}(1+\tau_T) \tag{2.38a}$$

Given this change in the specification, let me first focus on the two-way causality between export-quality and the rate of return to capital (or, the price of the non-traded good). The effect of an increase in the rate of return to capital on the export-quality follows from the marginal condition for quality choice as discussed earlier: Q rises if $\gamma_{SZ} < \gamma_{KZ}$, and falls otherwise. In Figure 2.4, this is shown by the curve labeled QQ with its slope equal to:

$$\left.\frac{dr}{dQ}\right|_{QQ} = -\frac{1}{\frac{P_Z^W}{\delta Q^2}\theta_{KZ}(\gamma_{SZ}-\gamma_{KZ})}\frac{r}{Q} \tag{2.57}$$

Now there is also a reverse causation from a change in export quality to a change in the rate of return to capital. Given flexible unskilled wage even in the composite traded sector, the rate of return to capital, along with the unskilled wage, now gets determined by the locally determined price of the non-traded good as is evident from the zero-profit conditions (2.38a) and (2.39). However, as already explained, the price of the non-traded good depends, among other things, on the level of export quality of Z. More precisely, from (2.53) it follows that a ceteris paribus increase in quality of Z will raise the capital requirement in the production of good Z if $\gamma_{KZ} > \lambda_{SZ}$. Corresponding withdrawal of some capital from the (T, N) nugget causes output of the composite traded good to fall and that of the non-traded good to rise. This in turn lowers PN and consequently lowers the unskilled wage and raises the rate of return to capital by the standard price magnification effect. That is, through the market-clearing condition for the non-traded good, now an increase in Q raises r if $\gamma_{KZ} > \lambda_{SZ}$; but lowers r if $\gamma_{SZ} > \gamma_{KZ}$. This relationship between Q and r – the causality running from Q to r – is captured through the curve labeled *rr* in Figure 2.4. Algebraically, as shown in the appendix, the slope of this curve is given as:

$$\left.\frac{dr}{dQ}\right|_{M_N} = -\frac{\theta_{LT}\lambda_{KZ}(\gamma_{SZ}-\gamma_{KZ})}{\varepsilon_N |\theta\|\lambda|}\frac{r}{Q} \tag{2.58}$$

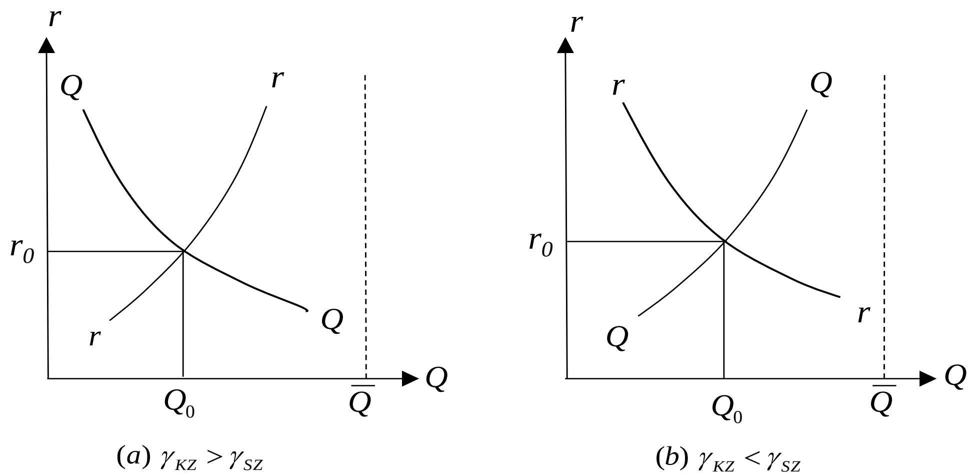

Figure 2.4: Simultaneous determination of Q and r

The equilibrium quality Q_0 of the export good Z and the rate of return to capital r_0 are thus determined simultaneously at the intersection of the *QQ* and *rr* curves for any given rates of input tariffs. Starting from this initial equilibrium, let us analyse the effect of sector specific input tariff liberalization policies on the equilibrium choice of export quality. However, for reasons explained earlier, I focus on the case $\gamma_{KZ} > \lambda_{SZ}$.

Now, input tariff reductions change the quality level and the rate of return to capital as follows (see Appendix):

$$\hat{Q} = \frac{1}{\Delta}\frac{P_Z^W}{\delta Q^2}\left[\frac{\varepsilon_N\theta_{LN}\theta_{KZ}\theta_{fT}}{\theta_{LT}}(\gamma_{SZ}-\gamma_{KZ})\beta_f\hat{\tau}_T - \frac{\varepsilon_N\theta_{fZ}|\theta|}{\theta_{LT}}(\gamma_{fZ}-\gamma_{SZ})\rho\hat{\tau}\right] \tag{2.59}$$

$$\hat{r} = \frac{1}{\Delta}\left[\frac{P_Z^W}{\delta Q^2}\frac{\lambda_{KZ}\theta_{fZ}}{|\lambda|}(\gamma_{SZ}-\gamma_{KZ})(\gamma_{fZ}-\gamma_{SZ})\rho\hat{\tau} - \frac{\varepsilon_N\theta_{LN}\theta_{fT}}{\theta_{LT}}\beta_f\hat{\tau}_T\right] \tag{2.60}$$

where, $\Delta = \left(\frac{\lambda_{KZ}\theta_{KZ}(\gamma_{SZ}-\gamma_{KZ})^2}{|\lambda|}\frac{P_Z^W}{\delta Q^2} - \frac{\varepsilon_N|\theta|}{\theta_{LT}}\right) > 0$, $\delta < 0, |\theta| < 0, |\lambda| < 0$.

Hence, again similar conditions underlie quality improvement as under segmented labour market. However, there is a magnitude change due to the two-way causality. For example, when there is a ceteris paribus reduction in the tariff on imported input used in production of Z, from the marginal condition for quality choice it is apparent that at the initial equilibrium rate of return to capital, the export-quality improves if $\gamma_{fZ} > \gamma_{SZ}$. In Figure 2.5, the *QQ* curve thus shifts to the right. In fact, the magnitude of this shift is given by the change in export-quality that I obtained under segmented labour market: $dQ = \frac{P_Z^W \theta_{fZ}}{\delta Q}(\gamma_{fZ} - \gamma_{SZ})\rho\hat{\tau}$. But, as $\gamma_{KZ} > \lambda_{SZ}$, so the *rr* curve is upward rising meaning that the rise in Q raises the rate of return to capital, which in turn lowers the export-quality to some extent. That is, the extent of final improvement in the export quality will be less than its initial improvement due to the two-way causality. It is needless to say that had $\gamma_{KZ} < \lambda_{SZ}$ been the case, then *r* would have fallen which in turn would have *increased Q further*. That is, the extent of final improvement in the export quality would have been larger than its initial improvement in such a case. Similarly, the reduction of tariff on imported input used in production of the composite traded good lowers Q under $\gamma_{KZ} > \lambda_{SZ}$ more than it would under segmented labour market (and hence under one-way causality). The QQ curve now would have shifted to the left along the downward sloping *rr* curve in Figure 2.5.

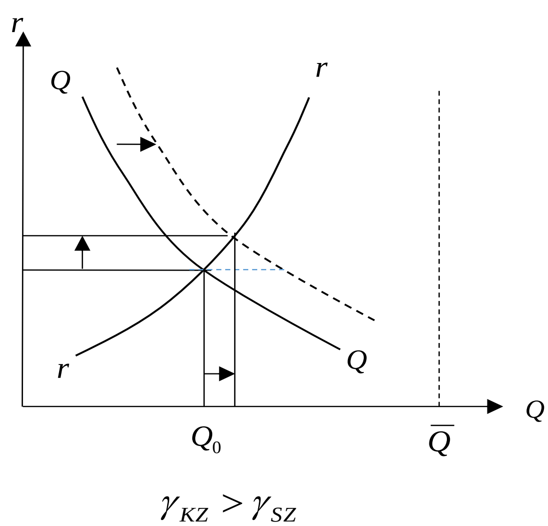

Figure 2.5: Reduction of Input Tariff and Export Quality

Proposition 2.7: *Given the assumption that* $\gamma_{KZ} > \lambda_{SZ}$, *a reduction of tariff on imported input that is used in production of quality differentiated export goods upgrades export quality under flexible wage to a larger extent than under segmented labour market; whereas a reduction of tariff on imported input used in production of the composite traded good degrades export quality under flexible wage to a larger extent than under segmented labour market*

Proof: Follows from (2.59) and Figure 2.5. □

Using $\hat{r}$ from (2.60), the change in skilled wage can be obtained as:

$$\hat{w}_S = -\frac{\theta_{fZ}}{\theta_{SZ}}\left[\frac{P_Z^W}{\delta Q^2\Delta}\frac{\lambda_{KZ}\theta_{KZ}}{|\lambda|}(\gamma_{SZ}-\gamma_{KZ})(\gamma_{fZ}-\gamma_{SZ})+1\right]\rho\hat{\tau}+\frac{\varepsilon_N\theta_{LN}\theta_{fT}}{\Delta\theta_{LT}}\frac{\theta_{KZ}}{\theta_{SZ}}\beta_f\hat{\tau}_T \qquad (2.61)$$

The unskilled wage, on the other hand, changes as follows:

$$\hat{w} = \left[-\frac{\theta_{KN}\theta_{fT}}{|\theta|}+\frac{\theta_{KT}}{|\theta|}\frac{P_Z^W\lambda_{KZ}}{\delta Q^2\Delta|\lambda|}\frac{\theta_{LN}\theta_{KZ}\theta_{fT}}{\theta_{LT}}(\gamma_{SZ}-\gamma_{KZ})^2\right]\beta_f\hat{\tau}_T-\frac{P_Z^W\lambda_{KZ}}{\delta Q^2\Delta|\lambda|}\frac{\theta_{KT}\theta_{fZ}}{\theta_{LT}}(\gamma_{SZ}-\gamma_{KZ})(\gamma_{fZ}-\gamma_{SZ})\rho\hat{\tau} \qquad (2.62)$$

Note that a ceteris paribus reduction in tariff on the imported input used in production of the quality-differentiated good, $\hat{\tau} < 0 = \hat{\tau}_T$, changes the skilled wage on two counts: First, it *raises* the skilled wage directly (and, at the initial rate of return to capital) as captured through the term $-\frac{\theta_{fZ}}{\theta_{SZ}}\rho\hat{\tau}$ as before; and second, it affects the skilled wage indirectly through the change in the rate of return to capital by changing the export-quality – the direction of change is ambiguous though – as captured by the other composite term in the parenthesis associated with $-\frac{\theta_{fZ}}{\theta_{SZ}}\rho\hat{\tau}$. This second and indirect effect brings out the role of the non-traded good and the two-way causality between export-quality and the rate of return to capital. Comparison of no-impact of a reduction of tariff on the imported input used in production of the quality-differentiated good Z_1 on the rate of return to capital in Section 2.3 with the *rise* in the rate of return to capital in this case for similar reduction in input-tariff ($\hat{\tau} < 0 = \hat{\tau}_T$) reveals this important change due to the two-causality. The skilled wage due to this induced quality-effect falls under the assumption $\gamma_{KZ} > \lambda_{SZ}$ if $\gamma_{fZ} > \lambda_{SZ}$. However, as shown in the appendix, if $\gamma_{KZ} > \lambda_{fZ}$, then this quality-effect is dominated by the direct effect so that the skilled wage increases at the new equilibrium. Thus, $\hat{w}_S > 0$ if $\gamma_{KZ} > \gamma_{fZ} > \gamma_{SZ}$. Since by Corollary 2.1, unskilled wage falls under the same factor-intensity ranking, so the wage inequality will worsen if $\gamma_{KZ} > \gamma_{fZ} > \gamma_{SZ}$.

On the other hand, for a ceteris paribus reduction of tariff on imported input used in production of the composite traded good, $\hat{\tau}_T < 0 = \hat{\tau}$, the skilled wage unambiguously falls. Note that the induced quality-effect on the skilled wage now only changes the magnitude of the increase in the skilled wage, which is captured through the term Δ in the denominator of the third term in the expression for $\hat{w}_S$ in (2.6). The unskilled wage changes on two counts though as was the case under segmented labour market. It *falls* through the direct effect of reduction of τ_T, and *increases* through induced quality effect. The same elasticity condition as under segmented-labour market case – $\varepsilon_N > \bar{\varepsilon}_N$ as in (2.54) – the direct effect is stronger and the unskilled wage falls at the new equilibrium. In such a case, the wage inequality may decline or worsen. On the other hand, if $\varepsilon_N < \bar{\varepsilon}_N$ then as the unskilled wage increases at the new equilibrium due to stronger quality-effect, so the wage inequality declines. All these results can be summarized in the following Proposition:

Proposition 2.8: *A ceteris paribus reduction in tariff on the imported input used in production of the quality-differentiated good,* $\hat{\tau} < 0 = \hat{\tau}_T$*, worsens the wage inequality if* $\gamma_{KZ} > \gamma_{fZ} > \gamma_{SZ}$*; whereas a ceteris paribus reduction of tariff on imported input used in production of the composite traded good,* $\hat{\tau}_T < 0 = \hat{\tau}$*, lowers the wage inequality if* $\varepsilon_N < \bar{\varepsilon}_N$*, but may worsen it if* $\varepsilon_N > \bar{\varepsilon}_N$*.*

Proof: Follows from the above discussion.□

2.7 Conclusion

The last century has seen an increasing number of emerging and developing economies adopting trade liberalization measures as part of their globalization efforts. The success of such measures from the point of view of export promotion policies, in boosting export-led-growth prospects of the developing countries largely depends on to what extent they induce export quality upgrading to align export offers of these countries with the world demand. In this Chapter, I have focused on the *domestic-factor* cost effects of tariff liberalization policies and its joint role with the imported-input to show that tariff reductions *may* adversely affect export-qualities. This is the central result of the benchmark analysis in terms of the four-sector general equilibrium framework of a small open economy with two quality-differentiated export products that differ from each other with respect to the relative domestic-factor intensities for their respective higher qualities. This provides a plausible theoretical explanation for the observed asymmetric quality variations across different product groups reported in Chapter 1. Given such asymmetric quality-effects of reduction of tariff, I examined how concurrent policies like a quality-content production subsidy, and input-subsidy for use of capital and/or skilled labour can effectively target to upgrade quality for those export-product groups whose quality is downgraded on account of tariff cuts. A quality-neutral income tax levied on income earners, except unskilled workers, can be a way to finance these subsidies.

I have also explored the implications of such tariff-reduction induced asymmetric export-quality variations for wage inequality among skilled and unskilled workers, as well as among the unskilled workers themselves, by taking into account formal-informal segmentation of the labour market. Quality variations are found to accentuate wage inequality through informalization and consequent decline in the informal unskilled wage thus posing a policy dilemma for policymakers to sustain quality-upgrading export-promotion policies.

The robustness of the production structure is considered by allowing the same and mobile capital used in both the formal and informal sectors of production, instead of capital and land being specific factors in these two sectors. While the effect on export quality levels remain the same, the initial equilibrium level of quality now plays an important role in determining if tariff reduction widens wage inequality. Further extension of the benchmark production structure allow for sector-specific imported inputs used in producing the two quality-differentiated export goods. In such a context, I have demonstrated that reduction of tariffs on these inputs generate similar asymmetric quality variations as does the reduction of tariff on a final import good.

Finally, I have brought out the role of domestic demand by considering production of a non-traded good. The effects on the level of export-quality and wage inequality now depend on the value of price elasticity of demand for the non-traded good.

Appendix

A.2.1. Relation between export-quality and cost of capital

Total differentiation of the marginal condition (2.7) in the text yields:

$$P_{Zm}^{W''}(Q_m)dQ = a_{SZ}^{m''}(Q_m)w_S dQ + a_{SZ}^{m'}(Q_m)dw_S + r_i a_{KZ}^{im''}(Q_m)dQ + a_{KZ}^{im'}(Q_m)dr_i$$

$$\Rightarrow \left[P_{Zm}^{W''}(Q_m) - a_{SZ}^{m''}(Q_m)w_S - r_i a_{KZ}^{im''}(Q_m)\right]dQ = w_S a_{SZ}^{m'}(Q_m)\hat{w}_S + r_i a_{KZ}^{im'}(Q_m)\hat{r}_i$$

$$\Rightarrow \delta_m \hat{Q}_m Q_m = \frac{a_{KZ}^{im}(Q_m)r_i}{P_{Zm}^W}\frac{P_{Zm}^W}{Q_m}\left[\frac{Q_m a_{KZ}'^m(Q_m)}{a_{KZ}^m(Q_m)}\right]\hat{r}_i + \frac{a_{SZ}^m(Q_m)w_S}{P_{Zm}^W}\frac{P_{Zm}^W}{Q_m}\left[\frac{Q_m a_{SZ}'^m(Q_m)}{a_{SZ}^m(Q_m)}\right]\hat{w}_S$$

$$\Rightarrow \delta_m \hat{Q}_m = \frac{P_{Zm}^W}{Q_m^2}\left[\theta_{KZ}^m \gamma_{KZ}^m \hat{r}_i + \theta_{SZ}^m \gamma_{SZ}^m \hat{w}_S\right] \qquad \text{(A.2.1)}$$

where, by the second-order condition for profit maximization with respect to quality choice in each sector, $\delta_m \equiv P_{Zm}^{W''}(Q_m) - a_{SZ}^{m''}(Q_m)w_S - r_i a_{KZ}^{m''}(Q_m) < 0,\ m = 1, 2.$

From the zero profit condition in Z_m sector given by (2.6) in the text, the proportional change in skilled wage is given by, $\hat{w}_S = -\frac{\theta_{KZ}^m}{\theta_{SZ}^m}\hat{r}_i$. Substituting this in (A.2.1) yields,

$$\delta_m \hat{Q}_m = \frac{P_{Z1}^W}{Q_m^2}\left[\theta_{KZ}^m \gamma_{KZ}^m \hat{r}_i + \theta_{SZ}^m \gamma_{SZ}^m\left(-\frac{\theta_{KZ}^m}{\theta_{SZ}^m}\right)\hat{r}_i\right] \Rightarrow \hat{Q}_m = \frac{P_{Zm}^W}{\delta_m Q_m^2}\theta_{KZ}^m(\gamma_{KZ}^m - \gamma_{SZ}^m)\hat{r}_i \qquad \text{(A.2.2)}$$

A.2.2: Quality changes and Capital requirement in Z_1 sector

By definition,

$$K_Z^1 = a_{KZ}^1(Q_1)Z_1 \qquad \text{(A.2.3)}$$

Log differentiation yields:

$$\hat{K}_Z^1 = \hat{Z}_1 + \gamma_{KZ}^1 \hat{Q}_1 \qquad \text{(A.2.4)}$$

Total differentiation of (2.9) and (2.10) gives,

$$\hat{\bar{K}}_2 = 0 = (\hat{Z}_2 + \gamma_{KZ}^2 \hat{Q}_2) \Rightarrow \hat{Z}_2 = -\gamma_{KZ}^2 \hat{Q}_2 \qquad \text{(A.2.5)}$$

$$\hat{\bar{S}} = 0 = \lambda_{SZ}^1 \hat{Z}_1 + \lambda_{SZ}^2 \hat{Z}_2 + \lambda_{SZ}^2 \gamma_{SZ}^2 \hat{Q}_2 + \lambda_{SZ}^1 \gamma_{SZ}^1 \hat{Q}_1 \qquad \text{(A.2.6)}$$

Substitution of (A.2.5) and (A.2.6) in (A.2.4), using (A.2.3), yields:

$$\hat{K}_Z^1 = -\frac{\lambda_{SZ}^2}{\lambda_{SZ}^1}\hat{Z}_2 - \frac{\lambda_{SZ}^2}{\lambda_{SZ}^1}\gamma_{SZ}^2 \hat{Q}_2 - \gamma_{SZ}^1 \hat{Q}_1 + \gamma_{KZ}^1 \hat{Q}_1$$

$$\Rightarrow \hat{K}_Z^1 = \frac{\lambda_{SZ}^2}{\lambda_{SZ}^1}\gamma_{KZ}^2 \hat{Q}_2 - \frac{\lambda_{SZ}^2}{\lambda_{SZ}^1}\gamma_{SZ}^2 \hat{Q}_2 - \gamma_{SZ}^1 \hat{Q}_1 + \gamma_{KZ}^1 \hat{Q}_1$$

$$\Rightarrow \hat{K}_Z^1 = (\gamma_{KZ}^1 - \gamma_{SZ}^1)\hat{Q}_1 - \frac{\lambda_{SZ}^2}{\lambda_{SZ}^1}(\gamma_{SZ}^2 - \gamma_{KZ}^2)\hat{Q}_2 \qquad \text{(A.2.7)}$$

This is what is stated in (2.15) in the text.

A.2.3 <u>Effect of tariff reduction on informal wage.</u>

Total differentiation of the other full employment conditions (2.8), (2.11) and (2.12) in the text yields following relationships between output changes and quality change:

$$\hat{\bar{K}}_1 = 0 = \lambda_{KY}(\hat{Y} + \hat{a}_{KY}) + \lambda_{KZ}^1(\hat{Z}_1 + \gamma_{KZ}^1\hat{Q}_1) \qquad \text{(A.2.8)}$$

$$\hat{X} = -\hat{a}_{TX} \qquad \text{(A.2.9)}$$

$$\hat{\bar{L}} = 0 = \lambda_{LX}(\hat{X} + \hat{a}_{LX}) + \lambda_{LY}(\hat{Y} + \hat{a}_{LY}) \qquad \text{(A.2.10)}$$

Substituting (A.2.9) in (A.2.10), I can write $\hat{Y}$ as:

$$\hat{Y} = -\hat{a}_{LY} - \frac{\lambda_{LX}}{\lambda_{LY}}\sigma_X(\hat{R} - \hat{w}) \qquad \text{(A.2.11)}$$

where $\sigma_X = \dfrac{\hat{a}_{TX} - \hat{a}_{LX}}{\hat{w} - \hat{R}}$ is absolute value of elasticity of substitution between land and unskilled labour in sector-X.

Note that by the condition for least-cost choice of inputs (see Jones (1965)):

$$\hat{a}_{KX} = \hat{a}_{TX} - \theta_{TX}\hat{a}_{TX} - \theta_{LX}\hat{a}_{LX} \Rightarrow \hat{a}_{TX} = \theta_{LX}(\hat{a}_{TX} - \hat{a}_{LX}) = \sigma_X\theta_{LX}(\hat{w} - \hat{R})$$

$\hat{a}_{LX}$ and $\hat{a}_{LY}$ can be expressed similarly.

Substituting (A.2.7) and (A.2.11) in (A2.8) gives us the change in the informal unskilled wage:

$$0 = \lambda_{KY}(\hat{a}_{KY} - \hat{a}_{LY}) - \lambda_{KY}\frac{\lambda_{LX}}{\lambda_{LY}}\sigma_X(\hat{R} - \hat{w}) + \lambda_{KZ}^1\left[(\gamma_{KZ}^1 - \gamma_{SZ}^1)\hat{Q}_1 - \frac{\lambda_{SZ}^2}{\lambda_{SZ}^1}(\gamma_{SZ}^2 - \gamma_{KZ}^2)\hat{Q}_2\right]$$

$$0 = \lambda_{KY}\sigma_Y(\hat{w} - \hat{r}_1) + \lambda_{KY}\frac{\lambda_{LX}}{\lambda_{LY}}\frac{\sigma_X}{\theta_{TX}}\hat{w} + \lambda_{KZ}^1\left[(\gamma_{KZ}^1 - \gamma_{SZ}^1)\hat{Q}_1 - \frac{\lambda_{SZ}^2}{\lambda_{SZ}^1}(\gamma_{SZ}^2 - \gamma_{KZ}^2)\hat{Q}_2\right]$$

$$\Rightarrow \hat{w} = \frac{1}{\bar{\lambda}}\frac{\lambda_{KY}\sigma_Y}{\theta_{KY}}\beta\hat{t} - \frac{\lambda_{KZ}^1}{\bar{\lambda}}\left[(\gamma_{KZ}^1 - \gamma_{SZ}^1)\hat{Q}_1 - \frac{\lambda_{SZ}^2}{\lambda_{SZ}^1}(\gamma_{SZ}^2 - \gamma_{KZ}^2)\hat{Q}_2\right] \qquad \text{(A.2.12)}$$

where, $\bar{\lambda} = \lambda_{KY}\sigma_Y + \lambda_{KY}\dfrac{\lambda_{LX}}{\lambda_{LY}}\dfrac{\sigma_X}{\theta_{TX}} > 0$

A.2.4 <u>Quality content production subsidy</u>

Log differentiating the marginal condition (2.19) in the text for choice of quality of Z_2 under production subsidy, I get:

$$P_{Z2}^{W''}(Q_2)dQ_2 = a_{SZ}^{2''}(Q_2)dQ_2 w_S + a_{SZ}^{2'}(Q_2)dw_S + ra_{KZ}^{2''}(Q_2)dQ_2 + a_{KZ}^{\prime 2'}(Q_2)dr - bdQ_2 - dbQ_2$$

$$\Rightarrow Q_2\left[P_Z^{W''}(Q_2) - ra''_{KZ}(Q_2) - w_S a''_{SZ}(Q_2) + b\right]\hat{Q}_2 = ra'_{KZ}(Q_2)\hat{r} + w_S a'_{SZ}(Q_2)\hat{w}_S - \hat{b}bQ_2$$

Dividing the above throughout by $\dfrac{P_{Z2}^W}{Q_2}$ gives,

$$\Rightarrow \frac{Q_2^2}{P_Z^W}\delta_2\hat{Q}_2 = \frac{a_{KZ}(Q_2)r}{P_Z^W}\left[\frac{Q_2 a'_{KZ}(Q_2)}{a_{KZ}(Q_2)}\right]\hat{r} + \frac{a_{SZ}(Q_2)w_S}{P_Z^W}\left[\frac{Q_2 a'_{SZ}(Q_2)}{a_{SZ}(Q_2)}\right]\hat{w}_S - \hat{b}\frac{bQ_2^2}{P_Z^W(Q_2)}$$

$$\Rightarrow \hat{Q}_2 = \frac{P_Z^W}{\delta_2 Q_2^2}\left(\theta_{KZ}\gamma_{KZ}\hat{r} + \theta_{SZ}\gamma_{SZ}\hat{w}_S\right) - \hat{b}\frac{b}{\delta_2}$$

Substituting $\hat{r} = 0$ and $\hat{w}_S = \dfrac{1}{\theta_{SZ}}\left[\dfrac{bQ_2^2}{2P_Z^W}\right]\hat{b}$ from the zero-profit condition (2.18), I get,

$$\hat{Q}_2 = \frac{P_Z^W}{\delta_2 Q_2^2}\gamma_{SZ}\left(\frac{bQ_2^2}{2P_Z^W}\right)\hat{b} - \hat{b}\frac{b}{\delta_2} = \frac{b}{2\delta_2}(\gamma_{SZ} - 2)\hat{b} \qquad \text{(A.2.13)}$$

A.2.5 Homogeneous and Mobile capital

Given the definition of cost share of capital in Z_1 production, I write θ_{KZ}^1 as,

$$P_{Z1}^W(Q_1)\theta_{KZ}^1 = a_{KZ}^1(Q_1)r_1$$

Differentiating the above for a given r_1,

$$P_{Z1}^{W'}(Q_1)\theta_{KZ}^1 dQ_1 + P_{Z1}^W(Q_1)d\theta_{KZ}^1 = a_{KZ}^{1'}(Q_1)r_1 dQ_1$$

$$\Rightarrow P_{Z1}^W(Q_1)\left(\frac{Q_1 P_{Z1}^{W'}(Q_1)}{P_{Z1}^W(Q_1)}\right)\theta_{KZ}^1\hat{Q}_1 + P_{Z1}^W(Q_1)d\theta_{KZ}^1 = r_1 a_{KZ}^{1'}(Q_1)\left(\frac{Q_1 a_{KZ}^{1'}(Q_1)}{a_{KZ}^1(Q_1)}\right)\hat{Q}_1$$

$$\Rightarrow P_{Z1}^W(Q_1)d\theta_{KZ}^1 = \left[r_1 a_{KZ}^1(Q_1)\gamma_{KZ}^1 - P_{Z1}^W(Q_1)\gamma_Z^1\theta_{KZ}^1\right]\hat{Q}_1 = P_{Z1}^W(Q_1)\theta_{KZ}^1(\gamma_{KZ}^1 - \gamma_Z^1)\hat{Q}_1$$

$$\Rightarrow d\theta_{KZ}^1 = \theta_{KZ}^1(\gamma_{KZ}^1 - \gamma_Z^1)\hat{Q}_1 \qquad \text{(A.2.14)}$$

Similarly, $d\theta_{SZ}^1 = \theta_{SZ}^1(\gamma_{SZ}^1 - \gamma_Z^1)\hat{Q}_1$ (A.2.15)

Now by definition, $\mu_1(Q_1) \equiv \dfrac{\theta_{KZ}^1(Q_1)}{\theta_{SZ}^1(Q_1)}$, that is, $\mu_1(Q_1)\theta_{SZ}^1(Q_1) = \theta_{KZ}^1(Q_1)$

Total differentiation yields:

$$\frac{d\mu_1(Q_1)}{dQ_1}\theta_{SZ}^1(Q_1) + \mu_1(Q_1)\frac{d\theta_{SZ}^1(Q_1)}{dQ_1} = \frac{d\theta_{KZ}^1(Q_1)}{dQ_1}$$

$$\Rightarrow \frac{d\mu_1(Q_1)}{dQ_1}\theta_{SZ}^1(Q_1) = \frac{d\theta_{KZ}^1(Q_1)}{dQ_1} - \mu_1(Q_1)\frac{d\theta_{SZ}^1(Q_1)}{dQ_1}$$

Substituting expression for $d\theta_{KZ}^1$ from (A.2.14) in the above gives,

$$\Rightarrow \frac{d\mu_1(Q_1)}{dQ_1}\theta_{SZ}^1(Q_1) = \frac{\theta_{KZ}^1(\gamma_{KZ}^1-\gamma_Z^1)}{Q_1} - \mu_1(Q_1)\frac{\theta_{SZ}^1(\gamma_{SZ}^1-\gamma_Z^1)}{Q_1}$$

$$= \frac{\theta_{KZ}^1(\gamma_{KZ}^1-\gamma_Z^1)}{Q_1} - \frac{\theta_{KZ}^1(\gamma_{SZ}^1-\gamma_Z^1)}{Q_1} = \frac{\theta_{KZ}^1(\gamma_{KZ}^1-\gamma_{SZ}^1)}{Q_1}$$

$$\Rightarrow \mu_1'(Q_1) = \frac{\theta_{KZ}^1(\gamma_{KZ}^1-\gamma_{SZ}^1)}{\theta_{SZ}^1 Q_1}$$

So $\mu_1'(Q_1) > 0$ since $\gamma_{KZ}^1 > \gamma_{SZ}^1$.

Proof of Proposition 2.3

(a) By Lemma 2.4, $\mu_1(0) < \mu_1(\overline{Q}_1)$ and thus, given monotonicity of $\mu_1(Q_1)$, $\hat{w}_S^1 > \hat{w}\ \forall\, Q_1 \in [0, \overline{Q}_1]$ if $\frac{\theta_{KX}}{\theta_{LX}} < \mu_1(0)$.

(b) Note that by monotonicity of $\mu_1(Q_1)$, $\tilde{Q}_1 \in [0, \overline{Q}_1]$ will exist only if $\mu(0) < \frac{\theta_{KX}}{\theta_{LX}} < \mu(\overline{Q}_1)$. Rest of the proof follows from Lemma 2.

A.2.6 Reduction of tariff on imported inputs and asymmetric quality variations

From the marginal condition (2.34) in the text, proceeding similarly as in Appendix A.2.1 above I can rewrite (A.2.1) as:

$$\Rightarrow \delta_m \hat{Q}_m = \frac{P_{Zm}^W}{Q_m^2}\left[\theta_{KZ}^m\gamma_{KZ}^m\hat{r}_i + \theta_{SZ}^m\gamma_{SZ}^m\hat{w}_S + \theta_{fZ}^m\gamma_{fZ}^m\rho_m\hat{\tau}_m\right] \qquad \text{(A.2.16)}$$

On the other hand, given that $\hat{r}_1 = 0$ (since the tariff on Y is kept unchanged), the proportional change in skilled wage, and the rate of return to type-2 capital can be obtained from the zero profit condition in Z_m sector given by (2.33) in the text as:

$$\hat{w}_S = -\frac{\theta_{fZ}^1}{\theta_{SZ}^1}\rho_1\hat{\tau}_1,\ \hat{r}_2 = -\frac{\theta_{SZ}^2}{\theta_{KZ}^2}\hat{w}_S - \frac{\theta_{fZ}^2}{\theta_{SZ}^2}\rho_2\hat{\tau}_2 = \frac{\theta_{SZ}^2}{\theta_{KZ}^2}\frac{\theta_{fZ}^1}{\theta_{SZ}^1}\rho_1\hat{\tau}_1 - \frac{\theta_{fZ}^2}{\theta_{SZ}^2}\rho_2\hat{\tau}_2 \qquad \text{(A.2.17)}$$

Substituting this in (A.2.16) yields the changes in quality levels as specified in (2.35) and (2.36) in the text:

$$\hat{Q}_1 = \frac{P_{Z1}^W\theta_{fZ}^1}{\delta_1 Q_1^2}(\gamma_{fZ}^1 - \gamma_{SZ}^1)\rho_1\hat{\tau}_1 \qquad \text{(A.2.18)}$$

$$\hat{Q}_2 = \frac{P_{Z2}^W}{\delta_2 Q_2^2}\left[-\theta_{SZ}^2(\gamma_{SZ}^2 - \gamma_{KZ}^2)\frac{\theta_{fZ}^1}{\theta_{SZ}^1}\rho_1\hat{\tau}_1 + \theta_{fZ}^2(\gamma_{fZ}^2 - \gamma_{KZ}^2)\rho_2\hat{\tau}_2\right] \qquad \text{(A.2.19)}$$

A.2.7 Composite Traded Good and a Non-Traded Good: Segmented labour market

Using the marginal condition (2.7) in the text, from the zero profit condition in the Z sector we get:

$$\theta_{KZ}\hat{r} + \theta_{SZ}\hat{w}_S + \theta_{fZ}\rho\hat{\tau} = 0 \Rightarrow \hat{w}_S = -\frac{\theta_{KZ}}{\theta_{SZ}}\hat{r} - \frac{\theta_{fZ}}{\theta_{SZ}}\rho\hat{\tau} \quad \text{(A.2.20)}$$

The change in quality can be obtained from total differentiation of the marginal condition:

$$\hat{Q} = \frac{P_Z^W}{\delta Q^2}\left(\theta_{SZ}\gamma_{SZ}\hat{w}_S + \theta_{KZ}\gamma_{KZ}\hat{r} + \theta_{fZ}\gamma_{fZ}\rho\hat{\tau}\right) \quad \text{(A.2.21)}$$

where $\delta \equiv \left[P_Z^{W''}(Q) - w_S a''_{SZ}(Q) - ra''_{KZ}(Q) - (1+\tau)a''_{fZ}(Q)\right] < 0$ by the second order condition for profit maximization.

Substitution the value for $\hat{w}_S$ from (A.2.20) in (A.2.21) yields:

$$\hat{Q} = -\frac{P_Z^W}{\delta Q^2}\theta_{KZ}(\gamma_{SZ} - \gamma_{KZ})\hat{r} + \frac{P_Z^W}{\delta Q^2}\theta_{fZ}(\gamma_{fZ} - \gamma_{SZ})\rho\hat{\tau} \quad \text{(A.2.22)}$$

Substitution of $\hat{r} = -\frac{\theta_{fT}}{\theta_{KT}}\beta_f\hat{\tau}_T$ from (2.48) in the text, this boils down to:

$$\hat{Q} = \frac{P_Z^W}{\delta Q^2}\left[\frac{\theta_{KZ}\theta_{fT}}{\theta_{KT}}(\gamma_{SZ} - \gamma_{KZ})\beta_f\hat{\tau}_T + \theta_{fZ}(\gamma_{fZ} - \gamma_{SZ})\rho\hat{\tau}\right] \quad \text{(A.2.22a)}$$

where, $\beta_f \equiv \frac{\tau_T}{1+\tau_T}$.

Now to obtain change in the informal unskilled wage, $\hat{w} = \frac{\hat{P}_N}{\theta_{LN}} - \frac{\theta_{KN}}{\theta_{LN}}\hat{r}$ as given in (2.50) in the text, change in the price of the non-traded good is obtained from the market clearing condition as:

$$-\varepsilon_N\hat{P}_N = \hat{X}_N - \hat{X}_T \quad \text{(A.2.23)}$$

Regarding the output changes, from the capital constraint and the skilled-labour constraint I obtain:

$$-\left(\gamma_{KZ}\hat{Q} - \hat{X}_Z\right)\lambda_{KZ} = \lambda_{KT}\hat{X}_T + \lambda_{KN}\hat{X}_N \quad \text{(A.2.24)}$$

$$\hat{X}_Z = -\gamma_{SZ}\hat{Q} \quad \text{(A.2.25)}$$

Substitution of (A.2.25) in (A.2.24) yields:

$$\lambda_{KN}\hat{X}_N + \lambda_{KT}\hat{X}_T = \lambda_{KZ}(\gamma_{SZ} - \gamma_{KZ})\hat{Q} \quad \text{(A.2.26)}$$

On the other hand, a trade-off between changes in output of the composite traded good and of the non-traded good is given by the unskilled-labour constraint:

$$0 = \lambda_{LT}\hat{X}_T + \lambda_{LN}\hat{X}_N \quad \text{(A.2.27)}$$

Representing (A.2.27) and (A.2.26) in matrix notation,

$$\begin{bmatrix}\lambda_{LT} & \lambda_{LN}\\ \lambda_{KT} & \lambda_{KN}\end{bmatrix}\begin{bmatrix}\hat{X}_T\\ \hat{X}_N\end{bmatrix}=\begin{bmatrix}0\\ \lambda_{KZ}(\gamma_{SZ}-\gamma_{KZ})\hat{Q}\end{bmatrix}$$

and solving for the values of $\hat{X}_T$ and $\hat{X}_N$ yields:

$$\hat{X}_T=-\frac{\lambda_{KZ}\lambda_{LN}(\gamma_{SZ}-\gamma_{KZ})\hat{Q}}{|\lambda|};\ \hat{X}_N=\frac{\lambda_{KZ}\lambda_{LT}(\gamma_{SZ}-\gamma_{KZ})\hat{Q}}{|\lambda|} \tag{A.2.28}$$

Substituting (A.2.28) in (A.2.23) yields:

$$\hat{P}_N=-\frac{\hat{X}_N-\hat{X}_T}{\varepsilon_N}=-\frac{\lambda_{KZ}(\gamma_{SZ}-\gamma_{KZ})\hat{Q}}{|\lambda|\varepsilon_N} \tag{A.2.29}$$

as in the text.

Substitution of (A.2.22a) yields:

$$\hat{P}_N=-\frac{P_Z^W\lambda_{KZ}}{\delta Q^2\varepsilon_N|\lambda|}\left[\frac{\theta_{KZ}\theta_{fT}}{\theta_{KT}}(\gamma_{SZ}-\gamma_{KZ})^2\beta_f\hat{\tau}_T+\theta_{fZ}(\gamma_{SZ}-\gamma_{KZ})(\gamma_{fZ}-\gamma_{SZ})\rho\hat{\tau}\right]$$

Using this and $\hat{r}=-\frac{\theta_{fT}}{\theta_{KT}}\beta_f\hat{\tau}_T$, I can write the change in the informal unskilled wage as:

$$\hat{w}=-\frac{P_Z^W\lambda_{KZ}}{\delta Q^2\varepsilon_N|\lambda|\theta_{LN}}\left[\frac{\theta_{KZ}\theta_{fT}}{\theta_{KT}}(\gamma_{SZ}-\gamma_{KZ})^2\beta_f\hat{\tau}_T+\theta_{fZ}(\gamma_{SZ}-\gamma_{KZ})(\gamma_{fZ}-\gamma_{SZ})\rho\hat{\tau}\right]+\frac{\theta_{KN}\theta_{fT}}{\theta_{LN}\theta_{KT}}\beta_f\hat{\tau}_T$$

Rearrangement yields the expression as in (2.52) in the text.

Finally subtracting this from $\hat{w}_S=\frac{\theta_{KZ}}{\theta_{SZ}}\frac{\theta_{fT}}{\theta_{KT}}\beta_f\hat{\tau}_T-\frac{\theta_{fZ}}{\theta_{SZ}}\rho\hat{\tau}$ as in (2.49) in the text, I get the change in wage inequality as:

$$\hat{w}_S-\hat{w}=\left[\frac{\theta_{KZ}\theta_{fT}}{\theta_{SZ}\theta_{KT}}-\frac{\theta_{KN}\theta_{fT}}{\theta_{LN}\theta_{KT}}+\frac{P_Z^W}{\delta Q^2}\frac{\lambda_{KZ}\theta_{KZ}\theta_{fT}}{\varepsilon_N|\lambda|\theta_{LN}\theta_{KT}}(\gamma_{SZ}-\gamma_{KZ})^2\right]\beta_f\hat{\tau}_T-\left[\frac{\theta_{fZ}}{\theta_{SZ}}-\frac{P_Z^W}{\delta Q^2}\frac{\theta_{KZ}\theta_{fZ}}{\varepsilon_N|\lambda|\theta_{LN}}(\gamma_{SZ}-\gamma_{KZ})(\gamma_{fZ}-\gamma_{SZ})\right]\rho\hat{\tau}$$

A.2.7 Composite Traded Good and a Non-Traded Good under flexible unskilled wage

For $\hat{\tau}=0$, (A.2.22) gives us a relationship between Q and the r consistent with the marginal condition for profit maximizing choice of export quality as specified in the text:

$$\left.\frac{dr}{dQ}\right|_{QQ}=-\frac{1}{\frac{P_Z^W}{\delta Q^2}\theta_{KZ}(\gamma_{SZ}-\gamma_{KZ})}\frac{r}{Q} \tag{A.2.22b}$$

For the reverse causality I proceed as follows. Since *w* is flexible now in the T-sector, so the rate of return to capital changes with P_N as well. From the zero profit conditions in (T, N) changes in the unskilled wage and the rate of return to capital when P_N changes can be traced out as follows:

$$\begin{aligned}\theta_{LT}\hat{w}+\theta_{KT}\hat{r}&=-\theta_{fT}\beta_f\hat{\tau}_T\\ \theta_{LN}\hat{w}+\theta_{KN}\hat{r}&=\hat{P}_N\end{aligned} \quad \Rightarrow \begin{bmatrix}\theta_{LT} & \theta_{KT}\\ \theta_{LN} & \theta_{KN}\end{bmatrix}\begin{bmatrix}\hat{w}\\ \hat{r}\end{bmatrix}=\begin{bmatrix}-\theta_{fT}\beta_f\hat{\tau}_T\\ \hat{P}_N\end{bmatrix}$$

Solution yields:

$$\hat{w}=-\frac{\theta_{KT}}{|\theta|}\hat{P}_N-\frac{\theta_{KN}\theta_{fT}}{|\theta|}\beta_f\hat{\tau}_T \text{ , } \hat{r}=\frac{\theta_{LT}}{|\theta|}\hat{P}_N+\frac{\theta_{LN}\theta_{fT}}{|\theta|}\beta_f\hat{\tau}_T \quad \text{(A.2.30)}$$

where, $|\theta|$ is the determinant of the cost share matrix in the (T, N) nugget.

Hence, using (A.2.29), from (A.2.30) I obtain the change in r following a change in Q as:

$$\frac{\lambda_{KZ}(\gamma_{SZ}-\gamma_{KZ})\hat{Q}}{|\lambda|}+\frac{\varepsilon_N\,|\theta|}{\theta_{LT}}\hat{r}=\frac{\varepsilon_N\theta_{LN}\theta_{fT}}{\theta_{LT}}\beta_f\hat{\tau}_T \quad \text{(A.2.31)}$$

For $\hat{\tau}_T=0$, (A.2.31) gives us a relationship between Q and r consistent with the market-clearing condition for the non-traded good as captured by the rr curve in the text:

$$\left.\frac{dr}{dQ}\right|_{M_N}=-\frac{\theta_{LT}\lambda_{KZ}(\gamma_{SZ}-\gamma_{KZ})}{\varepsilon_N\,|\theta|\,|\lambda|}\frac{r}{Q} \quad \text{(A.2.31a)}$$

Rewriting (A.2.31) and (A.2.22) in matrix notation,

$$\begin{bmatrix}\dfrac{\lambda_{KZ}(\gamma_{SZ}-\gamma_{KZ})}{|\lambda|} & \dfrac{\varepsilon_N\,|\theta|}{\theta_{LT}}\\ 1 & \dfrac{P_Z^W}{\delta Q^2}\theta_{KZ}(\gamma_{SZ}-\gamma_{KZ})\end{bmatrix}\begin{bmatrix}\hat{Q}\\ \hat{r}\end{bmatrix}=\begin{bmatrix}\dfrac{\varepsilon_N\theta_{LN}\theta_{MT}}{\theta_{LT}}\beta_M\hat{\tau}_M\\ \dfrac{P_Z^W}{\delta Q^2}\theta_{IZ}(\gamma_{IZ}-\gamma_{SZ})\rho\hat{\tau}\end{bmatrix}$$

we solve for $\hat{Q}$ and $\hat{r}$ in terms of the parameters as:

$$\hat{Q}=\frac{1}{\Delta}\frac{P_Z^W}{\delta Q^2}\left[\frac{\varepsilon_N\theta_{LN}\theta_{KZ}\theta_{MT}}{\theta_{LT}}(\gamma_{SZ}-\gamma_{KZ})\beta_M\hat{\tau}_M-\frac{\varepsilon_N\theta_{IZ}\,|\theta|}{\theta_{LT}}(\gamma_{IZ}-\gamma_{SZ})\rho\hat{\tau}\right] \quad \text{(A.2.32)}$$

$$\hat{r}=\frac{1}{\Delta}\left[\frac{P_Z^W}{\delta Q^2}\frac{\lambda_{KZ}\theta_{IZ}}{|\lambda|}(\gamma_{SZ}-\gamma_{KZ})(\gamma_{IZ}-\gamma_{SZ})\rho\hat{\tau}-\frac{\varepsilon_N\theta_{LN}\theta_{MT}}{\theta_{LT}}\beta_M\hat{\tau}_M\right] \quad \text{(A.2.33)}$$

where, $\Delta=\left(\dfrac{\lambda_{KZ}\theta_{KZ}(\gamma_{SZ}-\gamma_{KZ})^2}{|\lambda|}\dfrac{P_Z^W}{\delta Q^2}-\dfrac{\varepsilon_N\,|\theta|}{\theta_{LT}}\right)>0$ since $|\theta|<0$.

Turning now to wage inequality, first of all note that substitution of (A.2.33) in (A.2.20) yields the equilibrium change in the skilled wage:

$$\hat{w}_S=-\frac{\theta_{KZ}}{\theta_{SZ}}\frac{1}{\Delta}\left[\frac{P_Z^W}{\delta Q^2}\frac{\lambda_{KZ}\theta_{IZ}}{|\lambda|}(\gamma_{SZ}-\gamma_{KZ})(\gamma_{IZ}-\gamma_{SZ})\rho\hat{\tau}-\frac{\varepsilon_N\theta_{LN}\theta_{MT}}{\theta_{LT}}\beta_M\hat{\tau}_M\right]-\frac{\theta_{IZ}}{\theta_{SZ}}\rho\hat{\tau}$$

$$\Rightarrow \hat{w}_S=-\frac{\theta_{IZ}}{\theta_{SZ}}\left[\frac{P_Z^W}{\delta Q^2\Delta}\frac{\lambda_{KZ}\theta_{KZ}}{|\lambda|}(\gamma_{SZ}-\gamma_{KZ})(\gamma_{IZ}-\gamma_{SZ})+1\right]\rho\hat{\tau}+\frac{\varepsilon_N\theta_{LN}\theta_{MT}}{\Delta\theta_{LT}}\frac{\theta_{KZ}}{\theta_{SZ}}\beta_M\hat{\tau}_M \quad \text{(A.2.34)}$$

For $\hat{\tau}<0=\hat{\tau}_T$,

$$\hat{w}_S=\frac{\theta_{fZ}}{\theta_{SZ}}\left[-\frac{P_Z^W}{\delta Q^2\Delta}\frac{\lambda_{KZ}\theta_{KZ}}{|\lambda|}(\gamma_{SZ}-\gamma_{KZ})(\gamma_{fZ}-\gamma_{SZ})-1\right]\rho\hat{\tau}$$

$$\Rightarrow \hat{w}_S = \frac{\theta_{fZ}}{\theta_{SZ}}\left[\frac{-P_Z^W \lambda_{KZ}\theta_{KZ}(\gamma_{SZ}-\gamma_{KZ})(\gamma_{fZ}-\gamma_{SZ})-\delta Q^2\Delta|\lambda|}{\delta Q^2\Delta|\lambda|}\right]\rho\hat{\tau}$$

$$\Rightarrow \hat{w}_S = \frac{\theta_{fZ}}{\theta_{SZ}}\left[\frac{-P_Z^W \lambda_{KZ}\theta_{KZ}(\gamma_{SZ}-\gamma_{KZ})(\gamma_{fZ}-\gamma_{SZ})-P_Z^W \lambda_{KZ}\theta_{KZ}(\gamma_{SZ}-\gamma_{KZ})^2+\frac{\varepsilon_N\delta Q^2\Delta|\lambda||\theta|}{\theta_{LT}}}{\delta Q^2\Delta|\lambda|}\right]\rho\hat{\tau}$$

$$\Rightarrow \hat{w}_S = \frac{\theta_{fZ}}{\theta_{SZ}}\left[\frac{P_Z^W \lambda_{KZ}\theta_{KZ}(\gamma_{SZ}-\gamma_{KZ})(-\gamma_{fZ}+\gamma_{SZ}-\gamma_{SZ}+\gamma_{KZ})+\frac{\varepsilon_N\delta Q^2\Delta|\lambda||\theta|}{\theta_{LT}}}{\delta Q^2\Delta|\lambda|}\right]\rho\hat{\tau}$$

$$\Rightarrow \hat{w}_S = \frac{\theta_{fZ}}{\theta_{SZ}}\left[\frac{P_Z^W \lambda_{KZ}\theta_{KZ}(\gamma_{SZ}-\gamma_{KZ})(\gamma_{KZ}-\gamma_{fZ})+\frac{\varepsilon_N\delta Q^2\Delta|\lambda||\theta|}{\theta_{LT}}}{\delta Q^2\Delta|\lambda|}\right]\rho\hat{\tau}$$

Hence, for $\gamma_{KZ} > \gamma_{SZ}$, $\hat{w}_S > 0$ if $\gamma_{KZ} > \gamma_{fZ}$.

Second, substitution of (A.2.32) in (A.2.29) yields change in the price of the non-traded good as:

$$\hat{P}_N = -\frac{\lambda_{KZ}(\gamma_{SZ}-\gamma_{KZ})}{|\lambda|\varepsilon_N}\frac{P_Z^W}{\delta Q^2\Delta}\left[\frac{\varepsilon_N\theta_{LN}\theta_{KZ}\theta_{MT}}{\theta_{LT}}(\gamma_{SZ}-\gamma_{KZ})\beta_M\hat{\tau}-\frac{\varepsilon_N\theta_{IZ}|\theta|}{\theta_{LT}}(\gamma_{IZ}-\gamma_{SZ})\rho\hat{\tau}\right]$$

$$\Rightarrow \hat{P}_N = -\frac{P_Z^W\lambda_{KZ}}{\delta Q^2\Delta|\lambda|}\left[\frac{\theta_{LN}\theta_{KZ}\theta_{MT}}{\theta_{LT}}(\gamma_{SZ}-\gamma_{KZ})^2\beta_M\hat{\tau}_M-\frac{\theta_{IZ}|\theta|}{\theta_{LT}}(\gamma_{SZ}-\gamma_{KZ})(\gamma_{IZ}-\gamma_{SZ})\rho\hat{\tau}\right] \quad \text{(A.2.35)}$$

Hence, from (A.2.30) change in the unskilled wage can be worked out as:

$$\hat{w} = \frac{\theta_{KT}}{|\theta|}\frac{P_Z^W\lambda_{KZ}}{\delta Q^2\Delta|\lambda|}\left[\frac{\theta_{LN}\theta_{KZ}\theta_{MT}}{\theta_{LT}}(\gamma_{SZ}-\gamma_{KZ})^2\beta_M\hat{\tau}_M-\frac{\theta_{IZ}|\theta|}{\theta_{LT}}(\gamma_{SZ}-\gamma_{KZ})(\gamma_{IZ}-\gamma_{SZ})\rho\hat{\tau}\right]-\frac{\theta_{KN}\theta_{MT}}{|\theta|}\beta_M\hat{\tau}_M$$

$$\Rightarrow \hat{w} = \left[-\frac{\theta_{KN}\theta_{MT}}{|\theta|}+\frac{\theta_{KT}}{|\theta|}\frac{P_Z^W\lambda_{KZ}}{\delta Q^2\Delta|\lambda|}\frac{\theta_{LN}\theta_{KZ}\theta_{MT}}{\theta_{LT}}(\gamma_{SZ}-\gamma_{KZ})^2\right]\beta_M\hat{\tau}_M-\frac{P_Z^W\lambda_{KZ}}{\delta Q^2\Delta|\lambda|}\frac{\theta_{KT}\theta_{IZ}}{\theta_{LT}}(\gamma_{SZ}-\gamma_{KZ})(\gamma_{IZ}-\gamma_{SZ})\rho\hat{\tau} \quad \text{(A.2.36)}$$

Subtraction of (A.2.36) from (A.2.34) yields the expression for change in the wage inequality as:

$$\hat{w}_S-\hat{w} = \frac{\theta_{fZ}}{\theta_{SZ}\delta Q^2\Delta|\lambda|}\left[P_Z^W\lambda_{KZ}\theta_{KZ}(\gamma_{SZ}-\gamma_{KZ})(\gamma_{KZ}-\gamma_{fZ})+\frac{\varepsilon_N\delta Q^2\Delta|\lambda||\theta|}{\theta_{LT}}+\frac{P_Z^W\lambda_{KZ}\theta_{KT}\theta_{fZ}}{\theta_{LT}}(\gamma_{SZ}-\gamma_{KZ})(\gamma_{fZ}-\gamma_{SZ})\right]\rho\hat{\tau}$$
$$+\left[\frac{\varepsilon_N\theta_{LN}\theta_{MT}}{\Delta\theta_{LT}}\frac{\theta_{KZ}}{\theta_{SZ}}+\frac{\theta_{KN}\theta_{MT}}{|\theta|}-\frac{P_Z^W\lambda_{KZ}}{\delta Q^2\Delta|\lambda||\theta|}\frac{\theta_{KT}\theta_{LN}\theta_{KZ}\theta_{MT}}{\theta_{LT}}(\gamma_{SZ}-\gamma_{KZ})^2\right]\beta_M\hat{\tau}_M$$

(A.2.37)

Hence, $\hat{w}_S-\hat{w} > 0$ for $\hat{\tau} < 0 = \hat{\tau}_T$ when $\gamma_{KZ} > \gamma_{fZ} > \gamma_{SZ}$.

Chapter 3

Infrastructure Development, Export Quality and Labour Market Implications

3.1 Introduction

3.1.1 Perspective and Motivation

The role of infrastructure development as one of the key drivers of international competitiveness of a country has been well documented by researchers during the last two decades in particular. Success stories of export promotion and export-led growth have been associated with better infrastructure (Calderon´ and Serv´en (2005), Egert, Ko´zluk, and Sutherland (2009), Esfahani and Ramirez (2002), Fernald (1999), Ismail and Mahyideen (2015), Xing (2018)). On the other hand, Hummels (2001) demonstrated that inadequate infrastructure and poor transport networks adversely affect timely delivery and flexibility in the supply of goods that are major impediments for manufacturers to participate in global outsourcing. Inadequate or poor infrastructure also adversely affects export intensity and export participation, and explains why firms often sell larger proportions of their productions in the domestic markets (Hummels (2001), Moyo (2012)). Among other types of infrastructure, the information and communication technology (ICT) plays a major role in service trade and unlocking e-trade or digital-trade potentials of nations. Better telecommunication and advanced network connectivity can augment trade by enhancing factor productivity and thus establish or pronounce comparative advantage in service exports. For example, ICT infrastructure has been the key to success story of India in pushing up its growth rates in the last two decades through exports of IT-enabled services (ITeS), and some of the few East Asian countries such as China, Korea, and Vietnam.

Given such a perspective, in this chapter we examine the role of infrastructure development for upgrading export quality and thus promoting exports at the extensive margin. For the purpose, we consider two types of infrastructure – road infrastructure and

ICT infrastructure – that are specific to and relevant for exports of manufactured products and IT-enabled-services respectively. We primarily focus on the trade-off the government may face in the development of these two types of infrastructures due to the limited financing resources at its disposal. We analyze the implications of such a trade-off for choice of export quality.

In Section 3.1.2, I review the existing literature and in Section 3.1.3 I define my research objectives. In thetheoretical analysis in Section 3.2, I consider a quality-differentiated service-export, such as ITeS exports, for which level and quality of ICT infrastructure is highly relevant. With rest of the economy producing a composite traded good and a non-traded good, as in Section 2.7 in Chapter 2, I explore whether an increase in government expenditure on ICT infrastructure development induces quality upgrading of ITeS exports. In Section 3.3, I introduce another quality-differentiated manufacturing export-good, for which hard infrastructure like paved roads are more important. The fundamental purpose to consider two different types of infrastructures being used in production of two different types of exports is to highlight the sector-specific as well as factor-specific impacts that different types of infrastructures generate. Both types of infrastructure generate factor-productivity augmenting effects as well as adverse cost-cascading effects that originate in a certain sector and then get transmitted to other sectors of the economy in a general equilibrium framework. I assume that the government is a sole provider and invests in both road and ICT infrastructures through deficit financing, keeping with the fact that in the developing and less developed countries it is the government that plays the predominant role in financing and operating different types of infrastructure facilities including telecommunications networks.[21] In such a scenario I investigate how variations in the budgetary allocations would affect the export quality choices of the quality-differentiated export good and the quality-differentiated ITeS exports through domestic factor cost effects. I also look into the implications of the same for wage inequality between the skilled and unskilled workers. Finally in Section 3.5, I summarize the results

[21] In many instances, government investment in infrastructure seems to be driven by the motive of preventing private monopolies, and generating positive externalities from such social overheads. However, in a future extension I plan to study provision of ICT infrastructure by private firms, or through a public-private partnership.

derived in the current Chapter, and discuss some extensions of the present analysis and future research agenda in this regard.

3.1.2 Literature Review

Transport costs or transaction costs at largeand productivity of domestic factors of production, rather than individual firms, stand out as two key determinants of performance of exporters of a country and thus the gains from exports. In this sense, better infrastructural facilities can augment trade in broadly two ways. First, infrastructure facilities like improved port efficiency and increased provision of smooth paved roads, lower transaction costs and promote efficient export of commodities that. Development of such physical infrastructures may even establish comparative advantage in goods which were earlier not traded. In the literature, this dimension is termed as missing trade and has been well documented (Limao and Venables (2001), Clark et al (2004), Francois and Manchin (2007), UNCTAD (2003 a, b)). In the context of a Ricardian continuum goods model, Dornbusch, Fisher, Samuelson (1977), on the other hand, showed how transport cost causes countries to export a smaller range of goods than their respective comparative advantages would allow had there been no transport cost. With the decrease in the level of transport cost, the set of goods not being traded contracts. Thus, hard infrastructure facilitates trade at the extensive margin by lowering costs of transport goods. Second, infrastructural facilities, like better telecommunication, augment factor productivity and thus facilitate the volume as well as quality of service exports such as ITeS. The World Bank (2016), for example, identifies ICT as the digital dividend for trade.

So, different types of infrastructures may have different effects on the promotion of different types of exports. As discussed in Soobramanien and Zhuawu (2014) among others, and what I take up here as well is, rather than considering a combined overall index of infrastructure it is more effective to identify different types of infrastructure indicators and the distinct ways each work to boost export promotion prospects. The idea is to identify the sector-specific and input-specific impacts of various types of infrastructure. Studies in general equilibrium frameworks that capture such differential effects, and consequent cost of production changes due to resource allocation and change in factor prices, are indeed scant.

Few examples of studies that have taken up separate strands of infrastructure and analyzed how they facilitate and augment trade volumes include Moyo (2012), Blyde and Iberti (2014), Martincusa, Carballob and Cusolito (2017), Fiorini, Sanlippo and Sundaram (2017), and Park (2020). These studies reveal significant positive impact of quality of transport infrastructure and emphasizes upon port efficiency to be a major determinant of export performances. Garcia-Escribano et. al (2015) looked at the issue from the other side and found that an inadequate transport infrastructure indeed minimises productivity, promoting weak market integration and adversely impacting export levels. In a very recent study, Rehman and Sohag (2022) derived that higher indices of transport infrastructure spurs export sophistication and diversification both in the short run and long run in the G-20 economies by applying the cross-sectional dependency autoregressive distributed lag (ARDL) approach. Again Sénquiz-Díaz (2021) measured the effects of transport-freight common modals and logistics performance on the exports of goods in 29 developing economies based on micro fixed-effects panel data for the period 2012-2018. The results revealed that the quality of roads and ports contribute significantly to higher exports in developing economies. However, the quality of airport infrastructure and logistics show a harmful effect. She concluded that governments should prioritize formulating innovative policies to fully utilize current transportation assets, particularly airports in order to facilitate higher exports and expand export product diversification opportunities. This brings up the fact, which we also highlight in our analysis, that, not all types of infrastructures may end up delivering beneficial effects for export performance. Literature on impact of road infrastructure is found to abound in studies on how the quality of inland freight modes is relevant for timely delivery of tangible exports with intact quality (Rodrigue and Notteboom (2017)), reducing additional transportation costs, such as higher fuel consumption and transit time (Celbis, Nijkamp and Poot (2014)). Success stories about the usefulness of road infrastructure in trade have been documented at the country level as well. For example, Cosar and Demir (2014) established that investments in development of roads in Turkey augmented its exports by reducing transportation costs related to the movement of goods from the point of origin to destination markets on time. Kodongo and Ojah (2016) discovered that growth in Sub-Saharan Africa had also largely benefitted from continuous spending in road infrastructure. Jha and Arao (2018) asserts that in order to sustain trade-led growth, South Asian countries needs to invest heavily and steadily, almost 9% of its gross domestic product on infrastructure development over 2016–2030. They further discuss public and private sector financing of infrastructure and examines the factors driving infrastructure investment.

Beside road infrastructure, that investment in enhancing digital connectivity in terms of mobile/cellular, fixed broadband, and internet penetration do have a significant positive impact and is a major determinant of export performances of both developed and developing countries, have also been well documented. For example, Nordås and Piermartini (2004) in their study explored the role of quality of infrastructure on a country's trade performance by estimating a gravity model. By incorporating a number of indicators for the quality of infrastructure, they find that, among other things, timeliness and access to telecommunication are relatively more important for export competitiveness in the clothing and automotive sector. Again, Ismail and Mahyideen (2015) quantify the impacts of both hard and soft infrastructure on trade volume for exporters and importers in the region of Asia. They considered number of telephone lines, mobile phones, broadband access, internet users, and secure internet servers as indicators of ICT infrastructure, and concluded that although more attention has traditionally been given to hard infrastructure, the impact of soft infrastructure on trade flows must be more thoroughly examined. In an earlier study at the industry level, Shanks and Barnes (2008) estimated the effect of communications infrastructure on multi-factor productivity growth for Australia. Calderon and Severn (2002), on the other hand, estimated the effect of various types of infrastructure on growth and its implications for cross country inequality for over 100 countries. More recently, Xing (2018) examined the impact of internet and e-commerce adoption on bilateral trade flows using a panel of 21 developing- and least-developed countries and 30 OECD countries and found that better access to the modern ICT stimulates such bilateral trade flows. The study notes that the efficient use of ICT equipped with high speed internet and secured servers is a crucial milestone for unlocking the e-trade potentials for the developing and least-developed counties. Abeliansky and Hilbert (2017), Gnangnon and Iyer (2018), Kneller and Timmis (2016), Fernandes et al. (2019), Rodríguez-Crespo and Martínez-Zarzoso (2019) are some of the latest studies that also investigated the impact of ICT development on volume of trade. A very recent paper by Abeliansky et. al (2021) has tried to relate ICT to both the extensive and intensive margin of trade (the fraction of products that are exported and the market share, respectively). Using a dataset on the number of subscriptions (per capita) and the average quality of subscriptions (bandwidth), they applied an augmented Gravity Model of Trade for 150 countries over 1995–2014. Regression results prove that ICT matter immensely for the extensive margin of trade as well. As trade owes so much to development of ICT, on the basis of need assessment, Asian Development Bank quotes that investment in the telecommunication sector is needed to be $2.3 trillion from 2016 to 2030 (ADB report 2017).

3.1.3 Research Objectives

All these empirical works focus on infrastructure development enhancing the volume of trade, and hence gains in intensive margin. But, what impact infrastructure development may have on the *quality* of goods and services exported, and for the gains in the extensive margin, has not been addressed. To best of my knowledge, there is no theoretical analyse as well that focuses on such a relationship between infrastructure development (and its quality) and quality of goods and/or services exported by a country. With the exception of Acharyya (2014), the existing literature reviewed above also ignores the costs that infrastructure development may inflict upon the export sectors. While provision of better infrastructure benefits export sectors by improving productivity of factors and/or lowering cost of transporting the production, on one hand, it also raises factor costs since it uses some common scarce resources (such as, capital and/or land) as are used for production of export goods and services, on the other hand. Thus, as long as upgrading the quality of ITeS exports require more intensive use of domestic factors like skilled labour, development and provision of ICT infrastructure may have similar favourable and adverse effects on the quality of ITeS. Accordingly, raising the quality of ITeS exports through provision of ICT infrastructure (and a higher quality/efficiency of it) is not a foregone conclusion, and is thus worthwhile to analyze as well.

Development of road infrastructure may also have factor-cost cascading effects upon manufacturing exports. Acharyya (2014) had taken into account and formalised such adverse effects of infrastructure development on trade through rise in factor price(s). Extending the Ricardian continuum of goods model of Dornbusch, Fischer, and Samuelson (1977), he showed that public investment in hard infrastructure, like paved roads, that lowers the cost of transporting goods, does not necessarily lead to more goods being traded. My focus, however, is on the quality dimension of exports. In this context, I also take into account the trade-offs between two types of infrastructure that may arise in two ways. First, if the total budget allocation is fixed, then an increase in its allocationon one type of infrastructure means a commensurate decrease in allocation on the other type. Second, cost-cascading effect of each type of infrastructure lowers availability and/or quality of the other type. I shall elaborate upon these trade-offs later. Thus, apart from costs and benefits generated from development of each type of infrastructure, there are also *cross-effects* arising from these trade-offs. This is one of the highlighting dimensions of my analysis in this chapter. Finally, I also consider the distributional implications of a change in budgetary provision on the two types of infrastructures by examining the changes in the skilled-unskilled wage gap.

In sum, the analysis in this Chapter has three highlighting facets. First, I argue that infrastructure development may not necessarily improve export quality if a common basket of factors of production with fixed endowments is used to produce both infrastructure and final goods, which leads to cost-cascading effects. Second, I examine the sector-specific and factor-specific effects of different types of infrastructure and trade-offs that are faced by the government in developing different types of infrastructure. Finally, I examine the distributional implications of infrastructure development.

3.2 ICT Infrastructure Development and Quality of IT-enabled Service Exports[22]

3.2.1 Assumptions and Analytical Structure

In this section I explore whether and how increase in government investment in ICT infrastructure development through deficit financing induces quality upgrading of IT enabled services exports. I continue with the competitive general equilibrium production structure of a small open economy as in Section 2.6. To recall briefly, the economy has two broad sectors: the homogenous goods sector comprising of the composite traded good (T), which is all the homogenous traded goods clubbed together, and the non-traded good (N), making up the (T, N) nugget. T is produced using capital (K) and unskilled labour (L) and an imported input (M); and N uses only the domestic inputs. The other sector produces a quality-differentiated IT enabled service (ITeS) exports (Z), which does not involve any cross-border physical delivery mechanism. It primarily identifies with non-tangible skill intensive services whose production may not be subject to the availability of a structured office space with office equipment and capital supplies. Examples of such service exports are all IT-enabled services (ITeS) like banking and insurance services, software services, consultancy services related to law, medicine, education, and the like. The scope of the work-from-home for such ITeS, which has gained popularity among the ITeS providers world-wide during and after the Covid-19 pandemic, makes access to high speed uninterrupted telecommunication network and connection facilitiesfor the skilled worker as an essential prerequisite for production and export of such services. So instead of *physical capital* being used alongside skilled workers to produce a quality-differentiated manufacturing export-good, as specified in Chapter 2, the ICT service-quality is considered here to be a crucial factor along with skilled labour for the ITeS export Z. Since here my focus is not on input tariff reduction as a policy initiative, Iassume away the use of the imported input (I) in the Z sector. Similar to the technological specification in Chapter 2, higher quality varieties of ITeSrequire more intensive use of skilled labour (S). On the other hand, for any given quality Q of the ITeS, the per unit requirement of skilled worker declines as the quality of ICT infrastructure and consequently the quality of ICT service improves. That is, better

[22] This section is based on Ganguly and Acharyya (2021b).

quality of ICT service raises the productivity of skilled workers. For example, better connectivity and improved network speed (such as upgrading to 4G from 3G, or to 5G from 4G) enables a skilled worker to generate a given amount of Z-service in lesser amount of time. Let $q \in (0, \overline{q})$ represents the index of quality of ICT infrastructure provided by the government. Then per unit requirement of skilled labour varies positively with Q and inversely with *q*. More precisely,

$$a_{SZ} = a_{SZ}(Q,q), \frac{\partial a_{SZ}(Q,q)}{\partial Q} > 0, \frac{\partial^2 a_{SZ}(Q,q)}{\partial Q^2} > 0, \frac{\partial a_{SZ}(Q,q)}{\partial q} < 0, \frac{\partial}{\partial q}\left(\frac{\partial a_{SZ}(Q,q)}{\partial Q}\right) < 0 \qquad (3.1)$$

Note that in second-partial derivative on the extreme right I assume that if production technology for Z is such that an one percent improvement in its quality requires α-percent increase in skilled labour per unit of the Z-services, then better quality of the ICT infrastructure reduces the extent of such additional skilled labour requirement to less than α-percent[23]. As I will show later, an improvement in quality of ICT services will incentivize upgrading of quality of Z-services for any given level of the skilled wage through this specific skilled-labour-productivity augmenting effects.[24]

In addition, better quality of ICT infrastructure also reduces the use of ICT service per unit of for production of the Z-services. For example, poor network speed and connectivity would mean longer time for uploading and delivery of the service to the clients or consumers of Z-services, and consequently usage of longer time unit of the ICT service. Conversely, a higher quality of the ICT infrastructure and service would reduce its usage time for every unit of Z service being generated and delivered overseas. Thus, if we denote per unit use of ICT service – in time unit, say – by a_{IZ}, then:

$$a_{IZ} = a_{IZ}(q), a'_{IZ}(q) < 0 \qquad (3.2)$$

---

[23]An example of a specific functional form which will satisfy these properties is, $a_{SZ}(Q,q) = \frac{bQ^2}{q}$.

[24] I assume that the service providers of Z are equipped with the necessary technological support needed at their end to adopt the upgraded and better quality of ICT service once it is madeavailable by the government. They might incur fixed outlay costs in the process, but that will not affect the choice of export quality and thus have been normalized to keep the analysis simple.

As in Chapter 2, per unit input requirements to produce T and N are technologically fixed.

Given these assumptions, the analytical structure of our economy is specified by the following equations. First, perfect competition in commodity markets implies that producers of the three goods earn zero profits. Recall the zero-profit conditions for goods T and N specified in Section 2.6 in Chapter 2, which are reproduced below:

$$P_T^W = a_{LT} w + a_{KT} r + (1+\tau_T) a_{fT} \tag{3.3}$$

$$P_N = a_{LN} w + a_{KN} r \tag{3.4}$$

where, r is the rate of return to capital; w is the unskilled wage; P_T^W is the world price of the composite traded good given exogenously under the assumption of the economy under consideration being small; exogenously given world price of the imported input is normalized to unity; P_N is the price of the non-traded good which is determined locally; and $a_{ij}, i = L, K, f; j = T, N$, is per unit requirement of factor-*i* in producing homogeneous good *j*.

Regarding the quality-differentiatedITeS (Z), the world price of it that the foreign users are willing to pay rises with its better quality, similar to the world price of quality-differentiated manufacturing export goods discussed in Chapter 2. Thus,

$$P_Z^W = P_Z^W(Q), P_Z^{W'}(Q) > 0, P_Z^{W''}(Q) > 0 \tag{3.5}$$

Given these specifications in (3.1), (3.2)and (3.5), the zero-profit condition for the Z services can be written as:

$$P_z^w(Q) = a_{IZ}(q) P_I + a_{SZ}(Q, q) w_S \tag{3.6}$$

where, w_S is the skilled wage and P_I is the locally determined price of ICT service per unit charged by the government which may be conceived as usage charges per unit of time. Since ICT service is essentially a publicly provided private service so such user charges can be imposed and recovered.

The profit maximizing choice of quality Q_0 of ITeS is the one for which the marginal revenue from quality upgrading equals the marginal cost of quality upgrading, for any given level of quality of the ICT infrastructure:

$$P_Z^{W\prime}(Q_0) = \frac{\partial a_{SZ}(Q_0, q)}{\partial Q} w_S \qquad (3.7)$$

It is evident from this marginal condition that by the assumption made in (3.1), an improvement in the quality of the ICT infrastructure and service will improve the quality of the Z-services at any given skilled wage through augmenting the productivity of the skilled-labour. However, as we will show later, an improvement in the quality of the ICT infrastructure and service will also raise the skilled wage, and thus improvement in the quality of the Z-services is not certain.

The market clearing condition for N, under homothetic tastes, which also ensures trade balance for the economy is written as:

$$\frac{D_N}{D_T} = f\left(\frac{P_N}{P_T^W}\right) = \frac{X_N}{X_T} \qquad (3.8)$$

where, X_N and X_T denote output levels of non-traded good and composite traded good respectively.

Regarding the provision of ICT infrastructure, I assume that the basic set up and installation of network are done using technologically fixed units of capital for any given level of quality (*q)* of ICT. The government pays capital the market rate of return (*r*) per unit. However, the amount of capital needed for such set up and installation increases at an increasing rate with higher qualities of ICT infrastructure and service being provided:

$$K_I = \overline{K}(q),\ \overline{K}' > 0,\ \overline{K}'' > 0$$

Note that this capital cost signifies the additional cost incurred for upgrading the existing set up to a higher bandwidth for a faster network, from the set of technologically feasible qualities. Thus, higher capital costs incurred for the provision of a better quality of ICT should not be interpreted as an R&D cost as higher quality of ICT is not achieved through any R&D or innovation. Even if we interpret this capital cost as costs for technology upgrading necessary for provision of better quality of ICT, such technology upgrading is not in the nature of *innovation* of a better technology.

In addition to this fixed capital cost of ICT infrastructure, there is also a variable cost.Such costs arise for generating and providing ICT services to the users plus maintenance works and other regular front office works, all of which increases with the usage (time) of the ICT service demanded by the Z-service providers. To keep things simple, I assume that all these works are done by the unskilled workers hired by the government at the market wage *w*. Number of unskilled workers required to generate one unit of ICT service and perform associated works is assumed to be fixed and normalized to unity. The fixed cost is financed by the government through budgetary provisions or public expenditure G such that,

$$G = r\overline{K}(q) \qquad (3.9)$$

The variable cost per unit, on the other hand, is recovered through a price per unit of ICT usage such that:

$$P_I = w \qquad (3.10)$$

Total ICT services generated is determined by the demand for it in the service sector Z:

$$I(q) = a_{IZ}(q)Z \qquad (3.11)$$

Finally, there are the full employment conditions, which are ensured by flexibility in the rate of return to capital, unskilled wage and skilled wage along with competitive market forces, which are modified appropriately in the following way.

$$\overline{K} - K(q) = K^{+} = a_{KT}T + a_{KN}N \qquad (3.12)$$

$$\overline{L} - a_{IZ}(q)Z = L^{+} = a_{LT}T + a_{LN}N \qquad (3.13)$$

$$\overline{S} = a_{SZ}(Q,q)Z \qquad (3.14)$$

Note that $a_{IZ}(q)Z$ in equation (3.13) denotes the total requirement of unskilled labour in the I-sector, L_I, since per unit requirement of unskilled labour to make I is normalized to one. So the above set of nine equations in (3.3)-(3.5), (3.7)-(3.9) and (3.12)-(3.14) determine the nine unknowns of the model: w, r, w_S, q, Q, P_N, X_T, X_N, X_Z.

To understand how the quality of the ITeS exports is related to the quality of the ICT service, consider the interactions between factor-costs and quality levels of the ICT first. Note that for any given government expenditure G, an increase in the rate of return to capitalraises the marginal cost of the ICT infrastructure and thus lowers its quality. The negatively sloped II schedule in the (*r, q*) plane in Figure 3.1 reflects this inverse supply-side relationship between quality of ICT and the rate of return to capital for any given $\overline{G}$. Algebraically:

$$\hat{\overline{G}} = \gamma_{KI}\hat{q} + \hat{r} \Rightarrow \left.\frac{dr}{dq}\right|_{II} = -\gamma_{KI}\frac{r}{q} < 0 \tag{3.15}$$

where, "hat" over a variable denotes proportional change (e.g., $\hat{q} = \frac{dq}{q}$); $\gamma_{KI} \equiv \frac{qK'(q)}{K(q)}$ is the absolute value of the quality-elasticity of capital requirement for the ICT infrastructure.

On the other hand, an improvement in the quality of the ICT infrastructure and service will affect the rate of return to capital. For any given world price of the composite traded good, the rate of return to capital along with the unskilled wage depend on the locally determined price of the non-traded good, which in turn depends, among other things, on the quality of ICT infrastructure. This follows from the full employment conditions (3.12) - (3.14). To explain, consider a ceteris paribus increase in quality (*q*) of ICT. This quality upgrading will change the availability of both capital and unskilled labour for the (T, N) nugget. Whereas one percent improvement in quality of the ICT infrastructure will require larger amount of capital by the magnitude $\gamma_{KI}\hat{q}$, it changes the unskilled labour requirement in two ways. On the one hand, quality upgrading raises productivity of skilled workers in the Z service sector so that the per unit requirement of skilled workers falls. For any given level of quality of Z, the output of Z-services thus increases. From (3.14), the extent of such scale expansion is captured by $\hat{Z} = \gamma_{Sq}\hat{q}$, where $\gamma_{Sq} \equiv -\frac{q}{a_{SZ}(Q,q)}\frac{\partial a_{SZ}(Q,q)}{\partial q}$, is the absolute value of the degree of fall in the per unit requirement of skilled-labour in Z due to a rise in quality of ICT infrastructure. This additional Z-service production will raise the demand for ICT service, and consequently raise the demand for unskilled labour by the government to provide this additional ICT service. On the other hand, as assumed earlier, better quality of ICT services will mean lesser usage time of ICT per unit of output of Z: $\hat{a}_{IZ} = -\gamma_{IZ}\hat{q}$. Since ICT is specific to Z sector, this will lower the demand for ICT service and consequently lower the demand for unskilled labour. Hence, if $\gamma_{IZ} > \gamma_{Sq}$, that is, if the output augmenting effect of a rise in q (i.e. the scale effect) is stronger than the reduction in usage of ICT service use per unit of Z-services (i.e. the technique effect), then overall unskilled labour requirement in ICT production, given by $\hat{L}_I = \lambda_{LZ}(-\gamma_{IZ} + \gamma_{Sq})\hat{q}$, will fall. For now I shall work under the assumption that $\gamma_{IZ} > \gamma_{Sq}$, so that a ceteris paribus improvement in the quality of ICT infrastructure uses up more capital but releases unskilled labour thereby lowering the capital availability and raising unskilled labour availability in the (T, N) nugget. Later as a robustness check, I shall re-consider my results under the alternative assumption where $\gamma_{IZ} < \gamma_{Sq}$.

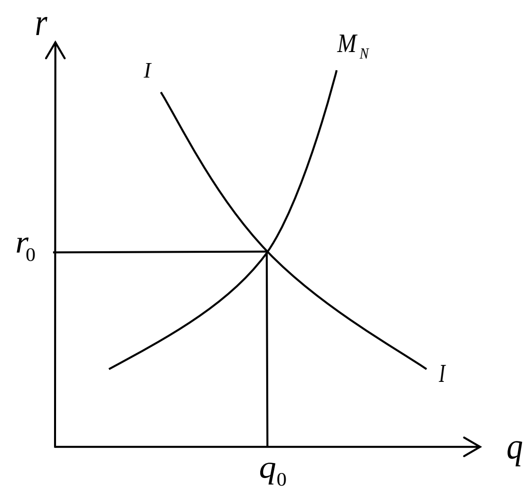

Figure 3.1: Choice of the quality of ICT infrastructure

Let me assume that the non-traded good is relatively more labour intensive. Then output of the non-traded good rises and that of the composite traded good fallsby the standard output magnification effect. The consequent excess supply of the non-traded good causes its price to fall, and this in turn lowers the unskilled wage and raises the rate of return to capital by the price magnification effect. The schedule labeled M_N in Figure 3.1 reflects this positive relationship between q and r *for any given level of export quality*. Algebraically, as shown in the appendix:

$$\left.\frac{dr}{dq}\right|_{M_N} = \frac{\tilde{\lambda}\theta_{LT}}{\varepsilon_N |\theta\|\lambda|}\frac{r}{q} > 0 \tag{3.16}$$

where, $\tilde{\lambda} = \left[(\lambda_{LN} + \lambda_{LT})\gamma_{KI}\lambda_{KI} + (\lambda_{KN} + \lambda_{KT})\lambda_{LI}(\gamma_{IZ} - \gamma_{Sq})\right] > 0$; ε_N is the absolute value of the price elasticity of (relative) demand for N; and $|\theta|$ *and* $|\lambda|$are the determinants of cost share and employment share matrices for the (T, N) nugget respectively[25].

Given these two relationships, the rate of return to capital and the quality of ICT infrastructure are determined simultaneously at the intersection of II and M_N schedules at point E in Figure 3.1.This pair of r and q is, however, determined *for any given quality of Z service exports*, Q. To trace out how a change in Q affects q, consider a ceteris paribus increase in Q. For any level of quality of the ICT infrastructure, q, a higher quality of Z services reduces its output, which in turn lowers the demand for ICT services and consequently its provision. Some unskilled workers are thus laid off from the ICT sector who then move to the (T, N) nugget. By similar logic as spelled out above, larger availability of unskilled labour for the (T, N) nugget then raises the rate of return to capital (and lowers the unskilled wage) for any given q, through rounds of output and price magnification effects. Given the government expenditure, $\overline{G}$, the increase in the rate of return to capital raises the capital-cost of the ICT infrastructure thereby forcing the government to provide an inferior quality of it. In panel-a of Figure 3.2, a rise in quality of Z-services shifts up the M_N curve along the II curve and lowers the quality of ICT infrastructure. Thus, the quality of ICT infrastructure and the quality of the Z-service exported are inversely related as shown in panel-b of Figure 3.2.

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25. It is easy to check that the same positive relationship would emerge if the non-traded sector had been relatively capital intensive. Algebraically, since $|\theta|$ *and* $|\lambda|$will have the same sign -- both negative if N is relatively unskilled labour intensive and both positive otherwise – so, $\left.\frac{dr}{dq}\right|_{M_N} > 0$ always.

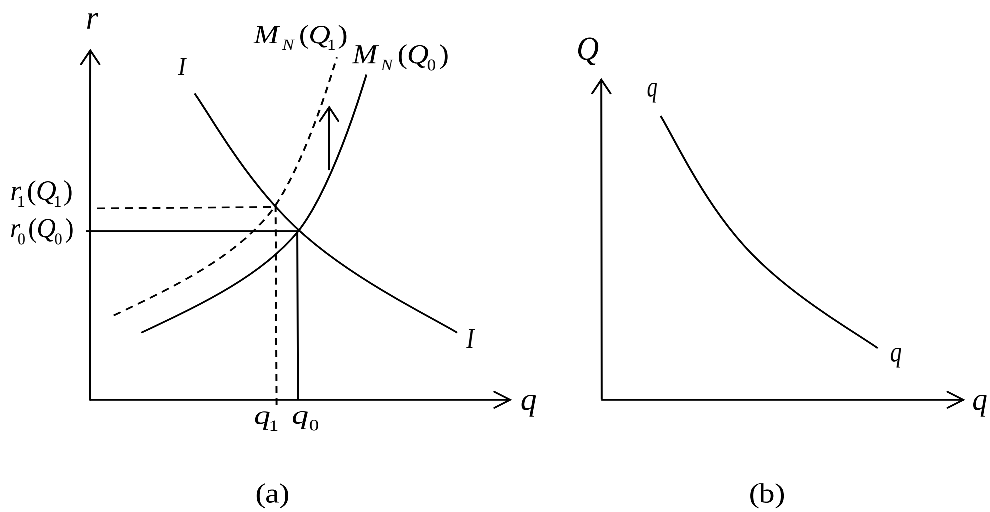

Figure 3.2: Effect of rise in *Q* on *q*

Turning now to the choices of quality of export-service by the service providers, note that by the marginal condition (6), we have an inverse relationship between the skilled wage and the level of export quality Q. If the skilled wage rises, it will raise the marginal cost of raising quality, and thereby will induce providers or producers of Z-service to lower the profit maximizing level of quality, Q. This inverse relation is captured by the negatively sloped π_Z curve in Figure 3.3 which is the locus of all combinations of w_S and Q that satisfies equation (6) *for any given quality of ICT infrastructure, q*. On the other hand, given the price or user charges for ICT service (P_I) and its quality (q), the skilled wage is determined by the zero-profit condition for Z for any given quality (Q) of such services. However, any change in the quality of Z-service exports will not affect the skilled wage due to optimal adjustment in per unit use of skilled labour. That is, by the Envelope Theorem, the skilled wage is invariant with respect to the service-export quality Q as shown by the horizontal line $w_S(q, P_I)$ in Figure 3.3. The initial choice of export quality Q_0 is thus obtained from the intersection of these two schedules for any given quality of ICT services provided by the government.

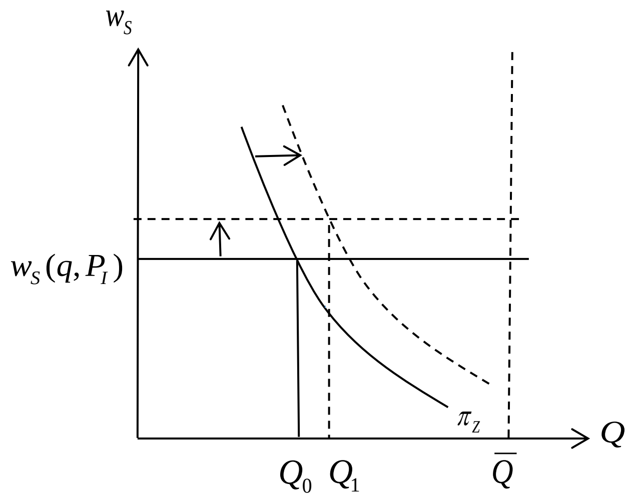

Figure 3.3: Effect of rise in *q* on *Q*

Now an increase in such quality (q) leads to two effects on the export quality (Q) of Z. First, it lowers the extent of additional skilled labour per unit required for quality upgrading by augmenting productivity of the skilled workers (as given in (3.1)): $\frac{\partial}{\partial q}\left(\frac{\partial a_{SZ}(Q)}{\partial Q}\right) < 0$. This lowers the marginal cost of raising export quality for any given skilled wage and thus incentivizes quality upgrading. Graphically, this is captured through a rightward shift of the π_Z curve. Second, it generates a wage-cost effect by raising the skilled wage at the initial level of Q. On the one hand, improvement in marginal productivity of skilled workers (captured through a fall in a_{SZ}) raises their wage. On the other hand, a better quality of ICT infrastructure lowers the use of ICT services per unit of output of Z (as given by (4b)). It also lowers the unskilled wage by lowering the price of the non-traded good as explained earlier. So the unit cost of using ICT services in the Z sector, $a_{IZ}(q)P_I$, falls, which in turn encourages providers of Z-services to expand their scale of service production. Consequent additional demand for skilled labour pushes up the skilled wage further. The rise in the skilled wage consequent upon the rise in q on account of these effects is reflected through an upward shift of the $w_S(q, P_I)$ line. So there are two opposing forces operating on the marginal cost of export-quality upgrading: a favourable productivity effect and an adverse wage-cost effect. A rise in quality of ICT (q) will induce quality (Q) upgrading of ITeS exports Z if the productivity augmenting effect is stronger than the wage-cost effect. It will be downgraded otherwise[26]. Algebraically, as shown in the appendix,

$$\hat{Q} = \frac{P_Z^W(Q)}{Q^2\delta}\gamma_{SZ}\theta_{SZ}(\hat{w}_S - \bar{\gamma}\hat{q}) \tag{3.17}$$

where, $\bar{\gamma}$ is the absolute value of the extent to which a rise in quality of ICT (q) lowers $\frac{\partial a_{SZ}(Q,q)}{\partial Q}$; and $\delta \equiv \left[P_Z^{W''}(Q) - w_S a''_{SZ}(Q,q)\right] < 0$ by the second order condition for profit maximization.

This brings out the cost cascading effect of infrastructure development that had been mentioned in the beginning. Increasing the provision of ICT services as well as improving its quality uses up the same scarce resources (capital and unskilled labour) that are also needed to produce the other final goods (T and N). The skilled wage thus increases, as spelled out above, causing the marginal cost of export-quality upgrading to rise. So infrastructure development does *not* have only a favourable effect. There are both benefits and costs of provision of ICT infrastructure and improving its quality, so that the net effect on the quality of the ITeS exports is ambiguous. More precisely, for any given $\overline{G}$, increase in the skilled wage due to rise in quality of ICT is given as (see appendix):

$$\hat{w}_S = \left[\frac{(\theta_{SZ}\gamma_{SZ} + \theta_{IZ}\gamma_{IZ})}{\theta_{SZ}} + \frac{\theta_{IZ}\tilde{\lambda}\theta_{KT}}{\theta_{SZ}\varepsilon_N|\lambda||\theta|}\right]\hat{q} \tag{3.18}$$

so that (3.17) boils down to,

$$\hat{Q} = \frac{P_Z^W}{\delta Q^2}\left[\left\{\frac{(\theta_{SZ}\gamma_{SZ} + \theta_{IZ}\gamma_{IZ})}{\theta_{SZ}} + \frac{\theta_{IZ}\tilde{\lambda}\theta_{KT}}{\theta_{SZ}\varepsilon_N|\lambda||\theta|}\right\} - \bar{\gamma}\right]\theta_{SZ}\gamma_{SZ}\hat{q} \tag{3.17a}$$

[26]Inflationary pressure from deficit financing that arises in a typical macro structure and causes cost of capital or the real rate of interest to fall, is assumed to be constant. Moreover, here there is no demand augmenting effect of deficit financing of ICT infrastructure. Rather, both the price of ICT service charged by the government, P_I, and correspondingly the price of the non-traded good P_N, fall as a result of the adverse cost effect of raising quality of ICT services. So the price index, at initial export quality, actually falls, therebyeasing the concern for deficit financing induced inflation.

Hence, better quality of ICT infrastructure improves the quality of Z-service exports if the productivity augmenting effect dominates the adverse wage cost in the following sense:

$$\bar{\gamma} > \frac{(\theta_{SZ}\gamma_{SZ} + \theta_{IZ}\gamma_{IZ})}{\theta_{SZ}} + \frac{\theta_{IZ}\tilde{\lambda}\theta_{KT}}{\theta_{SZ}\varepsilon_N |\lambda||\theta|} \tag{3.19}$$

From these discussions, I can write the following Lemma:

Lemma 3.1: *A ceteris paribus rise in quality of ICT infrastructure induces upgrading of quality of Z-services exports under condition (*3.*19).*

Proof: Follows from (3.17a) and (3.19). For details see the appendix. □

Equation (3.17a) gives us another causal relationship between the quality of the ICT infrastructure and the quality of the Z-services export. Under the condition stated in (3.19), by Lemma 3.1, such a relationship is depicted by the positively sloped *QQ* curve in Figure 3.4. Along with the negatively sloped *qq* schedule derived in Figure 3.2, the equilibrium quality of ICT (q_e) and that of ITeS exports Z (Q_e) are determined simultaneously at the intersection of *qq* and *QQ* schedules. To reduce multiplicity of cases, in rest of the analysis I assume the condition in (3.19) to hold.

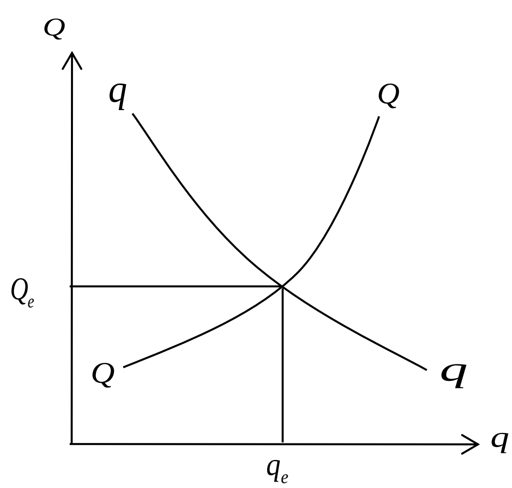

Figure 3.4: Equilibrium Levels of *Q* and *q*

3.2.2 ICT Infrastructure development and export quality

Consider now an exogenous rise in government expenditure on ICT infrastructure by the amount $\hat{G} > 0$. At the stroke of the pen, such an additional expenditure will raise the quality of the ICT infrastructure at the initial rate of return to capital. This will subsequently raise the rate of return to capital, however, under the assumption that $\gamma_{IZ} > \gamma_{Sq}$ as spelled out earlier. Graphically, referring back to Figure 3.1, the II curve shifts to the right along the M_N curve, raising thereby both *q* and *r*. By Lemma 3.1, such a rise in *q* will improve the quality of Z-services. Referring back to Figure 3.4, the *qq* curve shifts up along the *QQ* curve. Thus, an increase in G will unambiguously improve the quality of the Z-services. This will dampen the initial improvement in the quality of the ICT infrastructure due to the increase in the rate of return to capital and thus the capital cost of ICT infrastructure. Algebraically, as shown in the appendix:

$$\hat{q} = \frac{-\varepsilon_N |\theta\|\lambda|}{\Delta'\Delta\theta_{LT}}\hat{G} \tag{3.20}$$

$$\hat{Q} = -\frac{1}{\Delta'}\frac{P_Z^W}{\delta Q^2}\frac{\varepsilon_N |\lambda\|\theta|}{\Delta\theta_{LT}}\theta_{SZ}\tilde{\theta}\gamma_{SZ}\hat{G} \tag{3.21}$$

where, $\Delta' < 0, \Delta > 0;$ and $\tilde{\theta} \equiv \left[\left\{\frac{(\theta_{SZ}\gamma_{SZ} + \theta_{IZ}\gamma_{IZ})}{\theta_{SZ}} + \frac{\theta_{IZ}\tilde{\lambda}\theta_{KT}}{\theta_{SZ}\varepsilon_N|\lambda\|\theta|}\right\} - \bar{\gamma}\right] < 0$ under (3.19).

This result is summarized in Proposition 3.1 below:

Proposition 3.1: Increase in *government expenditure on ICT infrastructure unambiguously raises the quality of ICT facility, which under condition (3.19) raises the quality of the ITeS-exports Z.*

Proof: Follows from (3.20) and (3.21).□

3.2.3 Robustness of the results

The analysis so far has been carried out under the assumption that better quality of ICT services reduces its overall requirement in Z-service generation by the stronger technique effect than the scale effect: i.e. $\gamma_{IZ} > \gamma_{Sq}$. In this section I examine whether the results derived above change when $\gamma_{IZ} < \gamma_{Sq}$. Now better quality of ICT raises the overall use of ICT service in Z-service sector, and consequently raises the demand for unskilled labour. Thus, the availability of both capital and unskilled labour in the (T, N) nugget falls. This opens up two possibilities: better quality of the ICT infrastructure and a larger provision of ICT service requires relatively more capital than unskilled labour or it uses up relatively more of unskilled labour than capital. In the former case availability of capital relative to unskilled-labour falls like the situation under $\gamma_{IZ} > \gamma_{Sq}$. Hence, all the results derived above remain the same. In the latter case, on the other hand, availability of capital relative to unskilled-labour will rise for the (T, N) nugget. Thus, now by the output magnification effect, the output of the composite traded good will rise and that of the non-traded good will fall. Price of non-traded good will rise in consequence to clear the non-traded market. The unskilled wage will thus rise and the rate of return to capital will fall by the price magnification effect. So the M_N curve will now be *negatively sloped*, and to ensure stability, must be flatter than the negatively sloped *II* curve. Everything else will remain the same except the magnitude of changes. For example, graphically, the *qq* schedule will still be downward sloping, but an increase in G will now shift this schedule to the right by a larger magnitude, thereby causing the quality of the ITeS exports to improve to a larger extent. This is because, now the M_N curve being downward sloping, better quality of ICT induced by an increase in G will be reinforced by a consequent *fall* in the rate of return to capital.

3.3 Road Infrastructure versus ICT Infrastructure

3.3.1 Trade-off under Deficit Financing

In this section, I consider public provision of two types of infrastructure facilities: one is road infrastructure, denoted by I_1, that facilitates transport of workers and goods; and the other is the ICT, as discussed above, which I now denote by I_2. I assume that the availability of road infrastructure in the form of length and the density of smooth paved roads, as well as maintaining and upgrading of the existing lengths of paved roads. I measure this road infrastructure by the length of such paved roads (I_1) and development of road infrastructure by an increase in the length of paved roads.[27] Paved and asphalt coated roads enables smoother and faster travel and transportation for workers to their workplaces. This means that the workers can start each day's work with a fresher mind and body to carry out their jobs in the workplace. This positive effect of paved roads is captured here through improved productivity of workers – skilled and unskilled workers alike. Better roads also facilitate transportation of goods from production units to the marketplaces – be it domestic markets or world market –and augments trade by lowering transport costs as in Acharyya (2014). But, instead of such facilitation of transport of goods, I focus here on the productivity-augmenting effect of better roads through facilitating transportation of workers.[28]

However, productivity-augmenting effect of road infrastructure will be realized only for those activities whose production must be done at factory places and thus physical presence of workers in such places is a necessity. These are the so-called *contact-intensive goods*, a new categorization of goods and services that has come into vogue during the Covid-19 pandemic outbreak in 2020-21. I assume that both the composite traded good and the non-traded good fall in this category. Thus, productivity-augmenting effect of road infrastructure development can be realized for unskilled workers engaged in these sectors. That is, the per unit requirements of unskilled labour in the (T, N) nugget now varies inversely with the length of paved roads:

$$a'_{LT}(I_1) < 0;\ a'_{LN}(I_1) < 0 \qquad (3.22)$$

So I rewrite the price-average cost conditions in the (T, N) nugget as follows:

$$P_T^W = a_{LT}(I_1)w + a_{KT}r + a_{fT}(1+\tau_T) \qquad (3.23)$$

$$P_N = a_{LN}(I_1)w + a_{KN}r \qquad (3.24)$$

[27]Poor road infrastructure can also be due to poor maintenance of the paved roads, poor repairs and patchworks to cover potholes or small craters on the road surface, and the like. I_1 can be thought of capturing these dimensions of road infrastructure as well.

[28]I intend to explore implications of such facilitation of transporting goods through road infrastructure development on the export-quality in a future extension of the present analysis.

Now better road infrastructure also facilitates travel for skilled workers to their workplaces. However, the quality-differentiated IT enabled services (Z) considered in Section 3.2 provides scope for skilled workers to work from homes with the aid of ICT. In that case, they do not derive any benefits from better road. In general, skilled workers employed in such ITeS sectors benefit significantly more from better quality of ICT infrastructure and services than from better quality of roads. But, for workers engaged in production of quality-differentiated manufacturing goods, such as those considered in Chapter 2, better roads facilitating travel to the workplace confers upon them significant benefits since production of such goods does not have any scope for work-from-home. Thus, while ITeS exports are more dependent on soft infrastructure like ICT, manufacturing export goods benefit mostly from hard infrastructure such as road/railways that facilitate transportation of commodities and inputs and movements of workers, skilled and unskilled alike. To capture these sector-specific benefits of road and ICT infrastructures – for the skilled workers, in particular – I introduce in this section a quality-differentiated tangible manufactured export product whose production has to occur in a factory setup or manufacturing unit. Let us denote such a manufacturing export good by Z_1, which is produced by skilled workers and the same physical capital as used in the (T, N) nugget. I re-label the IT-enabled service exports as Z_2. So by our assumption, better roads augment productivity of skilled workers producing Z_1.Hence, the per unit requirement of skilled workers in producing good Z_1falls as road conditions improve or larger lengths of road are paved for any given export-quality Q_1; though rises with the quality level. Hence,

$$a_{SZ}^1 = a_{SZ}^1(Q_1, I_1), \frac{\partial a_{SZ}^1(Q_1, I_1)}{\partial I_1} < 0 \qquad (3.25)$$

Note that, consideration of two types of quality-differentiated exports is similar to the structure considered in Chapter 2 (Section 2.2) while discussing tariff liberalization policy as a plausible explanation for asymmetric quality variations observed across product groups in developing countries. The production structure of the export-good $Z_1$is the same as it was earlier: it requires skilled labour along with the same type of capital (K) as the other sectors in the economy, and both in larger (but different) proportions for quality upgrading. The difference, however, is that the per-unit skilled-labour requirement is now less when a larger length of roads is paved or maintained better. On the other hand, I define here the other quality-differentiated export Z_2 as software or ITeS; and instead of the sector-specific type-2 capital required to produce the good as in Chapter 2, I assume that it is the ICT service that is required by the skilled workers to provide the final IT-enabled services, and that better quality of ICT infrastructure augments the productivity of skilled workers in the Z_2 sector.

Under the technological specifications for skilled-labor requirement in (3.25) and recalling per-unit requirement of physical capital as specified in (2.4) in Chapter 2, the zero-profit condition for Z_1 is written as:

$$P_{Z1}^{W}(Q_1) = a_{KZ}^{1}(Q_1)r + a_{SZ}^{1}(Q_1, I_1)w_S \tag{3.26}$$

The marginal condition for the profit maximizing choice of quality of Z_1, Q_0^1, is same as specified in (2.7) of Section 2.2 and reproduced below:

$$P_{Z1}^{W\,\prime}(Q_0^1) = \frac{\partial a_{KZ}^{1}(Q_0^1)}{\partial Q_1} r + \frac{\partial a_{SZ}^{1}(Q_0^1, I_1)}{\partial Q_1} w_S \tag{3.27}$$

Note that unlike the case of ICT infrastructure, I assume that better roads does not affect the additional units of skilled labour needed for a unit rise in quality of Z_1, i.e. $\frac{\partial}{\partial I_1}\left(\frac{\partial a_{SZ}^{1}(Q_0^1, I_1)}{\partial Q_1}\right)$ is zero. In other words, factor-productivity augmenting effect of better roads is the same for all technologically feasible quality levels of Z_1. This assumption is purpose-specific to rule out that the skilled labour productivity augmenting effect of better paved roads “directly” improves the quality level Q_1. However, as we will soon see, better road infrastructure will still affect the choice of quality of Z_1 through its effects on the domestic factor prices (the skilled wage and the rate of return to capital).

Now turning to the provision of better paved roads, I assume a Ricardian production technology: to pave a unit length of road for smooth plying of vehicles and pedestrians, the government requires a_{LI}^{1} units of unskilled labour which is technologically fixed and is normalised to unity. Since road infrastructure is essentially a pure public good, it follows the non-rival and non-excludable properties. Thus, the government cannot levy a price upon users – here skilled and unskilled workers – to cover the cost of production and has finance the entire expenditure out of its own budgetary provision. Let G be the total budgetary provision for infrastructure development, with an allocation of G_1 amount of it for betterment and paving of roads (I_1) and G_2 amount on ICT infrastructure (I_2), such that G = G_1+ G_2. Thus, by assumption, the total length of roads that can be paved is given by:

$$I_1 = \frac{G_1}{w} \quad (3.28)$$

On the other hand, given the allocation of G_2 for provision of ICT infrastructure, I rewrite (3.9) as follows:

$$G_2 = r\tilde{K}(q) \quad (3.29)$$

Finally, taking into consideration the labour productivity augmenting effects of road infrastructure, I rewrite the full employment conditions for unskilled labour and capital as follows:

$$\bar{L} - \left\{a^1_{LI} I_1 + a^2_{IZ}(q) X^1_Z\right\} = \bar{L}(q, I_1) = a_{LT}(I_1) X_T + a_{LN}(I_1) X_N \quad (3.30)$$

$$\bar{K} - \left\{a^1_{KZ}(Q_1) X^1_Z + \tilde{K}(q)\right\} = \bar{K}(q, Q_1) = a_{KT} X_T + a_{KN} X_N \quad (3.31)$$

Here $\bar{L}(q, I_1)$ and $\bar{K}(q, Q_1)$ denote the total availability of unskilled labour and capital in the (T, N) nugget which varies with a change in quality of ICT infrastructure (*q*), the amount of road infrastructure produced (I_2) and the choice of quality of good Z_2. Changes in the level of road infrastructure and quality of ICT infrastructure will lead to re-allocation of scarce resources across the sectors. This will change the output levels of the four final products, X_T, X_N, Z_1 and Z_2. On the other hand, since both the quality-differentiated manufactured-exports Z_1 and ITeS export Z_2 use skilled labour, competitive market forces for the same give the following full employment condition:

$$\bar{S} = a^1_{SZ}(Q_1, I_1) X^1_Z + a^2_{SZ}(q, Q_2) X^2_Z \quad (3.32)$$

Note that while a rise in the export-quality levels Q_1 and Q_2, will have a dampening effect on the output levels, better quality of ICT (i.e. a rise in q) and/or a larger amount of road infrastructure (i.e. a rise in I_1), however, will lead to scale expansion of Z_1 and Z_2 respectively by lowering the per unit skill requirements. So the above set of twelve equations in (3.23), (3.24), (3.5), (3.7), (3.8) and (3.26) – (3.32) determine the twelve unknowns of the model: $w, r, w_S, P_N, Q_1, Q_2, q, I_1, X_Z^1, X_Z^2, X_T$ and X_N. A few important properties of this analytical structure which are significantly different from what we have discussed in Section 3.2 deserve attention. First, the domestic factor prices – w_S, w and r – and the level and quality of the two infrastructures are determined simultaneously. Second, these variables are not influenced by the price of the non-traded good and the output levels of the three final goods. In other words, the price sub-system is delinked from the output sub-system. Third, while factor prices and infrastructure levels influence the choice of qualities of Z_1 and Z_2, there is no reverse causality.

Before proceeding further, note that for development of the two types of infrastructures, the government has three options available. The first option is to increase the budgetary provision on only one type of infrastructure without reducing the provision of the other type:

$$\hat{G} = \hat{G}_1 > 0 = \hat{G}_2 \qquad (3.33a)$$

Or, $\hat{G} = \hat{G}_2 > 0 = \hat{G}_1$ (3.33b)

A second option for the government is to raise the total budget allocation on both types of infrastructures. If such increases are equi-proportionate, then the government essentially keeps the initial allocation unchanged. In such a case,

$$\hat{G} = \hat{G}_1 = \hat{G}_2 \qquad (3.34)$$

Finally, the third option is to reallocate a *fixed* budget of G amount on the two types of infrastructure:

$$\hat{G} = 0 = \hat{G}_1 + \hat{G}_2 \Rightarrow \hat{G}_1 = -\hat{G}_2 \qquad (3.35)$$

This possibility arises when the government is constrained by funds and thereby cannot increase the total budgetary provisions. Thus, here the choice the government faces is whether to reallocate a larger share of the total budget amount G on improving the quality of ICT or creating more paved roads.[29] There is thus a direct trade-off between better ICT

[29] Suppose $\hat{G}_1 = \hat{\psi} > 0$ $G_1 = \psi G$ and $G_2 = (1-\psi)G$. So if government plans to raise the allocation on road infrastructure, then and this causes ICT infrastructure to suffer since $\hat{G}_2 = -\tilde{\psi}\hat{\psi} < 0$ where, $\tilde{\psi} = \frac{\psi}{(1-\psi)}$.

infrastructure and the total length of paved roads. Note that in the first two options of infrastructure development, there is no direct (and apparent) trade-off between the two types of infrastructures. But still, a change in the provision of one affects that of the other through its impact on the factor prices. In fact, this *indirect trade-off* will also arise in the third option. In general, the two types of infrastructure developments are inter-dependent through the impacts each has on the factor prices due to the productivity-augmenting effect. For example, a ceteris paribus rise in the road infrastructure – under (3.33a) – will raise the wage to unskilled labour, at initial r, since it increases the marginal productivity, captured through a fall in $a_{LT}(I_1)$. Given the world price of the composite traded good, this should also change the rate of return to capital (see (3.23)), and correspondingly change the quality (*q*) of ICT infrastructure for any given level of G_2 (see (3.29)). Similarly, a ceteris paribus improvement in quality of the ICT infrastructure – under (3.33b) – will affect factor prices including the unskilled wage, and consequently the length of roads that can be paved and properly maintained. More precisely, from the zero-profit conditions it follows:

$$\hat{r} = -\frac{\theta_{SZ}^1}{\theta_{KZ}^1}\hat{w}_S + \frac{\theta_{SZ}^1}{\theta_{KZ}^1}\mu_S \hat{I}_1 \qquad (3.36)$$

$$\theta_{SZ}^2 \hat{w}_S + \theta_{IZ}^2 \hat{w} = (\theta_{SZ}^2 \gamma_{SZ}^2 + \theta_{IZ}^2 \gamma_{IZ}^2)\hat{q} \qquad (3.37)$$

$$\theta_{LT}\hat{w} + \theta_{KT}\hat{r} = \mu_L \theta_{LT}\hat{I}_1 \qquad (3.38)$$

where, $\mu_S \equiv -\frac{I_1}{a_{SZ}^1(Q_1, I_1)}\frac{\partial a_{SZ}^1(Q_1, I_1)}{\partial I_1}$ and $\mu_L \equiv -\frac{I_1}{a_{Lj}^j(I_1)}\frac{\partial a_{Lj}^{j1}(I_1)}{\partial I_1}; j = T, N$ are respectively the absolute values of the extent to which the per unit requirements of skilled and unskilled labour fall due to a one percent increase in the length of paved roads. That is, μ_S and μ_L are the absolute values of skilled-labour and unskilled-labour productivity-elasticity respectively.

As shown in the appendix A.3.6, using $\hat{I}_1 = \hat{G}_1 - \hat{w}$ and $\hat{q} = \frac{\hat{G}_2 - \hat{r}}{\gamma_{KI}}$ from percentage-change forms of (3.28) and (3.29), the factor price changes in (3.36) – (3.38) boil down to:

$$\hat{w}_S = \frac{1}{\Delta}\left\{-\frac{BA}{\gamma_{KI}}\hat{G}_2 + E\hat{G}_1\right\} \tag{3.39}$$

$$\hat{w} = \frac{1}{\Delta}\left\{\frac{B\theta^1_{SZ}}{\gamma_{KI}\theta^1_{KZ}}\hat{G}_2 - D\hat{G}_1\right\} \tag{3.40}$$

$$\hat{r} = F\hat{G}_1 - \frac{\theta_{LT}B\theta^1_{SZ}(\mu_L + 1)}{\theta_{KT}\Delta\gamma_{KI}\theta^1_{KZ}}\hat{G}_2 \tag{3.41}$$

where, $\Delta = \left(\frac{\theta^1_{SZ}}{\theta^1_{KZ}}C - A\theta^2_{SZ}\right)$, $A = \left(\frac{\theta^1_{SZ}}{\theta^1_{KZ}}\mu_S - \frac{\theta_{LT}(\mu_L + 1)}{\theta_{KT}}\right)$, $B = (\theta^2_{SZ}\gamma^2_{SZ} + \theta^2_{IZ}\gamma^2_{IZ}) > 0$,

$C = \left(\theta^2_{IZ} - \frac{B}{\gamma_{KI}}\frac{\theta_{LT}(\mu_L + 1)}{\theta_{KT}}\right)$, $D = \left(\frac{B\mu_L\theta^1_{SZ}\theta_{LT}}{\gamma_{KI}\theta^1_{KZ}\theta_{KT}} + \tilde{A}\theta^2_{SZ}\right)$, $E = \left(\frac{BA\mu_L\theta_{LT}}{\gamma_{KI}\theta_{KT}} + \tilde{A}C\right)$,

$F = \frac{\theta_{LT}}{\theta_{KT}}\left\{\mu_L + \frac{(\mu_L + 1)D}{\Delta}\right\}$ and $\tilde{A} = \left(\frac{\theta^1_{SZ}}{\theta^1_{KZ}}\mu_S - \frac{\mu_L\theta_{LT}}{\theta_{KT}}\right)$.

Observations on the signs of these expressions will be helpful. First, as shown in the appendix, C > 0 by stability requirement. Second, $\tilde{A} < 0$ for low values of μ_S in the following sense:

$$\mu_S < \bar{\bar{\mu}}_S \equiv \mu_L\left(\frac{\theta_{LT}}{\theta_{KT}}\frac{\theta^1_{KZ}}{\theta^1_{SZ}}\right) \tag{3.42}$$

To reduce the multiplicity of sub-cases, I shall assume this condition henceforth.

Third, given condition (3.42), that is, $\tilde{A} < 0$, we have A < 0 and $\Delta > 0$.[30] Fourth, $E < 0$ under the assumption (3.42). Fifth, $F > 0$ for the following reason. E < 0 means that the skilled wage falls as the government increases its expenditure on road infrastructure. Then, by (3.36), we must have $\hat{r} > 0$. Note that at the initial rate of return to capital, $\hat{w} = \frac{\mu_L}{(1+\mu_L)}\hat{G}_1$ as evident from the zero profit condition for the composite traded good so that $\hat{I}_1 = \hat{G}_1 - \hat{w} > 0$. That is, under the assumption (3.42), a ceteris paribus increase in G_1 must raise the rate of return to capital, and hence $F > 0$ by (3.41).

These sign patterns are summarized in the following Lemma:

[30]As shown in the appendix, $\Delta > 0$ by stability if A > 0.

Lemma 3.2:
(a) C > 0 and $\Delta > 0$ *by stability requirements.*
(b) Under the assumption (3.42), $\widetilde{A} < 0$ *, A < 0, E < 0 and F > 0.*

Proof: Follows from the above discussions. See appendix for formal proofs.□

Finally, because the initial wage increase due the productivity-augmenting effect of a ceteris paribus increase in G_1 is unlikely to be reverted by the subsequent fall in the unskilled wage due to the increase in the rate of return to capital, so by (3.40) it is reasonable to assume that,

$$D < 0 \tag{3.43}$$

Note that this requires a more stringent restriction on μ_S than specified in (3.42):

$$\mu_S < \left[\frac{\theta_{LT}}{\theta_{KT}} \frac{\theta_{KZ}^1}{\theta_{SZ}^1} - \frac{B}{\gamma_{KI}\theta_{SZ}^2} \frac{\theta_{LT}}{\theta_{KT}} \right] \mu_L$$

However, as we will see later, this condition is not required for most of the results derived subsequently, particularly, the direction of changes in the export-quality levels. On the other hand, $\Delta > 0$ puts a restriction on μ_S as:

$$\mu_S < \mu_S^* \equiv \frac{C}{\theta_{SZ}^2} + \frac{\theta_{LT}}{\theta_{KT}} \frac{\theta_{KZ}^1}{\theta_{SZ}^1} (\mu_L + 1) \tag{3.42a}$$

However, since $\mu_S^* > \overline{\overline{\mu}}_S \, \forall \, \mu_L > 0$, so (3.42) is a more stringent condition and thus is the binding one.

Given these sign patterns and restrictions, effects of increases in government expenditures on the two types of infrastructures on the factor prices can be summarized in the following Lemma:

Lemma 3.3: *Given Lemma 3.2 and the assumption (3.43),*

(a) If $\hat{G} = \hat{G}_1 > 0 = \hat{G}_2$*, then* $\hat{w}_S < 0$, $\hat{w} > 0$ *and* $\hat{r} > 0$.

(b) If $\hat{G} = \hat{G}_2 > 0 = \hat{G}_1$*, then* $\hat{w}_S > 0$, $\hat{w} > 0$ *and* $\hat{r} < 0$.

Proof: Follows from (3.39) - (3.41) and the sign patterns specified in Lemma 3.2. □

Thus, a ceteris paribus change in values of G_1 (or in G_2) will change *both* I_1 and q through changes in the factor prices. More precisely, as shown in the appendix:

$$\hat{q} = H\hat{G}_2 - \frac{F}{\Delta}\hat{G}_1 \quad (3.44)$$

$$\hat{I}_1 = \left(1 + \frac{D}{\Delta}\right)\hat{G}_1 - \left(\frac{\theta^1_{SZ}B}{\gamma_{KI}\theta^1_{KZ}\Delta}\right)\hat{G}_2 \quad (3.45)$$

where, $H = \left(1 + \frac{\theta_{LT}B\theta^1_{SZ}(\mu_L + 1)}{\theta_{KT}\Delta\gamma_{KI}\theta^1_{KZ}}\right) > 0$ and $\left(1 + \frac{D}{\Delta}\right) > 0$.

The interdependence between the developments of the two types of infrastructures as evident from (3.44) and (3.45) can be summarised in the following Proposition:

Proposition 3.3: *A ceteris paribus rise in expenditure by the government on road infrastructure development will worsen the quality of ICT infrastructure. Similarly, a smaller length of paved roads can be provided when the government increases the budget only for ICT infrastructure development.*

Proof: Under (3.33a), i.e., $\hat{G}_1 > 0 = \hat{G}_2$, it follows from (3.44) that $\hat{q} = -\frac{F}{\Delta}\hat{G}_1$. Since $F > 0$ by Lemma 3.2, so $\hat{q} < 0$. This completes proof of the first part. On the other hand, under (3.33b), i.e., $\hat{G}_2 > 0 = \hat{G}_1$, it follows from (3.45) that $\hat{I}_1 = -\left(\frac{\theta^1_{SZ}B}{\gamma_{KI}\theta^1_{KZ}\Delta}\right)\hat{G}_2 < 0$. This completes proof of the second part. □

To explain, consider for example road infrastructure development under (3.33a). This improves the productivity of unskilled workers by the magnitude of $(-\mu_L\hat{I}_1)$, which under perfectly competitive factor markets, is reflected in a proportionate rise in the unskilled wage, at initial rate of return to capital. This is the direct (own)-productivity augmenting effect of road infrastructure development on the unskilled wage. This raises the unit cost of using ICT services to produce Z_2, given by $a^2_{IZ}(q)P_I$, at initial q, which in turn forces providers of ITeS to contract their scale of service production. Consequent fall in the demand for skilled labour pushes down the skilled wage. At the same time, better road infrastructure also leads to productivity gains for the skilled workers, lowering $a^2_{SZ}(Q_2, q)$ by the magnitude of $(-\mu_S\hat{I}_1)$. So the total wage cost on skilled labour falls under the assumption (3.42). This is what is stated in Lemma 3.3. This induces producers of Z_1 to raise the scale of output, and correspondingly increases the demand for capital and the rate of return to capital. Consequent rise in the marginal cost of providing any level of ICT quality, would cause downgrading of the quality of ICT infrastructure. This explains the first part of Proposition 3.3. The other result in Proposition 3.3 can be similarly explained.

3.3.2 Infrastructure Development and Export Qualities

Variations in the quality levels of the manufactured export good Z_1 and ITeS export Z_2 depend on both the skilled wage and the level and quality of the two types of infrastructures. However, any change in these export quality levels will neither have any direct effect on the skilled wage nor any indirect effect through changes in the rate of return to capital and the unskilled wage. The former is because of the Envelope Theorem, whereas the latter is, as mentioned earlier, due to the independence of the factor prices from factor endowments, output levels and the price of the non-traded good. Thus, change in the capital availability to the (T, N) nugget as a consequence of changes in quality levels of Z_1 (or Z_2) will be inconsequential for the factor prices, unlike the situation in Section 3.2.While the change in the quality level for ITeS is the same as in Section 3.2 (which is reproduced in (3.47) below), the change in the quality of the manufacturing export good Z_1 is given in (3.46) below:

$$\hat{Q}_1 = \frac{P_{Z1}^W(Q_1)}{Q_1^2\delta_1}\left\{\theta_{SZ}^1(\gamma_{SZ}^1 - \gamma_{KZ}^1)\hat{w}_S + \mu_S\theta_{SZ}^1\gamma_{KZ}^1\hat{I}_1\right\} \qquad (3.46)$$

$$\hat{Q}_2 = \frac{P_{Z2}^W(Q_2)}{Q_2^2\delta_2}\gamma_{SZ}^2\theta_{SZ}^2(\hat{w}_S - \bar{\gamma}\hat{q}) \qquad (3.47)$$

where, $\bar{\gamma}$ is the absolute value of the extent to which a rise in quality of ICT (q) lower $\frac{\partial a_{sz}^2(Q_2,q)}{\partial Q_2}$ as in Section 3.2; $\delta_1 \equiv \left[P_{Z1}^{W''}(Q_1) - w_S a_{SZ}^{1''}(Q_1) - r a_{KZ}^{1''}(Q_1)\right] < 0$ and $\delta_2 \equiv \left[P_{Z2}^{W''}(Q_2) - w_S a_{SZ}^{2''}(Q_2,q)\right] < 0$ by the second order conditions for profit maximization.

As evident from (3.47) and as elaborately explained in Section 3.2 above, changes in quality level Q_2 of the ITeS is driven by the skilled-labour productivity augmenting effect of a rise in the quality (*q*) of ICT infrastructure, captured through $\bar{\gamma}\hat{q}$, relative to its cost cascading effect $\hat{w}_S$. In case of the manufacturing exports Z_1, on the other hand, it's quality depends not only on the relative skill intensity of its higher quality varieties, but also on the extent to which the productivity of skilled workers engaged in the production of Z_1 is improved due to better road infrastructure, as captured by the value of μ_S. In the extreme situation where μ_S is zero, that is, better roads do not facilitate travel by skilled workers and thus do not impact their productivity, variations in the quality of manufacturing exports will once again get driven *only* by the relative skill intensity of higher quality varieties. So the skilled-labour productivity augmenting effect of better road infrastructure brings out the primary departure in the condition for export quality upgrading from what we observed in the analysis in Chapter 2. Nevertheless, even when μ_S is zero, the domestic factor prices still depend on the levels of *q* and I_1, as discussed earlier. Thus, whereas on the one hand an improvement in the quality of ICT infrastructure affects the choice of quality of Z_1 (which though does not require ICT as an input), better provision of road infrastructure impacts quality of Z_2 (whose production does not depend on paved and smoother roads) on the other. This brings out the general-equilibrium factor cost effects of infrastructure development in a resource-constrained economy even though the two types of infrastructures may be sector-specific as considered here.

Another important point deserves attention. The skilled-labour productivity augmenting effect of better roads *adversely* affects the choice of quality Q_1 of the export-good Z_1. This is because it raises the rate of return to capital (at the initial skilled-wage) and consequently the marginal cost of quality upgrading. On the other hand, even if better roads improve the marginal productivity of skilled workers, it does not lower the *marginal cost of quality* and thus does not provide any incentives for quality upgrading since we assume that such productivity improvement does not lower the number of *additional* skilled workers required to upgrade quality Q_1: $\frac{\partial}{\partial I_1}\left(\frac{\partial a_{SZ}}{\partial Q}\right)=0$.

Substitution of values from (3.39), (3.44) and (3.45) yield the final expressions for change in the quality levels (see appendix for details):

$$\hat{Q}_1=\frac{P_{Z1}^W(Q_1)\theta_{SZ}^1}{Q_1^{\ 2}\delta_1}\left[\left\{\frac{(\gamma_{SZ}^1-\gamma_{KZ}^1)E}{\Delta}+\mu_S\theta_{SZ}^1\left(1+\frac{D}{\Delta}\right)\right\}\hat{G}_1-\left\{\frac{BA(\gamma_{SZ}^1-\gamma_{KZ}^1)}{\gamma_{KI}\Delta}+\frac{\mu_S\theta_{SZ}^1\gamma_{SZ}^1B}{\gamma_{KI}\theta_{KZ}^1\Delta}\right\}\hat{G}_2\right] \quad (3.48)$$

$$\hat{Q}_2=\frac{P_{Z2}^W(Q_2)\gamma_{SZ}^2\theta_{SZ}^2}{Q_2^{\ 2}\delta_2}\left[\frac{(E+F\bar{\gamma})}{\Delta}\hat{G}_1-\left(\frac{BA}{\gamma_{KI}\Delta}+\bar{\gamma}H\right)\hat{G}_2\right] \quad (3.49)$$

Now let us look at the effect on the choice of these export quality levels under the three options for further development of infrastructure that are available to the government. Under the first option, i.e. increase the budgetary provision on only one type of infrastructure without lowering that on the other, for export good Z_1, there will be an unambiguous downgrading in quality when higher quality varieties are relatively more capital intensive $(\gamma_{SZ}^1<\gamma_{KZ}^1)$. However, when $\gamma_{SZ}^1>\gamma_{KZ}^1$, change in quality Q_1 is ambiguous. More precisely, since $\delta_1<0$ by the second order condition for profit maximization with respect to quality choice, $1+\frac{D}{\Delta}>0$ even when D < 0 (as shown in the appendix) and $E<0$ by Lemma 3.2, so for $\hat{G}=\hat{G}_1>0=\hat{G}_2$, $\hat{Q}_1<0$ when $\gamma_{SZ}^1<\gamma_{KZ}^1$; but, $\hat{Q}_1$ may be positive or negative when $\gamma_{SZ}^1>\gamma_{KZ}^1$. Quality improves, $\hat{Q}_1>0$, if the adverse cost-cascading effect of skilled-labour productivity improvement due to better road infrastructure is weak in the following sense:

$$\mu_S<\tilde{\mu}_S\equiv\frac{(\gamma_{KZ}^1-\gamma_{SZ}^1)\left[(\tilde{B}-B)+\frac{B}{\gamma_{KI}}\right]\frac{\theta_{LT}}{\theta_{KT}}\mu_L}{(\gamma_{KZ}^1-\gamma_{SZ}^1)(\tilde{B}-B)\frac{\theta_{SZ}^1}{\theta_{KZ}^1}+(\Delta+D)\theta_{SZ}^1} \quad (3.50)$$

where, $\tilde{B}\equiv\frac{B}{\gamma_{KI}}\frac{\theta_{LT}}{\theta_{KT}}\mu_L+C+B$.

The reason is simple. An increase in G_1 to improve the road infrastructure lowers the skilled wage and raises the rate of return to capital by Lemma 3.3. Thus, the marginal cost of quality upgrading increases when the higher quality varieties are relatively capital intensive ($\gamma_{SZ}^1 < \gamma_{KZ}^1$), which reinforces the increase in the marginal cost due to the skilled-labour productivity effect of better roads. But, the marginal cost falls when the higher quality varieties are relatively more skill intensive $(\gamma_{SZ}^1 > \gamma_{KZ}^1)$, which may lead to an overall fall in the marginal cost and consequently quality improvement if the condition (3.50) holds.

Note that given the assumption in (3.42), this condition (3.50) is feasible if $\tilde{\mu}_S < \overline{\overline{\mu}}_S$. However, both these critical values vary with $\mu_L \in [0, \overline{\mu}_L]$, with the upper limit on μ_L being given by the stability requirement noted earlier that $C > 0$. More precisely, $\overline{\mu}_L$ is such that $C = \left(\theta_{IZ}^2 - \frac{B}{\gamma_{KI}} \frac{\theta_{LT}(\overline{\mu}_L + 1)}{\theta_{KT}} \right) = 0$, i.e.,

$$\overline{\mu}_L = \frac{\theta_{IZ}^2 - \dfrac{B\theta_{LT}}{\gamma_{KI}\theta_{KT}}}{\dfrac{B\theta_{LT}}{\gamma_{KI}\theta_{KT}}} \tag{3.50a}$$

As shown in the appendix, both $\tilde{\mu}_S$ and $\overline{\overline{\mu}}_S$ are increasing in μ_L, and $\tilde{\mu}_S(0) = \overline{\overline{\mu}}_S(0) = 0$. On the other hand, $\tilde{\mu}_S(\overline{\mu}_L) < \overline{\overline{\mu}}_S(\overline{\mu}_L)$ if,

$$\theta_{SZ}^2 \frac{\theta_{LT}}{\theta_{KT}} \frac{\theta_{SZ}^1}{\theta_{KZ}^1} \left[\theta_{IZ}^2 - \frac{B}{\gamma_{KI}} \frac{\theta_{LT}}{\theta_{KT}} \right] > (\gamma_{SZ}^1 - \gamma_{KZ}^1) \frac{B}{\gamma_{KI}\theta_{KZ}^1} \tag{3.50b}$$

Again, to reduce the multiplicity of sub-cases, I shall assume that this condition in (3.50a) holds. Figure 3.5 illustrates the relevant zone of combinations of the two factor-productivity elasticities of better road for which the quality of the manufacturing export good Z_1 will improve under $\gamma_{SZ}^1 > \gamma_{KZ}^1$ when the government increases its expenditure on road only. The relevant region consistent with the assumption in (3.42) is given by the area under the ray through the origin labeled $\overline{\overline{\mu}}_S$. That is, $\tilde{A} < 0$ for any combinations of μ_S and μ_L in the region below the $\overline{\overline{\mu}}_S$ - curve. The curve $\tilde{\mu}_S$ segments this region into quality-improvement and quality-deterioration regions. For any combinations of μ_S and μ_L in the region below the $\tilde{\mu}_S$ -curve the quality Q_1 improves following a ceteris paribus increase in G_1.

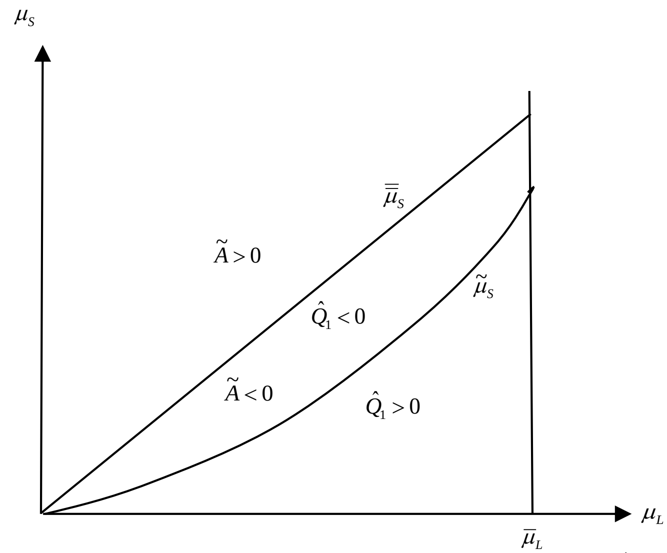

Figure 3.5: Quality Change for larger Expenditure on Road $\left(\gamma^1_{SZ} > \gamma^1_{KZ}\right)$

$$\hat{G}_1 > 0 = \hat{G}_2$$

Note that if the condition (3.50b) does not hold, condition (3.50) is still compatible with the condition (3.42), but now for a subset of the values of μ_L since $\tilde{\mu}_S(\bar{\mu}_L) > \bar{\bar{\mu}}_S(\bar{\mu}_L)$. Thus, now the region for which quality Q_1 will improve will be larger. Under the second option $\hat{G} = \hat{G}_2 > 0 = \hat{G}_1$, since A < 0 by the assumption (3.42), so $\hat{Q}_1 > 0$ when $\gamma^1_{SZ} < \gamma^1_{KZ}$; but, $\hat{Q}_1 > 0$ when $\gamma^1_{SZ} > \gamma^1_{KZ}$ only if skilled-labour productivity effect of better roads is now *large* in the following sense:

$$\mu_S > \bar{\mu}_S \equiv \frac{(\gamma^1_{SZ} - \gamma^1_{KZ})\left[\frac{\theta_{LT}}{\theta_{KT}}\mu_L + \frac{\theta_{LT}}{\theta_{KT}}\right]}{\frac{\theta^1_{SZ}}{\theta^1_{KZ}}(2\gamma^1_{SZ} - \gamma^1_{KZ})} \tag{3.51}$$

Intuitively, exactly the opposite logic applies for $\hat{G} = \hat{G}_2 > 0 = \hat{G}_1$ since in this case the rate of return to capital falls by Lemma 3.2, which at initial length of paved roads (I_1)

raises the skilled wage (see (3.36)). So, if higher quality variety of Z_1 is relatively capital-intensive then its quality increases unambiguously. In the opposite case, the marginal cost of quality increases. At the same time, a ceteris paribus increase in G_2 lowers I_1(see Proposition 3.3) and consequently lowers the marginal productivity of skilled workers. Thus, the skilled wage falls on this account, dampening thereby the rise in the skilled wage as is evident from (3.36). Larger is the value of μ_S, more dampened will be the rise in the skilled wage. Thus, now we require a larger value of skilled-labour productivity elasticity μ_S in the sense defined in (3.51) – in contrast to a smaller value of μ_S in the case $\hat{G} = \hat{G}_1 > 0 = \hat{G}_2$ – for incentivizing quality upgrading.

Again, this condition (3.51) is feasible if $\overline{\mu}_S < \overline{\overline{\mu}}_S$. As shown in the appendix, $\overline{\mu}_S$ is increasing in μ_L, and $\overline{\mu}_S(0) > \overline{\overline{\mu}}_S(0)$. On the other hand, under the same condition as in (3.50b), $\overline{\mu}_S(\mu_L) > \overline{\overline{\mu}}_S(\mu_L)\ \forall\ \mu_L < \tilde{\mu}_L < \overline{\mu}_L$. Figure 3.6 illustrates the feasible region for quality improvement as the one enclosed by the $\overline{\mu}_S$-curve from below and the $\overline{\overline{\mu}}_S$-curve from above. So, condition (3.51) is satisfied and $\hat{Q}_1 > 0$ for $\hat{G}_2 > 0 = \hat{G}_1$ only for $\mu_L \in (\tilde{\mu}_L, \overline{\mu}_L]$. Also note that it is likely that $\overline{\mu}_S(\overline{\mu}_L) < \tilde{\mu}_S(\overline{\mu}_L)$. In such a case, there is a very small overlapping region indicated by the area *abc* for which $\hat{Q}_1 > 0$ for both $\hat{G}_1 > 0 = \hat{G}_2$ and $\hat{G}_2 > 0 = \hat{G}_1$. But, if $\overline{\mu}_S(\overline{\mu}_L) > \tilde{\mu}_S(\overline{\mu}_L)$ for all μ_L, then there is no feasible combination of μ_S and μ_L for which $\hat{Q}_1 > 0$ for both these ceteris-paribus options of raising infrastructure expenditure.

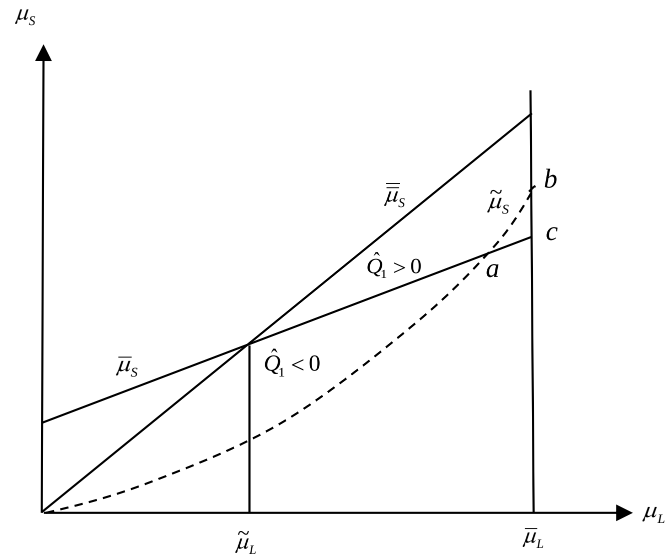

Figure 3.6: Quality Change for larger Expenditure on ICT $\left(\gamma^1_{SZ} > \gamma^1_{KZ}\right)$
$\hat{G}_2 > 0 = \hat{G}_1$

The other two options of infrastructure development have similar effects on qualities of the manufacturing export good Z_1 and ITeS exports Z_2. For example, from the above argument it appears that in the case where the government reallocates its fixed budget in favour of road infrastructure, $\hat{G}_1 = -\hat{G}_2 > 0, \hat{Q}_1 < 0$ when $\gamma^1_{SZ} < \gamma^1_{KZ}$, which is the same as under a ceteris paribus increase in G through increase in total budget provision for infrastructure development. When $\gamma^1_{SZ} > \gamma^1_{KZ}$, change in quality Q_1 is again ambiguous. Quality will improve only if,

$$\mu_S < \tilde{\tilde{\mu}}_S \equiv \frac{(\gamma^1_{SZ} - \gamma^1_{KZ})\left[\tilde{B}\gamma_{KI}\dfrac{\theta_{LT}}{\theta_{KT}}\mu_L + B\left(\dfrac{\theta_{LT}}{\theta_{KT}}\right)^2\mu_L + B\dfrac{\theta_{LT}}{\theta_{KT}}\right]}{\left[\gamma_{KI}\left(\gamma^1_{SZ} - \gamma^1_{KZ}\right)\tilde{B} + \left\{(\Delta + D)\gamma_{KI}\theta^1_{KZ} + B\gamma^1_{SZ}\right\}\right]\dfrac{\theta^1_{SZ}}{\theta^1_{KZ}}} \tag{3.52}$$

It is straightforward to check that $\tilde{\tilde{\mu}}_S$ is increasing in μ_L at a decreasing rate, and $\tilde{\tilde{\mu}}_S(0) > \bar{\bar{\mu}}_S(0)$. On the other hand, it is likely that $\tilde{\tilde{\mu}}_S(\bar{\mu}_L) < \bar{\bar{\mu}}_S(\bar{\mu}_L)$. Thus, as illustrated in Figure 3.8, $\hat{Q}_1 > 0$ for $\hat{G}_2 > 0 = \hat{G}_1$ only for $\mu_L < \tilde{\tilde{\mu}}_L$. Also note that condition (3.54) should be more lenient than condition (3.50) since a reduction of expenditure on ICT works in favour of upgrading of Q_1. In general, there can two possibilities. First, $\tilde{\tilde{\mu}}_S$-curve lies wholly above the $\tilde{\mu}_S$-curve; second, for a very high value of μ_L, $\tilde{\mu}_S$-curve crosses over the $\tilde{\tilde{\mu}}_S$-curve, which is shown by the broken convex curve cutting the broken concave curve from below. In either case, however, the region for $\hat{Q}_1 > 0$ is larger than when there is a ceteris paribus increase in expenditure on road development.

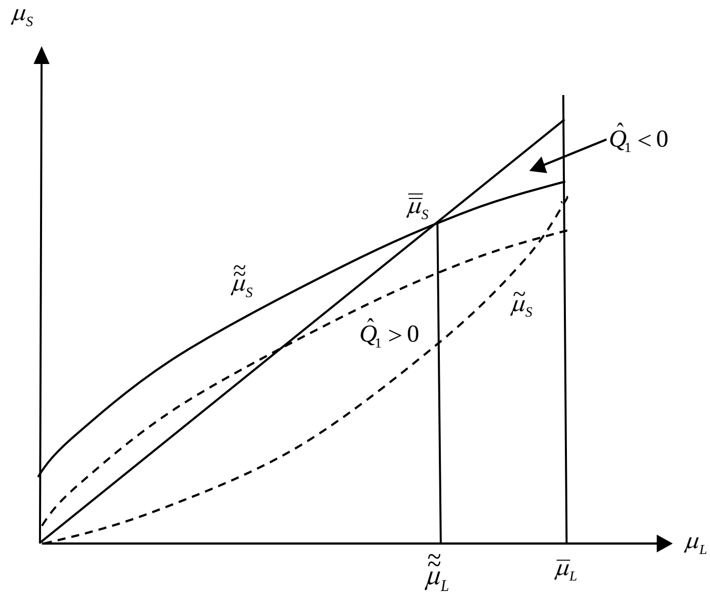

Figure 3.7: Quality Change for Reallocation of Budget on Road Development

$$\hat{G}_1 = -\hat{G}_2 > 0$$

But, for $\hat{G}_2 = -\hat{G}_1 > 0$, $\hat{Q}_1 > 0$ when $\gamma^1_{SZ} < \gamma^1_{KZ}$, whereas $\hat{Q}_1 > 0$ when $\gamma^1_{SZ} > \gamma^1_{KZ}$ only if μ_S is large for reasons as explained above. Finally, when there is an equi-proportionate increase in budget allocations on both types of infrastructures, $\hat{G}_2 = \hat{G}_1 = \hat{G} > 0$, the most relevant observation that deserves mention is that now quality of Z_1 can improve even when $\gamma^1_{SZ} < \gamma^1_{KZ}$. This is evident from rewriting (3.48) for $\hat{G}_1 = \hat{G}_2 = \hat{G} > 0$:

$$\hat{Q}_1 = \frac{P^W_{Z1}(Q_1)\theta^1_{SZ}}{Q_1{}^2\delta_1}\left[\frac{(\gamma^1_{SZ} - \gamma^1_{KZ})E}{\Delta} + \mu_S\theta^1_{SZ}\left(1 + \frac{D}{\Delta}\right) - \frac{BA(\gamma^1_{SZ} - \gamma^1_{KZ})}{\gamma_{KI}\Delta} - \frac{\mu_S\theta^1_{SZ}\gamma^1_{SZ}B}{\gamma_{KI}\theta^1_{KZ}\Delta}\right]\hat{G} \qquad (3.48a)$$

For better comprehension, let me denote the terms in the parenthesis on the right-hand side as $U_1(\mu_S) \equiv \frac{(\gamma_{SZ}^1 - \gamma_{KZ}^1)E}{\Delta} + \mu_S\theta_{SZ}^1\left(1+\frac{D}{\Delta}\right)$ and $V_1(\mu_S) \equiv \frac{BA(\gamma_{SZ}^1 - \gamma_{KZ}^1)}{\gamma_{KI}\Delta} + \frac{\mu_S\theta_{SZ}^1\gamma_{SZ}^1 B}{\gamma_{KI}\theta_{KZ}^1\Delta}$, so that (3.48a) can be re-written as $\hat{Q}_1 = \frac{P_{Z1}^W(Q_1)\theta_{SZ}^1}{Q_1^2\delta_1}[U_1(\mu_S) - V_1(\mu_S)]$. Recall that $\delta_1 < 0$. For $\gamma_{SZ}^1 < \gamma_{KZ}^1$, both $U_1(\mu_S)$ and $V_1(\mu_S)$ are positive in value. Hence, depending on the parametric configurations, it is plausible that $\hat{Q}_1 > 0$ even when $\gamma_{SZ}^1 < \gamma_{KZ}^1$ unlike the other cases of infrastructure development. By the same reason, now the quality of Z_1 can deteriorate even when $\gamma_{SZ}^1 > \gamma_{KZ}^1$. Note that from (3.50) and (3.51), it follows that $U_1(\mu_S) < 0$ for all $\mu_S < \tilde{\mu}_S$, whereas $V_1(\mu_S) > 0$ for all $\mu_S > \bar{\mu}_S$. Thus, if $\tilde{\mu}_S > \bar{\mu}_S$, then $\hat{Q}_1 > 0$ for all $\mu_S \in [\bar{\mu}_S, \tilde{\mu}_S]$. Referring back to Figure 3.6, this is the overlapping region labeled *abc*. However, by the discussion above, $\tilde{\mu}_S > \bar{\mu}_S$ cannot be guaranteed unambiguously and thus a region like *abc* may not exist. Accordingly, $\hat{Q}_1 < 0$ even when $\gamma_{SZ}^1 < \gamma_{KZ}^1$. For example, if $\tilde{\mu}_S < \bar{\mu}_S$, like the case to the left of the crossing of $\tilde{\mu}_S$-curve and the $\bar{\mu}_S$-curve – or, when the former lies wholly below the latter – then for $\mu_S = \tilde{\mu}_S$, $U_1(\tilde{\mu}_S) = 0$ whereas $V_1(\tilde{\mu}_S) < 0$ so that $\hat{Q}_1 < 0$. On the other hand, for $\mu_S = \bar{\mu}_S$, $U_1(\bar{\mu}_S) > 0$ whereas $V_1(\bar{\mu}_S) = 0$ so that $\hat{Q}_1 < 0$ again.

These results can be summarized in the following Proposition:

Proposition 3.4:
(a) If $\gamma_{SZ}^1 < \gamma_{KZ}^1$, *then* $\hat{Q}_1 < 0$ *for* $\hat{G} = \hat{G}_1 > 0 = \hat{G}_2$ *and for* $\hat{G}_1 = -\hat{G}_2 > 0$; $\hat{Q}_1 > 0$ *for* $\hat{G} = \hat{G}_2 > 0 = \hat{G}_1$ *and for* $\hat{G}_2 = -\hat{G}_1 > 0$; *$Q_1$ may improve for* $\hat{G}_1 = \hat{G}_2 = \hat{G} > 0$.
(b) If $\gamma_{SZ}^1 > \gamma_{KZ}^1$, *then* $\hat{Q}_1 > 0$ *for* $\hat{G} = \hat{G}_1 > 0 = \hat{G}_2$ *if condition* (3.50) *holds;* $\hat{Q}_1 > 0$ *for* $\hat{G} = \hat{G}_2 > 0 = \hat{G}_1$ *if condition (3.51) holds;* $\hat{Q}_1 > 0$ *for* $\hat{G}_1 = -\hat{G}_2 > 0$ *if condition (3.54) holds;* $\hat{Q}_1 < 0$ *for* $\hat{G}_2 = -\hat{G}_1 > 0$ *if condition (3.54) holds. Q_1 may improve for* $\hat{G}_1 = \hat{G}_2 = \hat{G} > 0$ *if* $\tilde{\mu}_S > \bar{\mu}_S$ *and* $\mu_S \in [\bar{\mu}_S, \tilde{\mu}_S]$.

Proof: Follows from Lemma 3.2, and above discussions.

On the other hand, regarding the quality Q_2 of the ITeS, note that by Lemma 3.3 and Proposition 3.3, the skilled wage falls and quality of ICT service worsens for $\hat{G}_1 > 0 = \hat{G}_2$; and the skilled wage rises and quality of ICT service improves for $\hat{G}_2 > 0 = \hat{G}_1$. Thus, the change in Q_2 is ambiguous in both cases. Referring back to (3.47), it is evident that while increase (decrease) in the skilled wage dis-incentivizes (incentivizes) providers of ITeS to upgrade quality, the improvement in ICT service quality incentivizes (dis-incentivizes) quality upgrading. In terms of the algebraic expression for $\hat{Q}_2$ in (3.49) this ambiguity is evident from A < 0, E < 0 and F > 0 by Lemma 3.2. More precisely, for $\hat{G}_1 > 0 = \hat{G}_2$, $\hat{Q}_2 > 0$ if $\bar{\gamma} < -\frac{E}{F}$, i.e., if:

$$\bar{\gamma} < \gamma^*(\mu_S, \mu_L) \equiv \frac{\left[\frac{B}{\gamma_{KI}} + (\tilde{B} - B)\right]\frac{\theta_{LT}}{\theta_{KT}}\mu_L - (\tilde{B} - B)\frac{\theta_{SZ}^1}{\theta_{KZ}^1}\mu_S}{F} \tag{3.53}$$

It can be verified that for $\mu_S = 0$, $\gamma^* > 0$; whereas $\gamma^* = 0$ for

$$\tilde{\mu}_{S2} \equiv \frac{\left[\frac{B}{\gamma_{KI}} + (\tilde{B} - B)\right]\frac{\theta_{LT}}{\theta_{KT}}\mu_L}{(\tilde{B} - B)\frac{\theta_{SZ}^1}{\theta_{KZ}^1}} > \bar{\bar{\mu}}_S$$

Furthermore, as shown in the appendix, γ^* is decreasing in μ_S. Figure 3.8a illustrates the feasibility of quality upgrading of the ITeS exports. For example, consider a value of $\bar{\gamma}$ such as $\bar{\gamma}_0$. In Figure 3.8a this value is given by the horizontal line. So given the downward sloping γ^*-curve, and for $\bar{\gamma}_0 < \bar{\gamma}^*$, condition (3.53) is satisfied for all $\mu_S < \tilde{\mu}_{S2}(\bar{\gamma}_0)$. Also note that, for any given μ_S, F is decreasing in μ_L, so that γ^* is larger for a larger value of μ_L, which is shown by the higher broken γ^*-curve. Thus, now $\hat{Q}_2$ > 0 for a larger subset of μ_S.

Now, for $\hat{G}_2 > 0 = \hat{G}_1$, $\hat{Q}_2 > 0$ if $\bar{\gamma} > -\dfrac{BA}{\gamma_{KI}\Delta H}$, i.e., if:

$$\bar{\gamma} > \gamma^{**}(\mu_S, \mu_L) \equiv \frac{\dfrac{\theta_{LT}}{\theta_{KT}} B(\mu_L + 1) - \dfrac{\theta^1_{SZ}}{\theta^1_{KZ}} B\mu_S}{\gamma_{KI}\left[\dfrac{\theta^1_{SZ}}{\theta^1_{KZ}} C - \dfrac{\theta^1_{SZ}}{\theta^1_{KZ}} \theta^2_{SZ}\mu_S + \dfrac{\theta_{LT}}{\theta_{KT}} \theta^2_{SZ}(\mu_L + 1)\right] + \dfrac{\theta^1_{SZ}}{\theta^1_{KZ}} \dfrac{\theta_{LT}}{\theta_{KT}} B(\mu_L + 1)} \qquad (3.54)$$

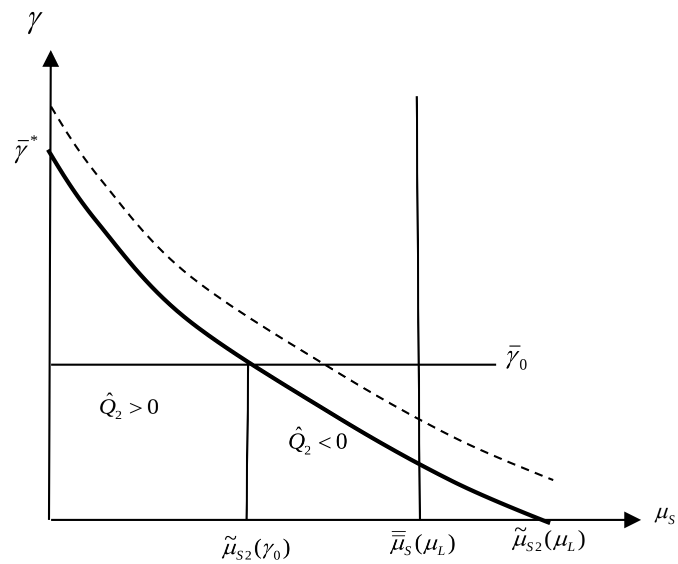

Figure 3.8a: Quality of ITeS Exports for larger Expenditure on Road

$$\hat{G}_1 > 0 = \hat{G}_2$$

It is easy to check that for $\mu_S = 0$, $\gamma^{**} = \bar{\gamma}^{**} > 0$; whereas $\gamma^{**} = 0$ for $\tilde{\tilde{\mu}}_{S2} \equiv \dfrac{\theta_{LT}}{\theta_{KT}} \dfrac{\theta^1_{KZ}}{\theta^1_{SZ}} (\mu_L + 1) > \bar{\bar{\mu}}_S$. Moreover, as shown in the appendix, γ^{**} is decreasing in μ_S $\forall\, \gamma^{**} < \bar{\gamma}^{**}$. Figure 3.8b illustrates the feasibility of quality upgrading of the ITeS exports. For $\bar{\gamma}_0 < \bar{\gamma}^{**}$, condition (3.56) is satisfied for all $\mu_S > \tilde{\tilde{\mu}}_{S2}(\bar{\gamma}_0)$. Again, for any given μ_S , γ^{**} is larger for a larger value of μ_L, in which case $\hat{Q}_2 > 0$ for a smaller subset of μ_S. Before proceeding further, note that $\hat{Q}_2 > 0$ in both these cases is feasible only if $\gamma^{**} < \gamma^*$. But this cannot be ensured a priori.

In case of reallocation of a fixed budget, say $\hat{G}_1 = -\hat{G}_2 > 0$, by Lemma 3.2 the reduction in expenditure on ICT infrastructure reinforces the fall in the skilled wage due to increase in expenditure on road development. At the same time, it lowers the quality of ICT further as is evident from (3.44). That is, both the favourable skilled-wage-cost effect and the adverse ICT-quality effect are stronger under increase in G_1 through budget re-allocation than under a ceteris paribus increase in G_1 through larger budget provision. Accordingly, a smaller productivity value may improve Q_2 if the downward reinforcement of the ICT-quality is smaller. Algebraically, using $\hat{G}_1 = -\hat{G}_2 > 0$, the condition for $\hat{Q}_2 > 0$ can be derived from (3.49) as:

$$\bar{\gamma} < \tilde{\gamma}(\mu_S, \mu_L) \equiv \frac{-\left[E + \frac{BA}{\gamma_{KI}}\right]}{\left[\frac{F}{\Delta} + H\right]} \tag{3.55}$$

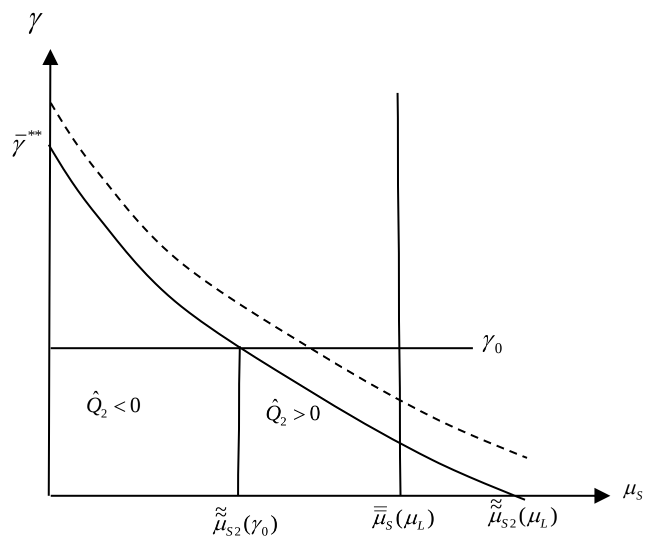

Figure 3.8b: Quality of ITeS Exports for better ICT
$$\hat{G}_2 > 0 = \hat{G}_1$$

Whether this condition is more or less stringent than the other two conditions (3.53) and (3.54) is ambiguous, and depends on the parametric configurations. For example, let me rewrite (3.49) by denoting $U_2(\bar{\gamma}) \equiv \frac{E+\bar{\gamma}F}{\Delta}$ and $V_2(\bar{\gamma}) \equiv \frac{BA}{\gamma_{KI}\Delta} + \bar{\gamma}H$:

$$\hat{Q}_2 = \frac{P_{Z2}^W(Q_2)\gamma_{SZ}^2\theta_{SZ}^2}{{Q_2}^2\delta_2}\left[U_2(\bar{\gamma}) + V_2(\bar{\gamma})\right]\hat{G}_1 \qquad (3.49a)$$

Now, suppose $\gamma^{**} < \gamma^{*}$. Then for all $\bar{\gamma} < \gamma^{**}$, both $U_2(\bar{\gamma})$ and $V_2(\bar{\gamma})$ are negative so that $\hat{Q}_2 > 0$ given $\delta_2 < 0$. But, for all $\bar{\gamma} > \gamma^{*}$, both $U_2(\bar{\gamma})$ and $V_2(\bar{\gamma})$ are positive so that $\hat{Q}_2 < 0$. By similar reasoning, if $\gamma^{**} > \gamma^{*}$, $\hat{Q}_2 > 0$ for all $\bar{\gamma} < \gamma^{*}$ and $\hat{Q}_2 < 0$ for all $\bar{\gamma} > \gamma^{**}$.

Finally, for the equi-proportionate increase in expenditures on road development and ICT infrastructure, I can write,

$$\hat{Q}_2 = \frac{P_{Z2}^W(Q_2)\gamma_{SZ}^2\theta_{SZ}^2}{{Q_2}^2\delta_2}\left[U_2(\bar{\gamma}) - V_2(\bar{\gamma})\right]\hat{G} \qquad (3.49b)$$

If $\gamma^{**} < \gamma^{*}$, then $\hat{Q}_2 > 0$ for all $\bar{\gamma} \in \left[\gamma^{**}, \gamma^{*}\right]$. Further, since $U_2(\bar{\gamma})$ and $V_2(\bar{\gamma})$ are monotonically decreasing in $\bar{\gamma}$, and $V_2(\gamma^{**}) = 0 > U_2(\gamma^{**})$, so $\hat{Q}_2 > 0$ even for "some" $\bar{\gamma} < \gamma^{**}$. By similar reasoning, $\hat{Q}_2 > 0$at least for "some" $\bar{\gamma} > \gamma^{*}$. On the other hand, if $\gamma^{*} < \gamma^{**}$, then it is less likely that the quality of the ITeS exports will improve. For example, in this case $\hat{Q}_2 < 0$ for all $\bar{\gamma} \in \left[\gamma^{*}, \gamma^{**}\right]$.

All these can be summarized in the following Proposition:

Proposition 3.5:

(a) $\hat{Q}_2 > 0$ *for* $\hat{G} = \hat{G}_1 > 0 = \hat{G}_2$ *if condition (3.55) holds;* $\hat{Q}_2 > 0$ *for* $\hat{G} = \hat{G}_2 > 0 = \hat{G}_1$ *if condition (3.56) holds.*

(b)For $\hat{G}_1 = -\hat{G}_2 > 0$, *if* $\gamma^{**} < \gamma^{*}$, *then* $\hat{Q}_2 > 0$*for all* $\bar{\gamma} < \gamma^{**}$, *and* $\hat{Q}_2 < 0$ *for all* $\bar{\gamma} > \gamma^{*}$*; otherwise,* $\hat{Q}_2 > 0$ *for all* $\bar{\gamma} < \gamma^{*}$ *and* $\hat{Q}_2 < 0$ *for all* $\bar{\gamma} > \gamma^{**}$.

(c) For $\hat{G}_1 = \hat{G}_2 = \hat{G} > 0$*, if* $\gamma^{**} < \gamma^{*}$ *then* $\hat{Q}_2 > 0$ *for all* $\bar{\gamma} \in [\gamma^{**}, \gamma^{*}]$*. Otherwise,* $\hat{Q}_2 < 0$ *for all* $\bar{\gamma} \in [\gamma^{*}, \gamma^{**}]$.

Proof: Follows from the above discussion.□

3.3.3 Policy implications

So the policy lesson that we can derive from the above discussion is the following. The government must be aware of the potential trade-off between the two types of infrastructures through the factor-cost effects in a general equilibrium, and consequently asymmetric effects that each may have on qualities of ITeS exports and the manufacturing export good. The budget provision for development of road and/or ICT infrastructure must be designed accordingly, taking into account, among others, the relative capital-intensity of the higher quality varieties of the manufactured export good (Z_1) and the factor-cost effects of developing different infrastructures. For example, due to general-equilibrium factor-cost cascading effects, better roads may actually degrade the quality of both the manufactured exports (Z_1) and the quality of the ITeS exports (Z_2). On the other hand, though re-allocation of a fixed budget for different types of infrastructure may appear to be harmful for one of these quality-differentiated exports since it a direct trade-off between quality and availability of those infrastructures, qualities may improve on the contrary. Take for example the case of re-allocation of a fixed budget on road development ($\hat{G}_1 = -\hat{G}_2 > 0$). It is imperative that while such re-allocation *may* improve the quality of the manufactured export good (Z_1) under the condition stated in Proposition 3.4, the quality of the ICT infrastructure and service will worsen and so will be the quality of the ITeS exports (Z_2). But, on the contrary, quality of ITeS exports under the condition stated in Proposition 3.5 despite quality of the ICT service deteriorating due to smaller allocation of budget on it. Again this is due to the general-equilibrium factor-cost effects. Since lower G_2 reduces the skilled wage (as stated in Lemma 3.2), so Q_2 may improve if adverse skilled-labour productivity due to worsened ICT-quality is weaker. Thus, policy design is not simple or straightforward, and may backfire as far as the target of export-quality promotion is concerned if it is not done taking into account the general-equilibrium effects of infrastructure development in a resource-scarce economy.

The adverse cost-cascading effects of infrastructure development may be mitigated through quality-content production subsidies or input subsidies as discussed in Chapter 2. Of course, such subsidies will put additional burden on the government budget; but this can be managed by either collecting revenues through taxes and tariffs; or, by allowing private firms to build the ICT infrastructure and provide the ICT services. These dimensions of analysis are part of my future research agenda.

3.3.4 Infrastructure Development and Wage Inequality

There can also be a distributive implication of infrastructure development, like a trade policy, as discussed in Chapter 2. Again, the primary concern of the government should below the unskilled workers are affected, in absolute as well as in relative terms.

Recall from Lemma 3.3 that a ceteris paribus increase in government spending on road infrastructure raises the unskilled wage and lowers the skilled wage. Hence, unskilled workers are better off both absolutely and relative to the skilled workers. The latter implies that the wage inequality declines. For a ceteris paribus increase in the government expenditure on ICT infrastructure also improves the absolute position of the unskilled workers since their money wage increases. But, since the skilled wage increases now, so the change in wage inequality is ambiguous. All these can be verified from the following expression for the change in wage inequality:

$$\hat{w}_S - \hat{w} = \frac{1}{\Delta}(E + D)\hat{G}_1 - \frac{1}{\Delta}\left[\frac{BA}{\gamma_{KI}} + \frac{B\theta_{SZ}^1}{\gamma_{KI}\theta_{KZ}^1}\right]\hat{G}_2 \tag{3.56}$$

Thus, for $\hat{G} = \hat{G}_2 > 0 = \hat{G}_1$, the wage inequality improves if,

$$\mu_S < 1 + (1 + \mu_L)\frac{\theta_{LT}}{\theta_{KT}}\frac{\theta_{KZ}^1}{\theta_{SZ}^1} \tag{3.57}$$

Note that this condition is satisfied under the earlier assumption (3.42).

For $\hat{G}_1 = \hat{G}_2 = \hat{G} > 0$, whereas the absolute position of unskilled workers improves, their relative position *may* worsen. However, even in such a case, the wage inequality will worsen to a lesser extent than under $\hat{G} = \hat{G}_2 > 0 = \hat{G}_1$ because the increase in G_1 lowers the wage inequality and thus at least mitigates the worsening effect of the increase in G_2. In fact, again the wage inequality will decline under condition (3.57), but now this is only a sufficient condition. Change in the wage inequality under re-allocation of a fixed budget is, however, uncertain. For $\hat{G}_1 = -\hat{G}_2 > 0$, (3.56) can be re-written as:

$$\hat{w}_S - \hat{w} = \frac{1}{\Delta}\left[(E+D) + \left\{\frac{BA}{\gamma_{KI}} + \frac{B\theta^1_{SZ}}{\gamma_{KI}\theta^1_{KZ}}\right\}\right]\hat{G}_1 \qquad (3.56a)$$

Since, $\frac{BA}{\gamma_{KI}} + \frac{B\theta^1_{SZ}}{\gamma_{KI}\theta^1_{KZ}} > 0$ under the assumption in (3.42) – i.e., for $\mu_S < \bar{\bar{\mu}}_S$ – so wage inequality may worsen. As shown in the appendix, $E + D + \frac{BA}{\gamma_{KI}} + \frac{B\theta^1_{SZ}}{\gamma_{KI}\theta^1_{KZ}} > 0$ for $\mu_S = \bar{\bar{\mu}}_S$ if $\frac{\theta^1_{SZ}}{\theta^1_{KZ}} > \frac{\theta_{LT}}{\theta_{KT}}$ [31]. Hence, given that $E + D + \frac{BA}{\gamma_{KI}}$ increases with μ_S, so $E + D + \frac{BA}{\gamma_{KI}} + \frac{B\theta^1_{SZ}}{\gamma_{KI}\theta^1_{KZ}} > 0$ *at least* for some $\mu_S < \bar{\bar{\mu}}_S$. Hence, the wage inequality accentuates for such values of $\mu_S < \bar{\bar{\mu}}_S$. On the other hand, if $\frac{\theta^1_{SZ}}{\theta^1_{KZ}} < \frac{\theta_{LT}}{\theta_{KT}}$, then $E + D + \frac{BA}{\gamma_{KI}} + \frac{B\theta^1_{SZ}}{\gamma_{KI}\theta^1_{KZ}} < 0$ for all $\mu_S < \bar{\bar{\mu}}_S$, and hence the wage inequality declines. For $\hat{G}_2 = -\hat{G}_1 > 0$, the changes in wage inequality is exactly in the opposite direction: it accentuates for all $\mu_S < \bar{\bar{\mu}}_S$ if $\frac{\theta^1_{SZ}}{\theta^1_{KZ}} < \frac{\theta_{LT}}{\theta_{KT}}$; but declines *at least* for some $\mu_S < \bar{\bar{\mu}}_S$ if $\frac{\theta^1_{SZ}}{\theta^1_{KZ}} > \frac{\theta_{LT}}{\theta_{KT}}$.

[31]Note that since the composite traded good is capital-intensive relative to the non-traded good, so $\theta_{LT} < \theta_{KT}$, so this condition is compatible with both $\theta^1_{SZ} > \theta^1_{KZ}$ and $\theta^1_{SZ} < \theta^1_{KZ}$.

These results are summarized in Proposition 3.5 below, given that condition (3.57) is satisfied under the assumption (3.42):

Proposition 3.6: *(a) Wage inequality declines for* $\hat{G} = \hat{G}_1 > 0 = \hat{G}_2$ *unambiguously, and for* $\hat{G} = \hat{G}_2 > 0 = \hat{G}_1$ *and* $\hat{G}_1 = \hat{G}_2 = \hat{G} > 0$ *under the assumption (3.42).*
(b) If $\frac{\theta_{SZ}^1}{\theta_{KZ}^1} < \frac{\theta_{LT}}{\theta_{KT}}$, *the wage inequality declines for* $\hat{G}_1 = -\hat{G}_2 > 0$, *and worsens for* $\hat{G}_2 = -\hat{G}_1 > 0$ *under the assumption (3.42). Otherwise, the wage inequality worsens under* $\hat{G}_1 = -\hat{G}_2 > 0$, *and declines under* $\hat{G}_2 = -\hat{G}_1 > 0$ *for some* $\mu_S < \bar{\bar{\mu}}_S$.

Proof: Follows from Lemma 3.2 and (3.56) and the above discussion.□

Note that for reasons spelled out in Section 2.4 in Chapter 2, validity of the condition stated in the Proposition 3.6(b), viz., $\frac{\theta_{SZ}^1}{\theta_{KZ}^1} < \frac{\theta_{LT}}{\theta_{KT}}$, depends on the initial level of quality of the manufactured-export good Z_1.

3.4 Concluding Remarks and Scope of Future Extensions

In this chapter, I have demonstrated that higher quality of the ICT infrastructure improves quality of an ITeS exports if its skilled-labour productivity improvement is larger than its skilled-wage increasing effect. This brings out the fact that in a resource constrained economy, if the production of goods and infrastructure development compete for some common scarce resources, then infrastructure development has a factor-cost cascading effect which, if large enough, may cause export-quality to degrade. This cost-cascading effect even leads to a trade-off between different types of infrastructure projects. This has been studied in the context of ICT infrastructure used in ITeS exports and quality of ICT augmenting productivity of skilled workers there, on the one hand; and better and paved roads facilitating movement of unskilled workers employed in traditional production sectors and skilled workers engaged in producing a quality-differentiated manufactured export good, on the other hand. Due to the factor-cost cascading effect, a ceteris paribus increase in the budget provision for road development, or a reallocation of a fixed budget in favour of road development, lowers the quality of the ICT infrastructure and service provided by the government. Consequently, the quality of ITeS exports may be degraded by the service providers. On the other hand, a ceteris paribus increase in the budget provision for ICT infrastructure, or a reallocation of a fixed budget in favour of it, worsens road infrastructure. This, by raising the capital-costs relative to the skilled wage cost, worsens the quality of the manufactured export good if its high-quality varieties are relatively capital intensive, Interestingly, when the high-quality varieties are relatively skilled-labour intensive, quality may improve depending on the value of infrastructure-elasticity of skilled and unskilled labour productivities.

The analysis in this Chapter holds potential to be extended into several directions in the future. One such relevant extension is to incorporate formal-informal segmentation of the labour market, as in Chapter 2. Its relevance is apparent from a simple example in the above context. Suppose, the government hires unskilled labour for road development at a fixed money wage. Then, even if an increase in expenditure on the ICT infrastructure raises the unskilled wage in the rest of the economy – especially in the informal sectors – it will not cause the length of paved roads or its maintenance to suffer. That is, the trade-off between two types of infrastructure may exist only partially. Apart from this particular implication, co-existence of formal and informal sectors enables to examine changes in wage inequality due to labour allocation across these sectors that infrastructure development may result in.

The other important extension is the mode of financing of government expenditure on infrastructure development. There exists a substantial literature that compare two types of financing methods of the government expenditures, deficit financing and balanced budget while analysing effects of fiscal policies on different aspects of growth and development. For example, Gardner and Kimbrough (1992) had developed a model of tariffs as the source of government revenue and related the behaviour of tariff rates and revenues to observable macroeconomic variables such as income and government spending to explain stylized facts concerning the changing role of the tariff in US history. Earlier, in the context of Heckscher-Ohlin-Samuelson model, Feehan (1988) examined that trade-off between the distortionary effects of a tariff and the benefits of the public good which it finances. Of late, with only ICT infrastructure and ITeS exports, Ganguly and Acharyya (2021) have examined whether and how the quality of ICT infrastructure and the quality of ITeS exports change under a tariff-revenue-financed balanced-budget infrastructure development, compared to deficit financed infrastructure development. Their analysis can be extended in the present context. To exemplify the scope of such an extension, let $\tau \in (0,1)$ be an ad-valorem tariff imposed on the imported input M used in production of the composite traded good. With the total volume of import being $a_{MT}X_T$ and the value of import being $a_{fT}X_T$, the tariff-revenue financed balanced budget means[32]:

$$\tau_T a_{fT} X_T = G = G_1 + G_2$$

Thus an increase in the total G – and the three alternative allocation possibilities of it we discussed above – will now be achieved through an increase in the input-tariff rate τ and corresponding increase in the tariff revenue. To briefly explain how the tariff-financed balanced budget case is different from the deficit-financed infrastructure development, suppose the additional revenue collected from a higher input tariff is used to develop only the ICT infrastructure further. Higher revenue will enable the government to improve the quality of the ICT infrastructure and service just like in case of larger budget allocation under deficit-financing. But, higher tariff itself has some general equilibrium effects which would affect the infrastructure development. Note that the composite traded good and the quality-differentiated manufacturing export-good display a specific-factor production structure with capital as the mobile factor, and unskilled labour and skilled labour as the two specific factors. Higher input tariff lowers the effective price (or revenue per unit) received by the domestic producers of the composite traded good. Thus, at the initial quality level Q_1, the effective relative price of the composite traded good, $\left[P_T^W - a_{fT}(1+\tau)\right] / P_{Z1}^W(Q_1)$, falls. Thus, by the standard price magnification effect in a specific-factor model a la Jones (1971), the skilled wage increases, and both the rate of

[32]In many developing countries import of petroleum, oil and lubricants (POL), for example, has been highly taxed to finance many fiscal expenditure of the local government. A very recent example being large amounts of taxes and duties imposed by the Union as well as the State governments in India to finance its fiscal stimulus in the face of economic downturn caused by the pandemic during 2020-21.

return to capital and the unskilled wage fall. Thus, the quality of the ICT infrastructure will improve further as a consequence of the decline in capital cost, and the length of paved roads will increase as a consequence of lower wage-cost, both due to the higher input tariff itself. These are the additional factor-cost effects on the two types of infrastructures under tariff-financed balanced-budget expenditures on infrastructure developments. There will then be the factor-price changes brought about by these initial changes in q and I_1 and the inter-dependences as under deficit-financing discussed earlier. A detailed analysis of this balanced-budget infrastructure development is, therefore, worthwhile as a future research agenda.

Another important future extension is to allow for provision of the ICT network and service by private firms, or in public-private partnership mode, which is not at odd with reality. This will be an effective instrument for the government to resolve its choice problem in allocating a limited budgetary provision on different types of infrastructures and the trade-off that emerges from a reallocation of the fixed budget. The cross cost-cascading effects would still exists though.

Finally, implications of road infrastructure lowering cost of transporting goods for export-qualities can be examined. One simple way to extend the present analysis in such a direction is to consider the iceberg model of transport cost a la Dornbusch, Fisher and Samuelson (1977) and Brander (1981), and assuming that road infrastructure reducing such costs as in Acharyya (2014).

Appendix

A.3.1 ICT Infrastructure: Determination of slope of M_N curve

From the zero profit condition in sector T we can obtain:

$$\hat{w} = -\frac{\theta_{fT}}{\theta_{LT}}\beta_f \hat{\tau}_T - \frac{\theta_{KT}}{\theta_{LT}}\hat{r} \qquad \text{(A.3.1)}$$

where, $\beta_f = \frac{\tau_T}{1+\tau_T}$.

From the zero profit condition in sector N we can obtain, $\hat{P}_N = \theta_{KN}\hat{r} + \theta_{LN}\hat{w}$

Using (A.3.1), I can write $\hat{P}_N$ as,

$$\hat{P}_N = -\frac{\theta_{LN}\theta_{fT}}{\theta_{LT}}\beta_f \hat{\tau}_T + \frac{|\theta|}{\theta_{LT}}\hat{r} \qquad \text{(A.3.2)}$$

where, $|\theta|$ is the determinant of the cost share matrix in the (T,N) nugget.

Percentage change form of the capital constraint (3.12) in the text gives us:

$$-\frac{K'(q)q}{K(q)}\frac{K(q)}{\bar{K}}\hat{q} = \frac{a_{KT}X_T}{\bar{K}}\hat{X}_T + \frac{a_{KN}X_N}{\bar{K}}\hat{X}_N$$

$$\Rightarrow -\gamma_{KI}\lambda_{KI}\hat{q} = \lambda_{KT}\hat{X}_T + \lambda_{KN}\hat{X}_N \qquad \text{(A.3.3)}$$

Percentage change form of the unskilled labour constraint (3.13) will give:

$$0 = \frac{a'_{IZ}(q)q}{a'_{IZ}(q)}\frac{a_{IZ}(q)X_Z}{\bar{L}}\hat{q} + \frac{a_{IZ}(q)X_Z}{\bar{L}}\hat{X}_Z + \frac{a_{LT}X_T}{\bar{L}}\hat{X}_T + \frac{a_{LN}X_N}{\bar{L}}\hat{X}_N$$

$$\Rightarrow 0 = \lambda_{LI}(-\gamma_{IZ}\hat{q} + \hat{X}_Z) + \lambda_{LT}\hat{X}_T + \lambda_{LN}\hat{X}_N \text{ (A.3.4)}$$

Percentage change form of the skilled labour constraint (3.14) in the text gives us:

$$0 = \left(\frac{\partial a_{SZ}(Q,q)}{\partial q}\frac{q}{a_{SZ}(Q,q)}\hat{q} + \frac{\partial a_{SZ}(Q,q)}{\partial Q}\frac{Q}{a_{SZ}(Q,q)}\hat{Q} + \hat{X}_Z\right)\frac{a_{SZ}(Q,q)X_Z}{\bar{S}}$$

$$\Rightarrow \hat{X}_Z = -\gamma_{SZ}\hat{Q} + \gamma_{Sq}\hat{q} \qquad \text{(A.3.5)}$$

Substituting expression for $\hat{X}_Z$ from (A.3.5) in (A.3.4) I get:

$$0 = \lambda_{LI}(\gamma_{Sq} - \gamma_{IZ})\hat{q} - \lambda_{LI}\gamma_{SZ}\hat{Q} + \lambda_{LT}\hat{X}_T + \lambda_{LN}\hat{X}_N \qquad \text{(A.3.6)}$$

where, $(\gamma_{Sq} - \gamma_{IZ}) < 0$ as assumed in the text.

Representing (A.3.3) and (A.3.6) in matrix notation:

$$\begin{bmatrix} \lambda_{LT} & \lambda_{LN} \\ \lambda_{KT} & \lambda_{KN} \end{bmatrix}\begin{bmatrix} \hat{X}_T \\ \hat{X}_N \end{bmatrix} = \begin{bmatrix} \lambda_{LI}(\gamma_{IZ} - \gamma_{Sq})\hat{q} + \lambda_{LI}\gamma_{SZ}\hat{Q} \\ -\gamma_{KI}\lambda_{KI}\hat{q} \end{bmatrix}$$

Solving for the values of $\hat{X}_T$ and $\hat{X}_N$ by Cramer's rule, I obtain output changes as:

$$\hat{X}_T = \frac{\{\lambda_{LN}\gamma_{KI}\lambda_{KI} + \lambda_{KN}\lambda_{LI}(\gamma_{IZ} - \gamma_{Sq})\}\hat{q} + \lambda_{KN}\lambda_{LI}\gamma_{SZ}\hat{Q}}{|\lambda|} \quad \text{(A.3.7)}$$

$$\hat{X}_N = \frac{-\{\lambda_{LT}\gamma_{KI}\lambda_{KI} + \lambda_{KT}\lambda_{LI}(\gamma_{IZ} - \gamma_{Sq})\}\hat{q} - \lambda_{KT}\lambda_{LI}\gamma_{SZ}\hat{Q}}{|\lambda|} \quad \text{(A.3.8)}$$

Now from the market clearing condition in the non-traded sector, under homothetic tastes we obtain,

$$-\varepsilon_N\hat{P}_N = \hat{X}_N - \hat{X}_T \quad \text{(A.3.9)}$$

Using (A.3.2), and the output levels derived, we can rewrite (A.3.9) as:

$$\tilde{\lambda}\hat{q} - \frac{\varepsilon_N|\lambda||\theta|}{\theta_{LT}}\hat{r} = -\frac{\varepsilon_N\theta_{LN}\theta_{fT}|\lambda|}{\theta_{LT}}\beta_f\hat{\tau}_T - (\lambda_{KN} + \lambda_{KT})\lambda_{LI}\gamma_{SZ}\hat{Q} \quad \text{(A.3.10)}$$

where, $\tilde{\lambda} = [(\lambda_{LN} + \lambda_{LT})\gamma_{KI}\lambda_{KI} + (\lambda_{KN} + \lambda_{KT})\lambda_{LI}(\gamma_{IZ} - \gamma_{Sq})] > 0$

At $\hat{\tau} = 0, \hat{Q} = 0$, (A.3.10) gives us a relationship between q and the r consistent with the market-clearing condition for the non-traded good as captured by the M_N curve in the text:

$$\hat{q} = \frac{\varepsilon_N|\lambda||\theta|}{\tilde{\lambda}\theta_{LT}}\hat{r} \quad \text{(A.3.10a)}$$

A.3.2.<u>Effect of a change in Q on choice of *q* by the government</u>

Total differentiation of Government's budget constraint (3.9) in the text gives me an inverse relationship between q and r, *for any given G*, as captured by the II curve in the text:

$$\hat{\bar{G}} = \gamma_{KI}\hat{q} + \hat{r} \quad \text{(A.3.11)}$$

Rewriting (A.3.10) and (A.3.11) in matrix notation:

$$\begin{bmatrix} \tilde{\lambda} & -\frac{\varepsilon_N|\lambda||\theta|}{\theta_{LT}} \\ \gamma_{KI} & 1 \end{bmatrix}\begin{bmatrix} \hat{q} \\ \hat{r} \end{bmatrix} = \begin{bmatrix} -\frac{\varepsilon_N\theta_{LN}\theta_{fT}|\lambda|}{\theta_{LT}}\beta_f\hat{\tau}_T - (\lambda_{KN} + \lambda_{KT})\lambda_{LI}\gamma_{SZ}\hat{Q} \\ \hat{\bar{G}} \end{bmatrix}$$

I solve for $\hat{q}$ and $\hat{r}$ in terms of $\hat{Q}$ and the other parameters ($\bar{G}$ *and* τ), by Cramer's rule:

$$\hat{q} = \frac{1}{\Delta}\left[-\frac{\varepsilon_N\theta_{LN}\theta_{fT}|\lambda|}{\theta_{LT}}\beta_f\hat{\tau}_T - (\lambda_{KN} + \lambda_{KT})\lambda_{LI}\gamma_{SZ}\hat{Q} + \frac{\varepsilon_N|\lambda||\theta|}{\theta_{LT}}\hat{\bar{G}}\right] \quad \text{(A.3.12)}$$

$$\hat{r} = \frac{1}{\Delta}\left[\tilde{\lambda}\hat{\bar{G}} + \frac{\gamma_{KI}\varepsilon_N\theta_{LN}\theta_{fT}|\lambda|}{\theta_{LT}}\beta_f\hat{\tau}_T + \gamma_{KI}(\lambda_{KN} + \lambda_{KT})\lambda_{LI}\gamma_{SZ}\hat{Q}\right] \quad \text{(A.3.13)}$$

where, $\Delta = \tilde{\lambda} + \frac{\gamma_{KI}\varepsilon_N|\lambda||\theta|}{\theta_{LT}} > 0$.

For any given $\bar{G}$ (that is, $\hat{\bar{G}} = 0$) and input tariff (that is $\hat{\tau}_T = 0$), (A.3.12) gives a relationship between Q and q as depicted by the qq curve in the text with slope as:

$$\left.\frac{dQ}{dq}\right|_{qq} = -\frac{\Delta}{(\lambda_{KN}+\lambda_{KT})\lambda_{LI}\gamma_{SZ}}\frac{Q}{q} < 0 .$$

A.3.3.<u>Profit maximizing choice of quality of Z-services</u>

The change in quality can be obtained from total differentiation of the marginal condition:

$$P_Z^{W''}(Q)dQ = w_S\frac{\partial}{\partial Q}\left(\frac{\partial a_{SZ}(Q,q)}{\partial Q}\right)dQ + w_S\frac{\partial}{\partial q}\left(\frac{\partial a_{SZ}(Q)}{\partial Q}\right)dq + \frac{\partial a_{SZ}(Q)}{\partial Q}dw_S$$

$$\Rightarrow \frac{Q^2}{P_Z^W}\delta\hat{Q} = \frac{a_{SZ}(Q)w_S}{P_Z^W}\left(\frac{\partial a_{SZ}(Q)}{\partial Q}\frac{Q}{a_{SZ}(Q)}\right)\left[\frac{\partial}{\partial q}\left(\frac{\partial a_{SZ}(Q)}{\partial Q}\right)\frac{q}{\frac{\partial a_{SZ}(Q)}{\partial Q}}\hat{q} + \hat{w}_S\right]$$

$$\Rightarrow \hat{Q} = \frac{P_Z^W}{\delta Q^2}\theta_{SZ}\gamma_{SZ}\left(-\bar{\gamma}\hat{q} + \hat{w}_S\right) \qquad \text{(A.3.14)}$$

where, $\delta \equiv \left[P_Z^{W''}(Q) - w_S\frac{\partial}{\partial Q}\left(\frac{\partial a_{SZ}(Q,q)}{\partial Q}\right)dQ\right] < 0$ by the second order condition for profit maximization; and $\bar{\gamma} \equiv -\frac{\partial}{\partial q}\left(\frac{\partial a_{SZ}(Q)}{\partial Q}\right)\frac{q}{\frac{\partial a_{SZ}(Q)}{\partial Q}} > 0$ by the assumption that $\frac{\partial}{\partial q}\left(\frac{\partial a_{SZ}(Q)}{\partial Q}\right) < 0$ in (3.1) in the text.

A.3.4. <u>Proof of Lemma 3.1</u>

From the zero profit condition in the Z sector we get:

$$P_Z^{W'}(Q)dQ = w_S\frac{\partial a_{SZ}(Q,q)}{\partial Q}dQ + w_S\frac{\partial a_{SZ}(Q,q)}{\partial q}dq + a_{SZ}(Q,q)dw_S + \frac{\partial a_{SZ}(q)}{\partial q}dqP_I + a_{IZ}(q)dP_I$$

Using the marginal condition (3.7) in the text and substituting P_I=w,I get,

$$0 = \left(\frac{\partial a_{SZ}(Q,q)}{\partial q}\frac{q}{a_{SZ}(Q,q)}\right)\frac{a_{SZ}(Q,q)w_S}{P_Z^W}\hat{q} + \frac{a_{SZ}(Q,q)w_S}{P_Z^W}\hat{w}_S + \left(\frac{\partial a_{IZ}(q)}{\partial q}\frac{q}{a_{IZ}(q)}\right)\frac{a_{IZ}(q)P_I}{P_Z^W}\hat{q} + \frac{a_{IZ}(q)P_I}{P_Z^W}\hat{P}_I$$

$$\Rightarrow 0 = \theta_{SZ}(-\gamma_{SZ}\hat{q} + \hat{w}_S) + \theta_{IZ}(-\gamma_{IZ}\hat{q} + \hat{w})$$

$$\Rightarrow \hat{w}_S = \frac{(\theta_{SZ}\gamma_{SZ} + \theta_{IZ}\gamma_{IZ})\hat{q} - \theta_{IZ}\hat{w}}{\theta_{SZ}} \qquad \text{(A.3.15)}$$

Now, for any given $\overline{G}$ and input tariff, and the relationship $\hat{w} = -\frac{\theta_{KT}}{\theta_{LT}}\hat{r}$, we obtain the change in the unskilled wage following a rise in q as:

$$\hat{w} = -\frac{\tilde{\lambda}\theta_{KT}}{\varepsilon_N|\lambda||\theta|}\hat{q} \qquad \text{(A.3.16)}$$

Substituting this in (A.15) we get the change in the skilled wage following a rise in q:

$$\hat{w}_S = \left[\frac{(\theta_{SZ}\gamma_{SZ} + \theta_{IZ}\gamma_{IZ})}{\theta_{SZ}} + \frac{\theta_{IZ}\tilde{\lambda}\theta_{KT}}{\theta_{SZ}\varepsilon_N|\lambda\|\theta|} \right]\hat{q} \tag{A.3.17}$$

Finally, substitution of (A.3.17) in (A.3.14) yields,

$$\hat{Q} = \frac{P_Z^W}{\delta Q^2}\theta_{SZ}\gamma_{SZ}\left[\left\{ \frac{(\theta_{SZ}\gamma_{SZ} + \theta_{IZ}\gamma_{IZ})}{\theta_{SZ}} + \frac{\theta_{IZ}A\theta_{KT}}{\theta_{SZ}\varepsilon_N|\lambda\|\theta|} \right\} - \bar{\gamma} \right]\hat{q} \tag{A.3.18}$$

Thus, if the productivity augmenting effect of better quality ICT infrastructure ($\bar{\gamma}$) is stronger than its adverse wage-cost effect, then by (A.18), $\hat{Q} > 0$ if $\hat{q} > 0$. This completes the proof of Lemma 3.1.

Also note that (A.18) gives a relationship between Q and q as depicted by the QQ curve in the text with slope as: $\left.\frac{dQ}{dq}\right|_{QQ} = \theta_{SZ}\tilde{\theta}\gamma_{SZ}\frac{P_Z^W}{\delta Qq}$, which is positive if $\tilde{\theta} \equiv \left[\left\{ \frac{(\theta_{SZ}\gamma_{SZ} + \theta_{IZ}\gamma_{IZ})}{\theta_{SZ}} + \frac{\theta_{IZ}\tilde{\lambda}\theta_{KT}}{\theta_{SZ}\varepsilon_N|\lambda\|\theta|} \right\} - \bar{\gamma} \right] < 0$ given that $\delta < 0$.

A.3.5 Effect of exogenous rise in G

Changes in the quality levels can be obtained by solving (A.12) by setting $\hat{\tau} = 0$ and (A.18). Writing in matrix notation:

$$\begin{bmatrix} \frac{(\lambda_{KN} + \lambda_{KT})\lambda_{LI}\gamma_{SZ}}{\Delta} & 1 \\ 1 & -\left(\frac{P_Z^W}{\delta Q^2}\theta_{SZ}\tilde{\theta}\gamma_{SZ} \right) \end{bmatrix} \begin{bmatrix} \hat{Q} \\ \hat{q} \end{bmatrix} = \begin{bmatrix} \frac{\varepsilon_N|\theta\|\lambda|}{\Delta\theta_{LT}}\hat{G} \\ 0 \end{bmatrix}$$

where, $\tilde{\theta} \equiv \left[\left\{ \frac{(\theta_{SZ}\gamma_{SZ} + \theta_{IZ}\gamma_{IZ})}{\theta_{SZ}} + \frac{\theta_{IZ}\tilde{\lambda}\theta_{KT}}{\theta_{SZ}\varepsilon_N|\lambda\|\theta|} \right\} - \bar{\gamma} \right]$.

By applying Cramer's rule, we get:

$$\hat{Q} = -\frac{1}{\Delta'}\frac{P_Z^W}{\delta Q^2}\frac{\varepsilon_N|\lambda\|\theta|}{\Delta\theta_{LT}}\theta_{SZ}\tilde{\theta}\gamma_{SZ}\hat{G} \tag{A.3.19}$$

$$\hat{q} = \frac{-\varepsilon_N|\theta\|\lambda|}{\Delta'\Delta\theta_{LT}}\hat{G} \tag{A.3.20}$$

where, $\Delta' = -\left(\frac{(\lambda_{KN} + \lambda_{KT})\lambda_{LI}\gamma_{SZ}}{\Delta}\left(\frac{P_Z^W}{\delta Q^2}\theta_{SZ}\tilde{\theta}\gamma_{SZ} \right) + 1 \right)$.

Thus, $\Delta' < 0$, $\hat{Q} > 0$ and $\hat{q} > 0$ if $\tilde{\theta} < 0$.

A.3.6: Road versus ICT Infrastructure: Derivation of domestic factor prices

Differentiating the zero-profit conditions for export-good Z_1, service-export $Z_2$and for the composite traded good T in the text, I get respectively:

$$\hat{r} = -\frac{\theta^1_{SZ}}{\theta^1_{KZ}}\hat{w}_S + \frac{\theta^1_{SZ}}{\theta^1_{KZ}}\mu_S \hat{I}_1 \tag{A.3.21}$$

$$\theta^2_{SZ}\hat{w}_S = B\hat{q} - \theta^2_{IZ}\hat{w} \tag{A.3.22}$$

$$\mu_L \theta_{LT}\hat{I}_1 = \theta_{KT}\hat{r} + \theta_{LT}\hat{w} \tag{A.3.23}$$

where, $B = (\theta^2_{SZ}\gamma^2_{SZ} + \theta^2_{IZ}\gamma^2_{IZ}) > 0$; $\mu_S \equiv -\frac{I_1}{a^1_{SZ}(Q_1, I_1)}\frac{\partial a^1_{SZ}(Q_1, I_1)}{\partial I_1}$.

From the budget allocation conditions for the two types of infrastructures (3.28) and (3.29), we get:

$$\hat{I}_1 = \hat{G}_1 - \hat{w} \tag{A.3.24}$$

$$\gamma_{KI}\hat{q} = \hat{G}_2 - \hat{r} \tag{A.3.25}$$

Substitution of (A.3.24) in (A.3.25) solves for $\hat{r}$:

$$\hat{r} = \frac{\mu_L \theta_{LT}}{\theta_{KT}}\hat{G}_1 - \frac{\theta_{LT}(\mu_L + 1)}{\theta_{KT}}\hat{w} \tag{A.3.26}$$

Substitution of (A.3.24) and (A.3.26) in (A.3.21) yields:

$$\tilde{A}\hat{G}_1 = \frac{\theta^1_{SZ}}{\theta^1_{KZ}}\hat{w}_S + A\hat{w} \tag{A.3.27}$$

where, $\tilde{A} = \left(\frac{\theta^1_{SZ}}{\theta^1_{KZ}}\mu_S - \frac{\mu_L\theta_{LT}}{\theta_{KT}}\right)$ and $A = \left(\frac{\theta^1_{SZ}}{\theta^1_{KZ}}\mu_S - \frac{\theta_{LT}(\mu_L + 1)}{\theta_{KT}}\right)$.

Note that $A \equiv \left(\tilde{A} - \frac{\theta_{LT}}{\theta_{KT}}\right)$, so if $\tilde{A} < 0$ for low values of μ_S, in the sense, $\mu_S < \mu_L\left(\frac{\theta_{LT}}{\theta_{KT}}\frac{\theta^1_{KZ}}{\theta^1_{SZ}}\right)$, then A<0 also.

Substituting (A.3.26) in (A.3.25), I get:

$$\gamma_{KI}\hat{q} = \hat{G}_2 - \frac{\mu_L\theta_{LT}}{\theta_{KT}}\hat{G}_1 + \frac{\theta_{LT}(\mu_L + 1)}{\theta_{KT}}\hat{w} \tag{A.3.28}$$

Substituting (A.3.28) in (A.3.22) yields:

$$\theta^2_{sz}\hat{w}_S + C\hat{w} = \frac{B}{\gamma_{KI}}\hat{G}_2 - \frac{B}{\gamma_{KI}}\frac{\mu_L\theta_{LT}}{\theta_{KT}}\hat{G}_1 \tag{A.3.29}$$

where, $C = \left(\theta^2_{IZ} - \frac{B}{\gamma_{KI}}\frac{\theta_{LT}(\mu_L + 1)}{\theta_{KT}}\right)$.

Note that while (A.3.28) gives us a relationship between q and w for any given G_1 and G_2 that satisfies the capital-cost equation of ICT infrastructure, (A.3.22) gives us a relationship between q and w for any given w_S. These two relationships determine q and w, given w_S, as shown by the qq and ww curves in Figure A.3.1. For stability, we require that the qq curve be steeper than the ww curve, which from (A.3.22) and (A.3.28) means,

$$\left.\frac{dw}{dq}\right|_{qq} = \frac{\gamma_{KI}\theta_{KT}}{(\mu_L+1)\theta_{LT}} > \left.\frac{dw}{dq}\right|_{ww} = \frac{B}{\theta_{IZ}^2}$$

This means, $C > 0$ by requirement of stability.

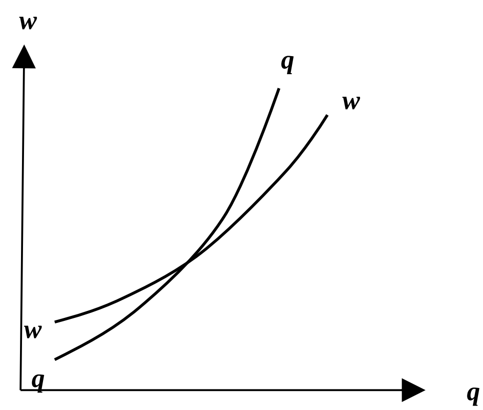

Figure A.3.1: Simultaneous determination of *q* and *w*, given w_s

Writing (A.3.27) and (A.3.29) in matrix notation:

$$\begin{bmatrix} \dfrac{\theta^1_{SZ}}{\theta^1_{KZ}} & A \\ \theta^2_{SZ} & C \end{bmatrix} \begin{bmatrix} \hat{w}_S \\ \hat{w} \end{bmatrix} = \begin{bmatrix} \tilde{A}\hat{G}_1 \\ \dfrac{B}{\gamma_{KI}}\hat{G}_2 - \dfrac{B}{\gamma_{KI}}\dfrac{\mu_L\theta_{LT}}{\theta_{KT}}\hat{G}_1 \end{bmatrix}$$

and solving the above by Cramer's rule for $\hat{w}_S$ *and* $\hat{w}$, I get:

$$\hat{w}_S = \frac{1}{\Delta}\left\{-\frac{BA}{\gamma_{KI}}\hat{G}_2 + E\hat{G}_1\right\} \qquad \text{(A.3.30)}$$

$$\hat{w} = \frac{1}{\Delta}\left\{\frac{B\theta^1_{SZ}}{\gamma_{KI}\theta^1_{KZ}}\hat{G}_2 - D\hat{G}_1\right\} \qquad \text{(A.3.31)}$$

where, $D = \left(\dfrac{B\mu_L\theta^1_{SZ}\theta_{LT}}{\gamma_{KI}\theta^1_{KZ}\theta_{KT}} + \tilde{A}\theta^2_{SZ}\right) < 0$, $E = \left(\dfrac{BA\mu_L\theta_{LT}}{\gamma_{KI}\theta_{KT}} + \tilde{A}C\right) < 0$; $\Delta = \left(\dfrac{\theta^1_{SZ}}{\theta^1_{KZ}}C - A\theta^2_{SZ}\right)$;

$\Delta > 0$ if *A<0* and $\Delta > 0$ by stability if *A>0*. Stability requires that the negatively sloped schedule $w(w_S)$ given by (A.29), to be flatter than the negatively sloped $w_S(w)$ schedule given by (A.3.27) in (w, w_S) space.

Note that we can break down D as:

$$D = \frac{B\mu_L\theta^1_{SZ}\theta_{LT}}{\gamma_{KI}\theta^1_{KZ}\theta_{KT}} + \theta^2_{SZ}\frac{\theta^1_{SZ}}{\theta^1_{KZ}}\mu_S - \theta^2_{SZ}\frac{\mu_L\theta_{LT}}{\theta_{KT}} \tag{A.3.32}$$

The first two terms in RHS of (A.3.32) capture the wage raising effects of a ceteris paribus rise in government expenditure on road infrastructure development. One is through augmenting productivity of unskilled labour itself (at initial rate of return to capital)and second is through the fall in the skilled wage. The third term captures the indirect adverse effect on w that the rise in r induces. By virtue of the argument presented in the text, that the direct effects are stronger than the indirect effect, such that, overall $\hat{w} > 0$ on account of $\hat{G}_1 > 0 = \hat{G}_2$, we assume *D<0.*

Substitution of (A.3.32) back in (A.3.27) yields the change in rate of return to capital as:

$$\hat{r} = F\hat{G}_1 - \frac{\theta_{LT}B\theta^1_{SZ}(\mu_L + 1)}{\theta_{KT}\Delta\gamma_{KI}\theta^1_{KZ}}\hat{G}_2 \tag{A.3.33}$$

where, $F = \frac{\theta_{LT}}{\theta_{KT}}\left\{\mu_L + \frac{(\mu_L + 1)D}{\Delta}\right\} > 0.$

A.3.7 Change in road infrastructure and quality of ICT infrastructure.

Substituting (A.3.31) in (A.3.24), I get $\hat{I}_1$ as:

$$\hat{I}_1 = \left(1 + \frac{D}{\Delta}\right)\hat{G}_1 - \frac{1}{\Delta}\frac{B\theta^1_{SZ}}{\gamma_{KI}\theta^1_{KZ}}\hat{G}_2 \tag{A.3.34}$$

Note:

$$\left(1 + \frac{D}{\Delta}\right) = \frac{\Delta + D}{\Delta}$$

$$= \frac{\frac{\theta^1_{SZ}}{\theta^1_{KZ}}C - A\theta^2_{SZ} + \left(\frac{B\mu_L\theta^1_{SZ}\theta_{LT}}{\gamma_{KI}\theta^1_{KZ}\theta_{KT}} + \tilde{A}\theta^2_{SZ}\right)}{\Delta} = \frac{\frac{\theta^1_{SZ}}{\theta^1_{KZ}}C - \theta^2_{SZ}\left(\tilde{A} - \frac{\theta_{LT}}{\theta_{KT}}\right) + \left(\frac{B\mu_L\theta^1_{SZ}\theta_{LT}}{\gamma_{KI}\theta^1_{KZ}\theta_{KT}} + \tilde{A}\theta^2_{SZ}\right)}{\Delta}$$

$$= \frac{\frac{\theta^1_{SZ}}{\theta^1_{KZ}}C + \theta^2_{SZ}\frac{B\mu_L\theta^1_{SZ}}{\gamma_{KI}\theta^1_{KZ}}\left(\frac{\theta_{LT}}{\theta_{KT}}\right)^2}{\Delta} > 0.$$

This implies that despite the cost-cascading effect, $\hat{G}_1 > 0$ leads to $\hat{I}_1 > 0$.

On the other hand, substituting (A.3.33) in (A.3.25), I get $\hat{q}$ as:

$$\hat{q} = H\hat{G}_2 - F\hat{G}_1 \tag{A.3.35}$$

where, $H = \left(1 + \dfrac{\theta_{LT} B \theta^1_{SZ}(\mu_L + 1)}{\theta_{KT}\Delta\gamma_{KI}\theta^1_{KZ}}\right) > 0.$

So $\hat{q} > 0$ under $\hat{G}_2 > 0$ and $\hat{q} < 0$ under $\hat{G}_1 > 0$.

A.3.8 Derivation of effect on export quality levels of Z_1 and Z_2.

The change in quality Q_2 as obtained in (A.3.14) above is rewritten as follows:

$$\Rightarrow \hat{Q}_2 = \frac{P^W_{Z2}}{\delta_2 Q_2^2}\theta^2_{SZ}\gamma^2_{SZ}\left(\hat{w}_S - \bar{\gamma}\hat{q}\right) \tag{A.3.36}$$

Substituting expressions for $\hat{w}_S$ *and* $\hat{q}$ from (A.3.30) and (A.3.35) respectively in (A.36), I get the final expression for change in service-export quality (as in (3.49) in the text) as follows:

$$\hat{Q}_2 = \frac{P^W_{Z2}}{\delta_2 Q_2^2}\theta^2_{SZ}\gamma^2_{SZ}\left\{\left(\frac{E}{\Delta} + \bar{\gamma}F\right)\hat{G}_1 - \left(\frac{BA}{\gamma_{KI}\Delta} + \bar{\gamma}H\right)\hat{G}_2\right\} \tag{A.3.37}$$

The change in quality Q_1can be obtained from total differentiation of the marginal condition given by (3.27) in the text:

$$P^{W''}_{Z1}(Q_1)dQ_1 = w_S\frac{\partial}{\partial Q_1}\left(\frac{\partial a^1_{SZ}(Q_1, I_1)}{\partial Q_1}\right)dQ_1 + \frac{\partial a^1_{SZ}(Q_1, I_1)}{\partial Q_1}dw_S + \frac{\partial a^1_{KZ}(Q_1)}{\partial Q_1}dr + \frac{\partial}{\partial Q_1}\left(\frac{\partial a^1_{KZ}(Q_1)}{\partial Q_1}\right)r$$

Proceeding as before, using (A.3.21), I get:

$$\hat{Q}_1 = \frac{P^W_{Z1}(Q_1)}{Q_1^2\delta_1}\left\{\theta^1_{SZ}\gamma^1_{SZ}\hat{w}_S + \theta^1_{KZ}\gamma^1_{KZ}\hat{r}\right\}$$

$$\Rightarrow \hat{Q}_1 = \frac{P^W_{Z1}(Q_1)}{Q_1^2\delta_1}\left\{\theta^1_{SZ}(\gamma^1_{SZ} - \gamma^1_{KZ})\hat{w}_S + \mu_S\theta^1_{SZ}\gamma^1_{KZ}\hat{I}_1\right\} \tag{A.3.38}$$

where, $\delta_1 \equiv \left[P^{W''}_{Z1}(Q_1) - w_S a^{1''}_{SZ}(Q_1) - r a^{1''}_{KZ}(Q_1)\right] < 0$ by the second order condition for profit maximization.

Substituting expressions for $\hat{w}_S$ *and* $\hat{I}_1$ from (A.3.30) and (A.3.34) respectively in (A.3.38), I get the final expression for change in export quality (as in (3.48) in the text) as follows:

$$\hat{Q}_1 = \frac{P^W_{Z1}(Q_1)\theta^1_{SZ}}{Q_1^2\delta_1}\left[\left\{\frac{(\gamma^1_{SZ} - \gamma^1_{KZ})E}{\Delta} + \mu_S\theta^1_{SZ}\left(1 + \frac{D}{\Delta}\right)\right\}\hat{G}_1 - \left\{\frac{BA(\gamma^1_{SZ} - \gamma^1_{KZ})}{\gamma_{KI}\Delta} + \frac{\mu_S\theta^1_{SZ}\gamma^1_{KZ}B}{\gamma_{KI}\theta^1_{KZ}\Delta}\right\}\hat{G}_2\right] \tag{A.3.39}$$

A.3.9 Derivation of condition (3.50)

For $\hat{G} = \hat{G}_1 > 0 = \hat{G}_2$, this boils down to:

$$\hat{Q}_1 = \frac{P_{Z1}^{W}(Q_1)\theta_{SZ}^{1}}{Q_1^{\ 2}\delta_1}\left[\left\{\frac{(\gamma_{SZ}^{1} - \gamma_{KZ}^{1})E}{\Delta} + \mu_S\theta_{SZ}^{1}\left(1 + \frac{D}{\Delta}\right)\right\}\right]\hat{G}_1 \qquad \text{(A.3.39a)}$$

Expanding the terms in the parenthesis on the right-hand side using $E = \left(\frac{BA\mu_L\theta_{LT}}{\gamma_{KI}\theta_{KT}} + \tilde{A}C\right)$,

I get:

$$\frac{1}{\Delta}\left[(\gamma_{SZ}^{1} - \gamma_{KZ}^{1})E + \mu_S\theta_{SZ}^{1}(\Delta + D)\right] = (\gamma_{SZ}^{1} - \gamma_{KZ}^{1})\left(\frac{BA\mu_L\theta_{LT}}{\gamma_{KI}\theta_{KT}} + \tilde{A}C\right) + \mu_S\theta_{SZ}^{1}(\Delta + D)$$

$$= (\gamma_{SZ}^{1} - \gamma_{KZ}^{1})\left[\frac{B\theta_{LT}}{\gamma_{KI}\theta_{KT}}\left(\tilde{A} - \frac{\theta_{LT}}{\theta_{KT}}\right)\mu_L + \tilde{A}C\right] + \mu_S\theta_{SZ}^{1}(\Delta + D)$$

$$= (\gamma_{SZ}^{1} - \gamma_{KZ}^{1})\left[\left\{\frac{B\theta_{LT}}{\gamma_{KI}\theta_{KT}}\mu_L + C\right\}\tilde{A} - \frac{B}{\gamma_{KI}}\left(\frac{\theta_{LT}}{\theta_{KT}}\right)^2\right] + \mu_S\theta_{SZ}^{1}(\Delta + D)$$

$$= (\gamma_{SZ}^{1} - \gamma_{KZ}^{1})\left[\left\{\frac{B\theta_{LT}}{\gamma_{KI}\theta_{KT}}\mu_L + C\right\}\left(\frac{\theta_{SZ}^{1}}{\theta_{SZ}^{1}}\mu_S - \frac{\theta_{LT}}{\theta_{KT}}\mu_L\right) - \frac{B}{\gamma_{KI}}\left(\frac{\theta_{LT}}{\theta_{KT}}\right)^2\right] + \mu_S\theta_{SZ}^{1}(\Delta + D)$$

$$= (\gamma_{SZ}^{1} - \gamma_{KZ}^{1})\left[(\tilde{B} - B)\left(\frac{\theta_{SZ}^{1}}{\theta_{SZ}^{1}}\mu_S - \frac{\theta_{LT}}{\theta_{KT}}\mu_L\right) - \frac{B}{\gamma_{KI}}\left(\frac{\theta_{LT}}{\theta_{KT}}\right)^2\right] + \mu_S\theta_{SZ}^{1}(\Delta + D)$$

$$= \left[(\gamma_{SZ}^{1} - \gamma_{KZ}^{1})(\tilde{B} - B)\frac{\theta_{SZ}^{1}}{\theta_{SZ}^{1}} + \theta_{SZ}^{1}(\Delta + D)\right]\mu_S - (\gamma_{SZ}^{1} - \gamma_{KZ}^{1})\left[(\tilde{B} - B) + \frac{B}{\gamma_{KI}}\frac{\theta_{LT}}{\theta_{KT}}\right]\frac{\theta_{LT}}{\theta_{KT}}\mu_L$$

where, $\tilde{B} = \frac{B\theta_{LT}}{\gamma_{KI}\theta_{KT}}\mu_L + C + B$.

Hence, $\hat{Q}_1 > 0$ for $\gamma_{SZ}^{1} > \gamma_{KZ}^{1}$ if condition (3.50) in the text holds:

$$\mu_S < \tilde{\mu}_S \equiv \frac{(\gamma_{KZ}^{1} - \gamma_{SZ}^{1})\left[(\tilde{B} - B) + \frac{B}{\gamma_{KI}}\right]\frac{\theta_{LT}}{\theta_{KT}}\mu_L}{(\gamma_{KZ}^{1} - \gamma_{SZ}^{1})(\tilde{B} - B)\frac{\theta_{SZ}^{1}}{\theta_{KZ}^{1}} + (\Delta + D)\theta_{SZ}^{1}}$$

Further, it can be checked that,

$$\frac{\partial\tilde{\mu}_S}{\partial\mu_L} \equiv \frac{(\gamma_{KZ}^{1} - \gamma_{SZ}^{1})\left[(\tilde{B} - B) + \frac{B}{\gamma_{KI}}\right]\frac{\theta_{LT}}{\theta_{KT}}\mu_L - \tilde{A}\frac{\partial\tilde{B}}{\partial\mu_L}}{(\gamma_{KZ}^{1} - \gamma_{SZ}^{1})(\tilde{B} - B)\frac{\theta_{SZ}^{1}}{\theta_{KZ}^{1}} + (\Delta + D)\theta_{SZ}^{1}} \qquad \text{(A.3.40)}$$

Since by definition $\frac{\partial \tilde{B}}{\partial \mu_L} = \frac{B\theta_{LT}}{\gamma_{KI}\theta_{KT}} > 0$, and $\tilde{A} < 0$ under the assumption (3.42) in the text, so $\frac{\partial \tilde{\mu}_S}{\partial \mu_L} > 0$. On the other hand, from (3.42) in the text, $\mu_S < \bar{\bar{\mu}}_S \equiv \mu_L \left(\frac{\theta_{LT}}{\theta_{KT}} \frac{\theta^1_{KZ}}{\theta^1_{SZ}} \right)$, it follows that the critical value $\bar{\bar{\mu}}_S$ is increasing in μ_L. Finally,

$$\bar{\bar{\mu}}_S - \tilde{\mu}_S = \frac{(\Delta + D)\frac{\theta_{LT}}{\theta_{KT}}\mu_L - (\gamma^1_{KZ} - \gamma^1_{SZ})\frac{B}{\gamma_{KI}}\frac{\theta_{LT}}{\theta_{KT}}\frac{\theta^1_{SZ}}{\theta^1_{KZ}}\mu_L}{(\gamma^1_{KZ} - \gamma^1_{SZ})(\tilde{B} - B)\frac{\theta^1_{SZ}}{\theta^1_{KZ}} + (\Delta + D)\theta^1_{SZ}}$$

$$= \frac{\theta^1_{SZ}(\Delta + D)\frac{\theta_{LT}}{\theta_{KT}}\mu_L - (\gamma^1_{KZ} - \gamma^1_{SZ})\frac{B}{\gamma_{KI}}\frac{\theta_{LT}}{\theta_{KT}}\frac{\theta^1_{SZ}}{\theta^1_{KZ}}\mu_L}{(\gamma^1_{KZ} - \gamma^1_{SZ})(\tilde{B} - B)\frac{\theta^1_{SZ}}{\theta^1_{KZ}} + (\Delta + D)\theta^1_{SZ}}$$

So, $\bar{\bar{\mu}}_S > \tilde{\mu}_S$ if $\theta^1_{SZ}(\Delta + D) > (\gamma^1_{KZ} - \gamma^1_{SZ})\frac{B}{\gamma_{KI}}\frac{\theta^1_{SZ}}{\theta^1_{KZ}}$.

Using the earlier derived expression for $(\Delta + D)$, this boils down to:

$$\frac{\theta^1_{SZ}}{\theta^1_{KZ}}C + \theta^2_{SZ}\frac{\theta_{LT}}{\theta_{KT}}\frac{B\mu_L\theta^1_{SZ}\theta_{LT}}{\gamma_{KI}\theta^1_{KZ}\theta_{KT}} > (\gamma^1_{KZ} - \gamma^1_{SZ})\frac{B}{\gamma_{KI}\theta^1_{KZ}}$$

$$\Rightarrow \frac{\theta^1_{SZ}}{\theta^1_{KZ}}\left[\theta^2_{IZ} - \frac{B}{\gamma_{KI}}\frac{\theta_{LT}}{\theta_{KT}}\mu_L - \frac{B}{\gamma_{KI}}\frac{\theta_{LT}}{\theta_{KT}}\right] + \theta^2_{SZ}\frac{B\mu_L\theta^1_{SZ}}{\gamma_{KI}\theta^1_{KZ}}\left(\frac{\theta_{LT}}{\theta_{KT}}\right)^2 > (\gamma^1_{KZ} - \gamma^1_{SZ})\frac{B}{\gamma_{KI}\theta^1_{KZ}}$$

$$\Rightarrow \frac{\theta^1_{SZ}}{\theta^1_{KZ}}\left[\frac{\theta^2_{IZ} - \frac{B}{\gamma_{KI}}\frac{\theta_{LT}}{\theta_{KT}}}{\frac{B}{\gamma_{KI}}\frac{\theta_{LT}}{\theta_{KT}}} - \mu_L\right]\frac{B}{\gamma_{KI}}\frac{\theta_{LT}}{\theta_{KT}} + \theta^2_{SZ}\frac{B\theta^1_{SZ}}{\gamma_{KI}\theta^1_{KZ}}\left(\frac{\theta_{LT}}{\theta_{KT}}\right)^2\mu_L > (\gamma^1_{KZ} - \gamma^1_{SZ})\frac{B}{\gamma_{KI}\theta^1_{KZ}}$$

(A.3.41)

Recall from (3.50a) in the text that stability requirement of C > 0 means an upper limit on μ_L as $\bar{\mu}_L = \frac{\theta^2_{IZ} - \frac{B\theta_{LT}}{\gamma_{KI}\theta_{KT}}}{\frac{B\theta_{LT}}{\gamma_{KI}\theta_{KT}}}$. Hence, (A.3.41) boils down to:

$$\frac{\theta^1_{SZ}}{\theta^1_{KZ}}[\bar{\mu}_L - \mu_L]\frac{B}{\gamma_{KI}}\frac{\theta_{LT}}{\theta_{KT}} + \theta^2_{SZ}\frac{B\theta^1_{SZ}}{\gamma_{KI}\theta^1_{KZ}}\left(\frac{\theta_{LT}}{\theta_{KT}}\right)^2\mu_L > (\gamma^1_{KZ} - \gamma^1_{SZ})\frac{B}{\gamma_{KI}\theta^1_{KZ}}$$

So, $\bar{\bar{\mu}}_S(\bar{\mu}_L) > \tilde{\mu}_S(\bar{\mu}_L)$ if:

$$\theta_{SZ}^{2}\frac{B\theta_{SZ}^{1}}{\gamma_{KI}\theta_{KZ}^{1}}\left(\frac{\theta_{LT}}{\theta_{KT}}\right)^{2}\left[\frac{\theta_{IZ}^{2}-\frac{B\theta_{LT}}{\gamma_{KI}\theta_{KT}}}{\frac{B\theta_{LT}}{\gamma_{KI}\theta_{KT}}}\right]>(\gamma_{KZ}^{1}-\gamma_{SZ}^{1})\frac{B}{\gamma_{KI}\theta_{KZ}^{1}}$$

$$\Rightarrow \theta_{SZ}^{2}\frac{\theta_{SZ}^{1}}{\theta_{KZ}^{1}}\frac{\theta_{LT}}{\theta_{KT}}\left(\theta_{IZ}^{2}-\frac{B\theta_{LT}}{\gamma_{KI}\theta_{KT}}\right)>(\gamma_{KZ}^{1}-\gamma_{SZ}^{1})\frac{B}{\gamma_{KI}\theta_{KZ}^{1}} \qquad \text{(A.3.41a)}$$

which is condition (3.50b) in the text.

Further note that,

$$\left.\frac{\partial\overline{\overline{\mu}}_{S}}{\partial\mu_{L}}\right|_{\mu_L=0}-\left.\frac{\partial\tilde{\mu}_{S}}{\partial\mu_{L}}\right|_{\mu_L=0}=\frac{\frac{\theta_{SZ}^{1}}{\theta_{KZ}^{1}}\frac{\theta_{LT}}{\theta_{KT}}\left[\theta_{SZ}^{1}\left(\theta_{IZ}^{2}-\frac{B\theta_{LT}}{\gamma_{KI}\theta_{KT}}\right)-(\gamma_{KZ}^{1}-\gamma_{SZ}^{1})\frac{B}{\gamma_{KI}\theta_{KZ}^{1}}\right]}{(\gamma_{KZ}^{1}-\gamma_{SZ}^{1})(\tilde{B}-B)\frac{\theta_{SZ}^{1}}{\theta_{KZ}^{1}}+(\Delta+D)\theta_{SZ}^{1}}$$

Thus, condition (A.41a) also ensures that $\left.\frac{\partial\overline{\overline{\mu}}_{S}}{\partial\mu_{L}}\right|_{\mu_L=0}>\left.\frac{\partial\tilde{\mu}_{S}}{\partial\mu_{L}}\right|_{\mu_L=0}$.

Hence $\overline{\overline{\mu}}_{S}>\tilde{\mu}_{S}$ for all $\mu_L\in[0,\overline{\mu}_L]$.

A.3.10 <u>Derivation of condition (3.51)</u>

For $\hat{G}=\hat{G}_2>0=\hat{G}_1$, (A.3.39) boils down to:

$$\hat{Q}_1=\frac{P_{Z1}^{W}(Q_1)\theta_{SZ}^{1}}{Q_1^{2}\delta_1}\left[-\left\{\frac{BA(\gamma_{SZ}^{1}-\gamma_{KZ}^{1})}{\gamma_{KI}\Delta}+\frac{\mu_S\theta_{SZ}^{1}\gamma_{SZ}^{1}B}{\gamma_{KI}\theta_{KZ}^{1}\Delta}\right\}\hat{G}_2\right] \qquad \text{(A.3.39b)}$$

Expanding the terms in the parenthesis on the right-hand side, the terms in the parenthesis on the right-hand side can be written as:

$$\frac{BA(\gamma_{SZ}^{1}-\gamma_{KZ}^{1})}{\gamma_{KI}\Delta}+\frac{\mu_S\theta_{SZ}^{1}\gamma_{sz}^{1}B}{\gamma_{KI}\theta_{KZ}^{1}\Delta}=\frac{B}{\gamma_{KI}\Delta}\left[(\gamma_{SZ}^{1}-\gamma_{KZ}^{1})\left\{\frac{\theta_{SZ}^{1}}{\theta_{KZ}^{1}}\mu_S-\frac{\theta_{LT}}{\theta_{KT}}\mu_L-\frac{\theta_{LT}}{\theta_{KT}}\right\}+\frac{\mu_S\theta_{SZ}^{1}\gamma_{SZ}^{1}}{\theta_{KZ}^{1}}\right]$$

$$=\frac{B}{\gamma_{KI}\Delta}\left[\frac{\theta_{SZ}^{1}}{\theta_{KZ}^{1}}\left\{\gamma_{SZ}^{1}+(\gamma_{SZ}^{1}-\gamma_{KZ}^{1})\right\}\mu_S-(\gamma_{SZ}^{1}-\gamma_{KZ}^{1})\left\{\frac{\theta_{LT}}{\theta_{KT}}\mu_L+\frac{\theta_{LT}}{\theta_{KT}}\right\}\right]$$

For $\gamma_{SZ}^{1}>\gamma_{KZ}^{1}$, this expression is positive and thus $\hat{Q}_1>0$ if condition (3.51) in the text holds:

$$\mu_S>\overline{\mu}_S\equiv\frac{(\gamma_{SZ}^{1}-\gamma_{KZ}^{1})\left[\frac{\theta_{LT}}{\theta_{KT}}\mu_L+\frac{\theta_{LT}}{\theta_{KT}}\right]}{\frac{\theta_{SZ}^{1}}{\theta_{KZ}^{1}}(2\gamma_{SZ}^{1}-\gamma_{KZ}^{1})}$$

Note: $\bar{\mu}_S > 0 \;\forall\; \mu_L \geq 0$, $\frac{\partial \bar{\mu}_S}{\partial \mu_L} > 0 \;\forall\; \mu_L \geq 0$ and $\frac{\partial}{\partial \mu_L}\left(\frac{\partial \bar{\mu}_S}{\partial \mu_L}\right) = 0$. Further,

$$\bar{\mu}_S - \bar{\bar{\mu}}_S = \frac{(\gamma_{SZ}^1 - \gamma_{KZ}^1)\left[\frac{\theta_{LT}}{\theta_{KT}}\mu_L + \frac{\theta_{LT}}{\theta_{KT}}\right]}{\frac{\theta_{SZ}^1}{\theta_{KZ}^1}(2\gamma_{SZ}^1 - \gamma_{KZ}^1)} - \frac{\frac{\theta_{LT}}{\theta_{KT}}\mu_L}{\frac{\theta_{SZ}^1}{\theta_{KZ}^1}} = \frac{(\gamma_{SZ}^1 - \gamma_{KZ}^1)\frac{\theta_{LT}}{\theta_{KT}} - 2\gamma_{SZ}^1\mu_L}{\frac{\theta_{SZ}^1}{\theta_{KZ}^1}(2\gamma_{SZ}^1 - \gamma_{KZ}^1)} \tag{A.3.42}$$

Thus, $\bar{\mu}_S > \bar{\bar{\mu}}_S$ for all $\mu_L < \tilde{\mu}_L \equiv \frac{\gamma_{SZ}^1 - \gamma_{KZ}^1}{\gamma_{SZ}^1}$, where

$$\tilde{\mu}_L - \bar{\mu}_L = \frac{\gamma_{SZ}^1 - \gamma_{KZ}^1}{\gamma_{SZ}^1} - \frac{\theta_{IZ}^2 - \frac{B\theta_{LT}}{\gamma_{KI}\theta_{KT}}}{\frac{B\theta_{LT}}{\gamma_{KI}\theta_{KT}}} = \frac{\left(\gamma_{SZ}^1 - \gamma_{KZ}^1\right)\frac{B\theta_{LT}}{\gamma_{KI}\theta_{KT}} - \gamma_{SZ}^1\left[\theta_{IZ}^2 - \frac{B\theta_{LT}}{\gamma_{KI}\theta_{KT}}\right]}{\gamma_{SZ}^1\frac{B\theta_{LT}}{\gamma_{KI}\theta_{KT}}} \tag{A.3.43}$$

Hence, $\tilde{\mu}_L < \bar{\mu}_L$ if,

$$\gamma_{SZ}^1\left[\theta_{IZ}^2 - \frac{B\theta_{LT}}{\gamma_{KI}\theta_{KT}}\right] > \left(\gamma_{SZ}^1 - \gamma_{KZ}^1\right)\frac{B\theta_{LT}}{\gamma_{KI}\theta_{KT}} \tag{A.3.44}$$

Note that the assumed condition in (A.3.41a) is

$$\theta_{SZ}^2\frac{\theta_{SZ}^1}{\theta_{KZ}^1}\frac{\theta_{LT}}{\theta_{KT}}\left(\theta_{IZ}^2 - \frac{B\theta_{LT}}{\gamma_{KI}\theta_{KT}}\right) > (\gamma_{KZ}^1 - \gamma_{SZ}^1)\frac{B}{\gamma_{KI}\theta_{KZ}^1} \Rightarrow \theta_{SZ}^2\theta_{SZ}^1\frac{\theta_{LT}}{\theta_{KT}}\left(\theta_{IZ}^2 - \frac{B\theta_{LT}}{\gamma_{KI}\theta_{KT}}\right) > (\gamma_{KZ}^1 - \gamma_{SZ}^1)\frac{B}{\gamma_{KI}}$$

So that (A.3.44) may be compatible with (A.3.41a). Hence, it is quite likely that $\tilde{\mu}_L < \bar{\mu}_L$ under the assumption (A.3.41a).

On the other hand, similar calculation for $\bar{\mu}_S(\bar{\mu}_L) - \tilde{\mu}_S(\bar{\mu}_L)$ indicates that it is morelikely that $\bar{\mu}_S(\bar{\mu}_L) < \tilde{\mu}_S(\bar{\mu}_L)$. However, as argued in the text, this makes not much of a difference for the results derived.

A.3.11 <u>Derivation of condition (3.54)</u>:

For $\hat{G}_1 = -\hat{G}_2 > 0$, (A.3.39) this boils down to:

$$\hat{Q}_1 = \frac{P_{Z1}^W(Q_1)\theta_{SZ}^1}{Q_1^{\;2}\delta_1}\left[\left\{\frac{(\gamma_{SZ}^1 - \gamma_{SZ}^1)E}{\Delta} + \mu_S\theta_{SZ}^1\left(1 + \frac{D}{\Delta}\right)\right\} + \left\{\frac{BA(\gamma_{SZ}^1 - \gamma_{KZ}^1)}{\gamma_{KI}\Delta} + \frac{\mu_S\theta_{SZ}^1\gamma_{SZ}^1 B}{\gamma_{KI}\theta_{KZ}^1\Delta}\right\}\right]\hat{G}_1$$

$$= \frac{P_{Z1}^W(Q_1)\theta_{SZ}^1}{Q_1^{\;2}\delta_1\gamma_{KI}\Delta}\left[(\gamma_{SZ}^1 - \gamma_{KZ}^1)\left(E\gamma_{KI} + BA\right) + \theta_{SZ}^1\left\{(\Delta + D)\gamma_{KI} + \frac{\gamma_{SZ}^1 B}{\theta_{KZ}^1}\right\}\mu_S\right]\hat{G}_1 \tag{A.3.39c}$$

Proceeding as before $E\gamma_{KI} + BA$ can be expanded as:

$$E\gamma_{KI}+BA=\left[\frac{B\theta_{LT}}{\gamma_{KI}\theta_{KT}}\left(\tilde{A}-\frac{\theta_{LT}}{\theta_{KT}}\right)\mu_L+\tilde{A}C\right]\gamma_{KI}+B\left(\tilde{A}-\frac{\theta_{LT}}{\theta_{KT}}\right)$$

$$=\left[\frac{B\theta_{LT}}{\gamma_{KI}\theta_{KT}}\mu_L+C+B\right]\tilde{A}\gamma_{KI}-B\left(\frac{\theta_{LT}}{\theta_{KT}}\right)^2\mu_L-B\frac{\theta_{LT}}{\theta_{KT}}$$

$$=\tilde{B}\tilde{A}\gamma_{KI}-B\left(\frac{\theta_{LT}}{\theta_{KT}}\right)^2\mu_L-B\frac{\theta_{LT}}{\theta_{KT}}=\tilde{B}\left[\frac{\theta^1_{SZ}}{\theta^1_{KZ}}\mu_S-\frac{\theta_{LT}}{\theta_{KT}}\mu_L\right]\gamma_{KI}-B\left(\frac{\theta_{LT}}{\theta_{KT}}\right)^2\mu_L-B\frac{\theta_{LT}}{\theta_{KT}}$$

Substitution of this in (A.3.39c) yields:

$$\hat{Q}_1=\frac{P^W_{Z1}(Q_1)\theta^1_{SZ}}{Q_1^{\,2}\delta_1\gamma_{KI}\Delta}\left[(\gamma^1_{SZ}-\gamma^1_{KZ})\left\{\tilde{B}\left(\frac{\theta^1_{SZ}}{\theta^1_{KZ}}\mu_S-\frac{\theta_{LT}}{\theta_{KT}}\mu_L\right)\gamma_{KI}-B\left(\frac{\theta_{LT}}{\theta_{KT}}\right)^2\mu_L-B\frac{\theta_{LT}}{\theta_{KT}}\right\}+\theta^1_{SZ}\left\{(\Delta+D)\gamma_{KI}+\frac{\gamma^1_{SZ}B}{\theta^1_{KZ}}\right\}\mu_S\right]\hat{G}_1$$

Hence, for $\gamma^1_{SZ}>\gamma^1_{KZ}$, this expression is positive and thus $\hat{Q}_1>0$ if condition (3.54) in the text holds:

$$\mu_S<\tilde{\tilde{\mu}}_S\equiv\frac{(\gamma^1_{SZ}-\gamma^1_{KZ})\left[\tilde{B}\gamma_{KI}\frac{\theta_{LT}}{\theta_{KT}}\mu_L+B\left(\frac{\theta_{LT}}{\theta_{KT}}\right)^2\mu_L+B\frac{\theta_{LT}}{\theta_{KT}}\right]}{\left[\gamma_{KI}\left(\gamma^1_{SZ}-\gamma^1_{KZ}\right)\tilde{B}+\left\{(\Delta+D)\gamma_{KI}\theta^1_{KZ}+B\gamma^1_{SZ}\right\}\right]\frac{\theta^1_{SZ}}{\theta^1_{KZ}}}$$

Now,

$$\tilde{\tilde{\mu}}_S(\bar{\mu}_L)=\frac{(\gamma^1_{SZ}-\gamma^1_{KZ})\left[\left(\frac{\theta_{LT}}{\theta_{KT}}\right)^2(\bar{\mu}_L)^2+\gamma_{KI}\frac{\theta_{LT}}{\theta_{KT}}\bar{\mu}_L+\left(\frac{\theta_{LT}}{\theta_{KT}}\right)^2\bar{\mu}_L+\frac{\theta_{LT}}{\theta_{KT}}\right]}{\left[\gamma_{KI}\left(\gamma^1_{SZ}-\gamma^1_{KZ}\right)\left(\gamma_{KI}\frac{\theta_{LT}}{\theta_{KT}}\bar{\mu}_L+1\right)+\left\{\theta^1_{SZ}\theta^2_{SZ}\left(\frac{\theta_{LT}}{\theta_{KT}}\right)^2\bar{\mu}_L+\gamma^1_{SZ}\right\}\right]\frac{\theta^1_{SZ}}{\theta^1_{KZ}}}$$

Hence,

$$\tilde{\tilde{\mu}}_S(\bar{\mu}_L)-\bar{\bar{\mu}}_S(\bar{\mu}_L)=\frac{(\gamma^1_{SZ}-\gamma^1_{KZ})\frac{\theta_{LT}}{\theta_{KT}}\left[\frac{\theta_{LT}}{\theta_{KT}}\bar{\mu}_L+1\right]-\left\{\theta^1_{SZ}\theta^2_{SZ}\left(\frac{\theta_{LT}}{\theta_{KT}}\right)^2\bar{\mu}_L+\gamma^1_{SZ}\right\}\frac{\theta_{LT}}{\theta_{KT}}\bar{\mu}_L}{\left[\gamma_{KI}\left(\gamma^1_{SZ}-\gamma^1_{KZ}\right)\left(\gamma_{KI}\frac{\theta_{LT}}{\theta_{KT}}\bar{\mu}_L+1\right)+\left\{\theta^1_{SZ}\theta^2_{SZ}\left(\frac{\theta_{LT}}{\theta_{KT}}\right)^2\bar{\mu}_L+\gamma^1_{SZ}\right\}\right]\frac{\theta^1_{SZ}}{\theta^1_{KZ}}}$$

$$=\frac{\frac{\theta_{LT}}{\theta_{KT}}\left[\left\{(\gamma^1_{SZ}-\gamma^1_{KZ})\frac{\theta_{LT}}{\theta_{KT}}-\gamma^1_{SZ}\right\}\bar{\mu}_L+(\gamma^1_{SZ}-\gamma^1_{KZ})-\theta^1_{SZ}\theta^2_{SZ}\left(\frac{\theta_{LT}}{\theta_{KT}}\right)^2(\bar{\mu}_L)^2\right]}{\left[\gamma_{KI}\left(\gamma^1_{SZ}-\gamma^1_{KZ}\right)\left(\gamma_{KI}\frac{\theta_{LT}}{\theta_{KT}}\bar{\mu}_L+1\right)+\left\{\theta^1_{SZ}\theta^2_{SZ}\left(\frac{\theta_{LT}}{\theta_{KT}}\right)^2\bar{\mu}_L+\gamma^1_{SZ}\right\}\right]\frac{\theta^1_{SZ}}{\theta^1_{KZ}}}$$

Since $\frac{\theta_{LT}}{\theta_{KT}} < 1$ by assumption, and $0 < (\gamma^1_{SZ} - \gamma^1_{KZ}) < \gamma^1_{SZ}$, so the first term in the numerator on the right-hand side is negative. So, it is more likely that the numerator as a whole is negative and thus $\tilde{\tilde{\mu}}_S(\bar{\mu}_L) < \bar{\bar{\mu}}_S(\bar{\mu}_L)$ as mentioned in the text.

<u>Derivation of condition (3.55)</u>:

By definition, $\gamma^* = -\frac{E}{F}$. As derived above, $E \equiv \left[(\tilde{B} - B)\left(\frac{\theta^1_{SZ}}{\theta^1_{SZ}}\mu_S - \frac{\theta_{LT}}{\theta_{KT}}\mu_L \right) - \frac{B}{\gamma_{KI}}\left(\frac{\theta_{LT}}{\theta_{KT}} \right)^2 \right]$.

Using this and the definition of *F*, I can write:

$$\gamma^*(\mu_S, \mu_L) \equiv \frac{\left[\frac{B}{\gamma_{KI}} + (\tilde{B} - B) \right] \frac{\theta_{LT}}{\theta_{KT}}\mu_L - (\tilde{B} - B)\frac{\theta^1_{SZ}}{\theta^1_{KZ}}\mu_S}{\frac{\theta_{LT}}{\theta_{KT}}\left[\frac{\Delta\mu_L + (\mu_L + 1)D}{\Delta} \right]} \qquad \text{(A.3.45)}$$

Expanding the denominator in (A.3.45) using $\Delta + D = \frac{\theta^1_{SZ}}{\theta^1_{KZ}}C + \theta^2_{SZ}\frac{B\mu_L\theta^1_{SZ}}{\gamma_{KI}\theta^1_{KZ}}\left(\frac{\theta_{LT}}{\theta_{KT}} \right)^2$, we get:

$$F = \frac{\theta_{LT}}{\theta_{KT}}\left[\frac{(\Delta + D)\mu_L + D}{\Delta} \right] = \frac{\frac{\theta_{LT}}{\theta_{KT}}\left[\left\{ \frac{\theta^1_{SZ}}{\theta^1_{KZ}}C + \theta^2_{SZ}\frac{B\theta^1_{SZ}}{\gamma_{KI}\theta^1_{KZ}}\left(\frac{\theta_{LT}}{\theta_{KT}} \right)^2 \mu_L \right\}\mu_L + D \right]}{\Delta} \qquad \text{(A.3.46)}$$

Since $D = \left(\frac{B\mu_L\theta^1_{SZ}\theta_{LT}}{\gamma_{KI}\theta^1_{KZ}\theta_{KT}} + \tilde{A}\theta^2_{SZ} \right)$ is increasing in μ_S and $\Delta = \left(\frac{\theta^1_{SZ}}{\theta^1_{KZ}}C - A\theta^2_{SZ} \right)$ is decreasing in μ_S, so F is increasing in μ_S. Hence, γ^* is decreasing in μ_S:

$$\frac{\partial\gamma^*}{\partial\mu_S} = \frac{-(\tilde{B} - B)\frac{\theta^1_{SZ}}{\theta^1_{KZ}} - \gamma^*\frac{\partial F}{\partial\mu_S}}{F} < 0 \qquad \text{(A.3.47)}$$

On the other hand, from (A.3.46), I can write:

$$\frac{\partial F}{\partial\mu_L} = \frac{\frac{\theta_{LT}}{\theta_{KT}}\left\{ \frac{\theta^1_{SZ}\theta^2_{IZ}}{\theta^1_{KZ}} - \theta^2_{SZ}\frac{\theta_{LT}}{\theta_{KT}} + \frac{B\theta^1_{SZ}\theta_{LT}}{\gamma_{KI}\theta^1_{KZ}\theta_{KT}}\left(\theta^2_{SZ}\frac{\theta_{LT}}{\theta_{KT}} - 2 \right)\mu_L \right\} - F\left(\theta^2_{SZ} - \frac{B\theta^1_{SZ}}{\gamma_{KI}\theta^1_{KZ}} \right)\frac{\theta_{LT}}{\theta_{KT}}}{\Delta}$$

Since, $\theta^2_{SZ}\frac{\theta_{LT}}{\theta_{KT}} < 1$, so $\frac{\partial F}{\partial\mu_L} < 0$ if $\theta^2_{SZ} > \frac{B\theta^1_{SZ}}{\gamma_{KI}\theta^1_{KZ}}$, unless $\frac{\theta^1_{SZ}\theta^2_{IZ}}{\theta^1_{KZ}}$ is too large. Now, from (A.3.45) we can obtain:

$$\frac{\partial \gamma^*}{\partial \mu_L} = \frac{\left[\frac{B}{\gamma_{KI}}\frac{\theta_{LT}}{\theta_{KT}} - \frac{B}{\gamma_{KI}}\frac{\theta_{LT}}{\theta_{KT}}\tilde{A} - (\tilde{B} - B)\frac{\partial \tilde{A}}{\partial \mu_L}\right] - \gamma^* \frac{\partial F}{\partial \mu_L}}{F} \qquad \text{(A.3.48)}$$

Since $\tilde{A} < 0$ under (3.42) and by definition $\frac{\partial \tilde{A}}{\partial \mu_L} < 0$, so $\frac{\partial \gamma^*}{\partial \mu_L} > 0$ under the condition stated above for which $\frac{\partial F}{\partial \mu_L} < 0$. However, note that we may have $\frac{\partial \gamma^*}{\partial \mu_L} > 0$ even when $\frac{\partial F}{\partial \mu_L} > 0$.

A.3.12 Derivation of condition (3.56):

By definition, $\gamma^{**} = -\frac{BA}{\gamma_{KI}\Delta H}$. Using $BA \equiv B\frac{\theta^1_{SZ}}{\theta^1_{KZ}}\mu_S - B\frac{\theta_{LT}}{\theta_{KT}}(\mu_L + 1)$ and $H = \left(1 + \frac{\theta_{LT}B\theta^1_{SZ}(\mu_L + 1)}{\theta_{KT}\Delta\gamma_{KI}\theta^1_{KZ}}\right)$, this can be written as:

$$\gamma^{**}(\mu_S, \mu_L) \equiv \frac{\frac{\theta_{LT}}{\theta_{KT}}B(\mu_L + 1) - \frac{\theta^1_{SZ}}{\theta^1_{KZ}}B\mu_S}{\gamma_{KI}\left[\frac{\theta^1_{SZ}}{\theta^1_{KZ}}C - \frac{\theta^1_{SZ}}{\theta^1_{KZ}}\theta^2_{SZ}\mu_S + \frac{\theta_{LT}}{\theta_{KT}}\theta^2_{SZ}(\mu_L + 1)\right] + \frac{\theta^1_{SZ}}{\theta^1_{KZ}}\frac{\theta_{LT}}{\theta_{KT}}B(\mu_L + 1)}$$

Hence the condition (3.56) in the text.

Further, from the above expression the following can be derived:

$$\left[\gamma_{KI}\left\{\frac{\theta^1_{SZ}}{\theta^1_{KZ}}C - \frac{\theta^1_{SZ}}{\theta^1_{KZ}}\theta^2_{SZ}\mu_S + \frac{\theta_{LT}}{\theta_{KT}}\theta^2_{SZ}(\mu_L + 1)\right\} + \frac{\theta^1_{SZ}}{\theta^1_{KZ}}\frac{\theta_{LT}}{\theta_{KT}}B(\mu_L + 1)\right]\gamma^{**} = \frac{\theta_{LT}}{\theta_{KT}}B(\mu_L + 1) - \frac{\theta^1_{SZ}}{\theta^1_{KZ}}B\mu_S$$

$$\Rightarrow \frac{\partial \gamma^{**}}{\partial \mu_S} = \frac{\frac{\theta^1_{SZ}}{\theta^1_{KZ}}\left[-B\mu_S + \gamma_{KI}\theta^2_{SZ}\gamma^{**}\right]}{\gamma_{KI}\left[\frac{\theta^1_{SZ}}{\theta^1_{KZ}}C - \frac{\theta^1_{SZ}}{\theta^1_{KZ}}\theta^2_{SZ}\mu_S + \frac{\theta_{LT}}{\theta_{KT}}\theta^2_{SZ}(\mu_L + 1)\right] + \frac{\theta^1_{SZ}}{\theta^1_{KZ}}\frac{\theta_{LT}}{\theta_{KT}}B(\mu_L + 1)} \qquad \text{(A.3.49)}$$

Hence, $\frac{\partial \gamma^{**}}{\partial \mu_S} < 0$ for all $\gamma^{**} < \tilde{\gamma}^{**} \equiv \frac{B}{\gamma_{KI}\theta^2_{SZ}}$. Finally,

$$\tilde{\gamma}^{**}-\bar{\gamma}^{**}(\mu_S,\mu_L)\equiv\frac{B}{\gamma_{KI}\theta_{SZ}^2}-\frac{\frac{\theta_{LT}}{\theta_{KT}}B(\mu_L+1)}{\gamma_{KI}\left[\frac{\theta_{SZ}^1}{\theta_{KZ}^1}\left(\theta_{IZ}^2-\frac{B}{\gamma_{KI}}\frac{\theta_{LT}(\mu_L+1)}{\theta_{KT}}\right)+\frac{\theta_{LT}}{\theta_{KT}}\theta_{SZ}^2(\mu_L+1)\right]+\frac{\theta_{SZ}^1}{\theta_{KZ}^1}\frac{\theta_{LT}}{\theta_{KT}}B(\mu_L+1)}$$

$$=\frac{B}{\gamma_{KI}\theta_{SZ}^2}-\frac{\frac{\theta_{LT}}{\theta_{KT}}B(\mu_L+1)}{\left[\frac{\theta_{SZ}^1}{\theta_{KZ}^1}\theta_{IZ}^2\gamma_{KI}+\frac{\theta_{LT}}{\theta_{KT}}\gamma_{KI}\theta_{SZ}^2(\mu_L+1)\right]}$$

$$=\frac{\frac{\theta_{SZ}^1}{\theta_{KZ}^1}\theta_{IZ}^2\gamma_{KI}B+\frac{\theta_{LT}}{\theta_{KT}}\gamma_{KI}\theta_{SZ}^2B(\mu_L+1)-\frac{\theta_{LT}}{\theta_{KT}}\gamma_{KI}\theta_{SZ}^2B(\mu_L+1)}{\gamma_{KI}\theta_{SZ}^2\left[\frac{\theta_{SZ}^1}{\theta_{KZ}^1}\theta_{IZ}^2\gamma_{KI}+\frac{\theta_{LT}}{\theta_{KT}}\gamma_{KI}\theta_{SZ}^2(\mu_L+1)\right]}$$

$$=\frac{\frac{\theta_{SZ}^1}{\theta_{KZ}^1}\theta_{IZ}^2\gamma_{KI}B}{\gamma_{KI}\theta_{SZ}^2\left[\frac{\theta_{SZ}^1}{\theta_{KZ}^1}\theta_{IZ}^2\gamma_{KI}+\frac{\theta_{LT}}{\theta_{KT}}\gamma_{KI}\theta_{SZ}^2(\mu_L+1)\right]}>0$$

Thus, $\frac{\partial\gamma^{**}}{\partial\mu_S}<0$ for all $\gamma^{**}<\bar{\gamma}^{**}<\tilde{\gamma}^{**}$. On the other hand,

$$\frac{\partial\gamma^{**}}{\partial\mu_L}=\frac{\frac{\theta_{LT}}{\theta_{KT}}\left[B-\gamma_{KI}\theta_{SZ}^2\gamma^{**}\right]}{\gamma_{KI}\left[\frac{\theta_{SZ}^1}{\theta_{KZ}^1}\theta_{IZ}^2\gamma_{KI}+\frac{\theta_{LT}}{\theta_{KT}}\gamma_{KI}\theta_{SZ}^2(\mu_L+1)-\frac{\theta_{SZ}^1}{\theta_{KZ}^1}\theta_{SZ}^2\mu_S\right]}\tag{A.3.50}$$

Thus, $\frac{\partial\gamma^{**}}{\partial\mu_L}>0$ for all $\gamma^{**}<\bar{\gamma}^{**}<\tilde{\gamma}^{**}$.

A.3.13 Condition for wage inequality

Proof of $E+D+\frac{BA}{\gamma_{KI}}+\frac{B\theta_{SZ}^1}{\gamma_{KI}\theta_{KZ}^1}>0$ for $\mu_S=\bar{\bar{\mu}}_S$ if $\frac{\theta_{SZ}^1}{\theta_{KZ}^1}>\frac{\theta_{LT}}{\theta_{KT}}$:

Note that for $\mu_S=\bar{\bar{\mu}}_S$: $\tilde{A}=0$; $A=-\frac{\theta_{LT}}{\theta_{KT}}$; $E=-\frac{B\theta_{LT}}{\gamma_{KI}\theta_{KT}}\left(\frac{\theta_{LT}}{\theta_{KT}}\right)^2\mu_L$; and $D=\frac{B\theta_{SZ}^1\theta_{LT}}{\gamma_{KI}\theta_{KZ}^1\theta_{KT}}\mu_L$.

Hence,

$$E + D + \frac{BA}{\gamma_{KI}} + \frac{B\theta_{SZ}^{1}}{\gamma_{KI}\theta_{KZ}^{1}} = -\frac{B\theta_{LT}}{\gamma_{KI}\theta_{KT}}\left(\frac{\theta_{LT}}{\theta_{KT}}\right)^{2}\mu_L + \frac{B\theta_{SZ}^{1}\theta_{LT}}{\gamma_{KI}\theta_{KZ}^{1}\theta_{KT}}\mu_L - \frac{B\theta_{LT}}{\gamma_{KI}\theta_{KT}} + \frac{B\theta_{SZ}^{1}}{\gamma_{KI}\theta_{KZ}^{1}}$$

$$= -\frac{B\theta_{LT}}{\gamma_{KI}\theta_{KT}}\left[\frac{\theta_{LT}}{\theta_{KT}} - \frac{\theta_{SZ}^{1}}{\theta_{KZ}^{1}}\right]\mu_L - \frac{B}{\gamma_{KI}}\left[\frac{\theta_{LT}}{\theta_{KT}} - \frac{\theta_{SZ}^{1}}{\theta_{KZ}^{1}}\right]$$

$$= -\frac{B}{\gamma_{KI}}\left[\frac{\theta_{LT}}{\theta_{KT}} - \frac{\theta_{SZ}^{1}}{\theta_{KZ}^{1}}\right]\left[\frac{\theta_{LT}}{\theta_{KT}}\mu_L + 1\right]$$

Therefore, $E + D + \frac{BA}{\gamma_{KI}} + \frac{B\theta_{SZ}^{1}}{\gamma_{KI}\theta_{KZ}^{1}} > 0$ for $\mu_S = \bar{\bar{\mu}}_S$ if $\frac{\theta_{SZ}^{1}}{\theta_{KZ}^{1}} > \frac{\theta_{LT}}{\theta_{KT}}$.

Chapter 4

Export Quality and Labour market under Managed Float: Role of Monetary Policies

4.1 Introduction

4.1.1 Perspective and Motivation

Monetary policies are widely used by the central banks of developing and developed countries alike for controlling a wide range of macroeconomic variables such as employment, inflation and exchange rate volatility. But, effect of monetary policy on the choice of quality of exports remains largely unexplored, which becomes relevant in the context of the quality-dimension of export-supply-import-demand misalignment problem as mentioned in Chapter 1. The primary channels through which monetary policies work are through changes in the interest rate in the economy and the exchange rate for the economy's domestic currency. At the same time, monetary policy is an important tool available for the policymakers to manage these two variables, and consequently controlling for inflation levels. Thus, we can expect the monetary policy to affect export-quality and consequently the country's export performance through changes in either of, or both, these variables. Moreover, due to the interdependence of countries through trade and capital flows, monetary policy effects originating in one country transmit or spill over to other countries. Thus, export-quality of one country may well be affected by the monetary policy of its trading partner.

Effects of exchange rate changes on export quality have been analyzed recently by Chen and Juvenal (2016), Ganguly and Acharyya (2022), Hu, Parsely and Tan (2017), and Yu (2013) among others. These analyses, however, have considered exchange rate as an "exogenous" variable and studied effects of exchange rate changes only as exogenous shocks. But under a floating exchange rate regime, exchange rate changes are essentially endogenous variables, influenced by changes in fundamentals including monetary policies of the trading nations. Many developing countries have now adopted a managed float for their domestic currencies that enable them not to worry about maintaining foreign exchange reserves that a pegged exchange rate would have required. Domestic and external shocks now changes the exchange rate and excessive exchange rate fluctuations are often moderated by monetary policies. Interest rate targeting is one such channel. In such a context, the effects of exchange rate changes on the quality of exports are actually consequences of monetary policies pursued by the central banks of the developing countries. This motivates me to examine whether and how an expansionary or a contractionary monetary policy affects the quality of exports for that economy. This is the main concern of this chapter. The other concern is once again the domestic labour market implications of monetary policies through their effects on export-quality.

In Section 4.1.2, I review the existing literature in two broad areas: one is on the integration of monetary policy in the real sector having a Walrasian general equilibrium framework; and the other is on the implications of monetary policy on wage inequality and the unemployment dynamics. In Section 4.1.3, I define my research objectives. My theoretical analysis begins in Section 4.2, where I elaborate upon the analytical structure that introduces money into the three sector competitive general equilibrium real economy through endogenous capital formation and exchange rate determination. Then in a set up with fully flexible wages to both skilled and unskilled labour, I explore whether an expansionary monetary policy being adopted by the government induce quality upgrading of exports of the country and secondly the implications of such quality variations for the skilled-unskilled wage gap. In Section 4.3, I introduce formal-informal segmentation of the unskilled labour market and recast the benchmark analysis to study the effect on three dimensions of wage inequality as defined in Chapter 2. When the government implements minimum wage to be paid to all unskilled workers in all sectors where they are employed, the unskilled workers will not be fully employed. In such a context, in Section 4.4, I look into the implications of monetary policy induced export-quality variations for the aggregate level of employment of unskilled workers. In Section 4.5, I examine how a foreign policy shock affects the domestic country's level of investment, capital formation and the choice of export-quality. This issue assumes relevance in the current scenario of US Federal Bank tightening its monetary policies and/or raising interest rates on dollar-denominated assets as it engages in inflation targeting. Section 4.6 presents informal discussions on two extensions of the benchmark analytical structure: introducing a transaction demand for money; and relaxing the assumption of perfect substitutability between domestic and foreign assets.

Finally in Section 4.7, I summarise the results and briefly discuss on how the analysis might change when production requires a scarce natural resource like land whose supply is fixed and cannot be augmented unlike capital formation and skill acquisition.

4.1.2 Literature Review

As elaborated in Mas-Colell (1995), general equilibrium models are pure real economies. Here agents are rational and utility optimising, and markets operate on the basis of barter, thus denouncing the essentiality of money, as was concluded by Arrow and Hahn (1972). However, given the broader role of money beyond being a medium of exchange, and particularly its importance of being a store of value, much research effort has been devoted to incorporate money in general equilibrium models. For example, Bewley (1980) argues that uncertainty generates a precautionary demand for money. Since there are no other store of value, money is held as a security against unexpected fall in value of endowment. Other studies in this direction include Brock (1974), Bryant and Wallace (1983), and Woodford (1986).

Schiff (1999) summarises the main directions that such research effort has taken and discusses some of the main approaches taken up by monetarists to integrate monetary and value theories. He segregates the approaches in two major classes, one where money is incorporated in the utility function of a representative individual (Sidrauski (1967) and Walsh (1998)); and second, a more sophisticated approach of modelling the transactions demand for money. Schiff then proceeds to further divide this transactions demand approach into the use of cash-in-advance constraints (Clower (1967), Sargent (1987)), real transactions costs, and search theory. While he believes that the first two does not achieve much as these end up putting further constraints on the choice of agents and reduce their exchange opportunities, Schiff finds the third approach coming closest to the general equilibrium style of modelling. Taking cue from Kiyotaki and Wright (1993) and Maskin and Banerjee (1996), he concludes that given the positive exchange value of money, though it is by itself worthless, the most satisfactory way to incorporate money in value theory is to treat it as a medium of exchange which all agents would like to hold as it will raise the probability of successful exchanges and trade. Mention must also be made of Brock's (1974) utility of holding money, infinite horizon model of Gale and Hellwig (1984), Duffie's (1990) positive bid-ask spreads, and discussion of incomplete markets by Cass (2006).

Notwithstanding such varied approaches taken up by the researchers, a thorough revision of these developments led Gale (2010) to conclude that it still remains a great challenge to develop satisfactory models of the process of monetary exchange at the level of the economy as a whole. Similar concerns have been projected by Duffie (1990) where he establishes a general monetary equilibrium in a static setting under the assumption that not trading at all is Pareto inefficient. Duffie explores the existence of monetary equilibria in finite horizon economies drawing from the fact that other than facilitating transactions, money also acts as a store of value thus bearing a non-zero price in all periods of a finite horizon economy.

The other approach to explaining the need to hold money was to identify the transaction costs advantage it generates. One must note here that this line of approach is different from that taken up by Baumol (1952) and later Tobin (1958) where they postulated that individuals intend to diversify their portfolio in order to minimise the risk of windfall losses. Even though money has no separate value of its own and no return can be expected from it in later periods, still it is held as a secure substitute to other interest yielding assets (like bonds). This is the *asset demand* for money or speculative demand that is interest elastic, as was originally proposed by Keynes in his General Theory (1936). However, in the case of transaction costs, money or cash balances are demanded by virtue of the fact that a substantial amount of transaction costs and time is incurred every time a part of deposits has to be withdrawn and converted into cash to pay for purchases made and exchanges done. The real value of that amount of money thus erodes in the process of such conversions. This gives money a separate value of its own in relation to other interest yielding assets. A more direct approach is taken up by Gale and Hellwig (1985) where money is modelled as a store of value against dividends paid by firms to identical infinitely lived agents. However, these studies have not gone much beyond establishing monetary equilibria and overlooked the possible real sector effects of any policy intervention from the point of initial equilibrium achieved.

Apart from these theoretical discourses on general equilibrium models with money, effects of monetary policies on the within-country distribution of labour incomes have mainly focused on channels like the heterogeneity in income sources, financial market segmentation, portfolio and asset-price effects, the heterogeneity in labour income responses, and differential response of borrowers versus savers to rise in interest rates (Andersen et al. (2021), Bernanke (2015), Coibion et al. (2012, 2014), Dossche et al. (2021), Draghi (2016), and Schnabel (2021)). For example, using household-level data from the Consumer Expenditures Survey (CEX), Coibion et al (2012) show that contractionary monetary policy shock systematically increases inequality in labour earnings, total income, and in consumption and total expenditures across households in the United States since 1980s. Bartscher (2021), Cloyne et al. (2020) and Mumtaz and Theophilopoulou (2017), on the other hand, show that lax monetary policy decreases inequality in labour earnings, consumption, and expenditures. Albert and Gómez-Fernández (2018) come to the exact opposite conclusion, however, as their simulations predict that the income and wealth of the poorest and wealthiest increase the most when monetary policy is loose. There are also studies by Aye and Harris (2019), Carnevali (2022) and Goldberg and Tracy (2001) on the effect of exchange rate volatility on income distribution.

Monetary policies have also been used by the authorities and governments as one of the tools to create job opportunities for the unemployed workers. The recent macroeconomic literature include studies by Alexius and Holmlund (2007), Altavilla and Ciccarelli (2009), Benazic and Rami (2016), Christiano, Eichenbaum, and Evans (1999), Parkin (1998), Lo Cascio (2001), and Zhou (2021) among others. Alexius and Holmlund (2007), for example, examine whether the effects on unemployment are more persistent in countries with highly regulated labour markets by looking at the Swedish experience of unemployment and monetary policy. Using a structural VAR model, they found that around 30 percent of the fluctuations in unemployment, which are also quite persistent, are caused by shocks to monetary policy. Altavilla and Ciccarelli (2009) explore the role of imperfect knowledge of the structure of the economy in determining the uncertainty the policymaker faces when setting the monetary policy with respect to the unemployment dynamics in the Euro area and in the United States. They find that monetary policy shocks have very similar recessionary effects on the two economies with a different role played by the participation rate in the transmission mechanism. A recent study by Zhou (2021), on the other hand, focuses on the relationship between monetary policy and unemployment of the United States before and after the 2008 world financial crisis. His finding suggests that central banks should adopt an easy monetary policy to stimulate the domestic economy from recession.

Employment effect of currency devaluation has been studied in macroeconomic models by Alexander (1952), Cooper (1971a, 1971b), Dornbusch (1980), Hanson (1983), Krugman and Taylor (1976), Lizondo and Montiel (1989), and Meade (1951), among others. Krugman and Taylor (1976) demonstrated that a devaluation may be contractionary, that is, may lower aggregate employment, due to initial trade deficit; or, if the marginal propensity to save from profit is higher than that from wages; or, through redistribution of incomes from private to the government when devaluation is administered in presence of export taxes and tariffs. On the other hand, using a deman-determined model, Hanson (1983) shows that depending on the values of price elasticities of demand for imported consumer goods and of derived demand for imported inputs, devaluation may be contractionary. In contrast, the theoretical analysis of Helpman (1977) considered a short run multi-sector model of an economy producing traded and non-traded goods with sectorally mobile labour but sector-specific capital, and showed that under downward rigidity of real wage, an exogenous rise in the exchange rate of domestic currency would raise aggregate employment of labour *unambiguously*.

4.1.3 Research Objectives

From the discussions above emerges the following research gaps and therefore scope for extending the existing literatures. First, whether a monetary policy promotes exports at the extensive margin – that is, in its export quality dimension – has not been explored in the existing literature. In this context, the relevant focal point of our analysis is how a monetary expansion changes the domestic factor costs of quality upgrading by changing the composition of output across sectors. This channel, which is particularly relevant for the developing countries where the aggregate output levels are constrained by scarcity of resources including capital, operates through larger investment and capital formation in the economy by lowering the cost of borrowing. And this composition effect arises due to changes in both the exchange rate and the price of the non-traded good induced by the monetary expansion. This gives our research question a broader perspective than what the existing literature on the exchange rate change and export-quality addresses. However, the factor price (and corresponding factor-cost) changes due to such a change in the composition of the aggregate output are often asymmetric because the goods produced in the economy require the factors of productions in different intensities. Thus, how an expansionary monetary policy affects the choice of export-quality depends on whether quality upgrading requires more intensive use of the skilled labour and/or the domestic capital.

The second research question that I address in this Chapter is how monetary policy induced quality changes cause further changes in the composition of output across the traded and non-traded sectors, as well as across formal and informal sectors, and thereby affect wage inequality and/or the aggregate level of employment of unskilled labour in the alternative specifications of unskilled labour market. By examining the impact of a monetary policy on the wage inequality or within-country distribution of labour incomes, through changes in the composition of aggregate output, I contribute to the discussions on income inequality that the major central banks in the world have initiated of late. This theoretical exploration also provides another plausible cause of the observed worsening of wage inequality as documented in Chapter 2. Further, similar to the discussions in

Chapter 2, I re-examine this issue of wage inequality by incorporating segmented labour markets and the informalization that a monetary policy may cause.

Finally, in the context of the minimum wage law being implemented uniformly across all the sectors that employ unskilled labour (so that informal sectors do not exist), I examine how monetary policies affect the aggregate level of employment of unskilled workers both directly as well as through export-quality variations that it induces. The large literature on effects of monetary policy and nominal devaluation on the employment levels, as reviewed in the earlier section, do not consider quality variations as a plausible channel through which policy shocks may affect the aggregate employment. In fact, most of the macroeconomic analyses mentioned earlier, made no distinction between different types of consumption goods in terms of their factor intensities and product heterogeneity or quality, or even between different types of labour in terms of their skill levels. This limits the scope for discussion on sectoral allocation of (unskilled) labour and implication of such reallocations on the aggregate level of employment. The multi-sector general equilibrium analysis of the employment effect of devaluation by Helpman (1977), on the other hand, though allow for such resource reallocations, by considering homogeneous traded goods it cannot shed any light on the policy conflict that may arise due to policy-induced quality upgrading of the export goods.

4.2 Money, Export-Quality and Wage Inequality: Case of Flexible Unskilled Wage

4.2.1 Analytical structure

Consider a small open economy with a real or production sector, a banking sector with a Central bank.[33] Real sectors are characterized by the competitive general equilibrium production structure as in Section 3.2: a homogenous composite traded good (T) and a non-traded good (N) produced by unskilled/low-skilled labour (L), and capital (K); and a quality differentiated export good (Z) produced by skilled labour (S) and capital. There are however, two points of departure. First, to keep things simple, I assume only one type

[33] The analytical structure of the monetary and banking sector developed here is based on Ganguly and Acharyya (2022b).

of quality differentiated export good. Second, physical capital is generated through investment and its supply is therefore endogenous. I shall return to the specification and process of capital formation shortly[34]. Assumptions about production technology for all the three final commodities and factor markets remain as discussed in the preceding chapters. For ready reference, I reproduce below the three zero-profit conditions for T, N and Z, the marginal condition for quality choice of Z and the market clearing condition for the non-traded good:

$$P_T = eP_T^W = a_{LT}w + a_{KT}r \tag{4.1}$$

$$P_N = a_{LN}w + a_{KN}r \tag{4.2}$$

$$eP_Z^W(Q) = a_{SZ}(Q)w_S + a_{KZ}(Q)r \tag{4.3}$$

$$eP_Z^{W'}(Q) = a'_{SZ}(Q)w_S + a'_{KZ}(Q)r \tag{4.4}$$

$$\frac{D_N}{D_T} = f\left(\frac{P_N}{P_T^W}\right) = \frac{X_N}{X_T} \tag{4.5}$$

Besides the production firms, there are small investment-firms which borrow money from banks or financial intermediaries to invest in capital formation. Abstracting from the detailed process of capital formation, and considering the investment simply as the addition to capital stock as in the macroeconomic and growth literature, we assume that the investment worth of one domestic-currency unit generates $\phi(1)$ units of physical capital. Thus, if these investment firms together make investment worth I units of domestic currency, then the total capital stock generated is,

$$K = \phi(I),\ \phi(0) = 0,\ \phi' > 0,\ \phi'' = 0 \tag{4.6}$$

With no initial stock of capital, K in (4.6) also means addition to the capital stock. Note that in (4.6) we assume a proportionality rule: a one percent increment in the capital stock would require one percent of additional investment. The investment-firms borrow money from the banks/financial intermediaries at the rate i_b. This lending rate of the banks is

[34] We here abstract from skill formation, and assume that some people are borne with some specific skill or ability. Of course, this is purpose specific given our primary concerns here as mentioned earlier.

higher than the market interest rate i that these banks pay on assets and deposits held by the domestic income-earners (or, wealth-holders). Banks have no influence on this market interest rate (i), which is determined from the money market equilibrium and the asset market equilibrium conditions stated later. The premium or the margin over the market interest (i_b - i) charged by the banks for each unit of investment fund borrowed by the investor-firms covers the institutional costs and service charges. This margin is determined partly by the operational costs and partly by a premium, which is varied by the banks according to the demand for and supply of loanable funds. I model the operational cost and the premium in the simplest possible manner as follows. Banks employ workers to facilitate the lending process, such as processing applications for investment loans and carrying out related administrative works. I assume that through on-job training such tasks can be performed by the same low-skilled/unskilled workers who produce the composite traded good and the non-traded good. That is, the unskilled workers employed by the banks have to undergo an on-job elementary/basic training programme to be acquainted with how to process such investment loans and other related office works. I make a simple assumption that the bank incurs a fixed training cost of ψ units per worker. Banks pay each unskilled workers the market wage, w, plus α, which can be interpreted in various ways such as incentives or return for some additional services they provide[35]. Banks vary this additional incentive, however, with the demand and supply of loanable funds. To keep things simple, I assume that the workers engaged by the commercial banks to manage/process the investment funds are proportional to the value of such funds. This is captured through normalizing a_{Lb} – the number of workers to manage one unit worth of investment funds – to unity. Thus, an increase in the supply of loanable funds expands the size the workforce in the banking sector proportionately. Given these simplifying assumptions, the cost of borrowing a unit value of investment fund for each investment-firm is $i_B = (\alpha + w + \psi + i)$. Setting aside any other costs of capital formation whatsoever, if each investment-firm borrows funds worth $\tilde{I}$ then, by

[35] Alternatively, this α can be viewed as a variable mark-up charged by the firm per unit of investment fund it lends out over and above the wage-cost and deposit rate i, which is paid out to each worker as "bonus".

(7), the unit cost of capital formation equals $\frac{i_b \tilde{I}}{\phi(\tilde{I})} \equiv \frac{(\alpha + w + \psi + i)\tilde{I}}{\phi(\tilde{I})}$. The capital market offers r as the rate of return to capital which is determined by the competitive market forces: the derived demand for capital coming from the producers of the three goods, and the stock of capital generated through investment (according to rule (4.6)). Free entry in the investment sector then forces each investment firms to break-even:

$$r = \frac{i_b \tilde{I}}{\phi(\tilde{I})} \equiv \frac{(\alpha + w + \psi + i)\tilde{I}}{\phi(\tilde{I})} \tag{4.7}$$

The total value of investment (I) that can be made by the investment-firms and the consequent capital stock available for production of the three goods as per (4.6), however, depends on the supply of loanable funds that can be borrowed from the banks or financial intermediaries. Following Krugman (1979), suppose the foreign wealth-holders do not buy the domestic bonds denominated in the home-country currency. Then the supply of such loanable funds comes entirely from the domestic wealth-holders buying the domestic bonds – which are assumed to be issued by these banks or financial intermediaries themselves – and/or holding deposits, with the banks lending out the entire amount of such loanable funds that it receives[36].

The total loanable fund received by the banks is an outcome of the optimal allocation of wealth over a portfolio. Each income-earner or wealth-holder holds l proportion of wealth in zero return domestic currency, or cash, and the remainder $(1 - l)$ proportion on the interest bearing assets available.[37] Regarding interest-bearing assets, the domestic wealth-holders have a choice to hold the domestic-currency denominated bonds (DCDB) or the foreign-currency denominated bonds (FCDB), or both. Suppose, m proportion of $(1 - l)$ proportion of the wealth is held in the domestic assets (bonds and/or bank deposits, all yielding the same domestic interest rate, i), and $(1 - m)$ proportion on the foreign-currency denominated assets/bonds. I assume that all the economic agents have identical and homothetic preferences for allocating their wealth over cash and the two types of

[36] Of late, production of traded goods by taking loans or credit from banks has been studied by Beladi et al. (2018), Marjit and Mishra (2020) and Marjit and Ray (2021), which motivates my analysis. However, I have a different point of concern altogether.

[37] The demand for cash may be for various reasons including precautionary and speculative purposes.

assets/bonds.[38] Thus, all the wealth-holders allocate the *same* l and m proportions, which are outcome of their utility maximizations given the wealth-budget constraint. Cash holding means foregoing interest earned on the two types of assets/bonds. While i is the return earned against each unit of domestic bonds held, let the rate of return or interest earned against each unit of foreign bonds held in foreign currency be i^*.[39] If e is the exchange rate at present and $\tilde{e}$ is the exchange rate expected by the wealth-holders at any point of time, then the expected rate of return on a unit of foreign bonds is given by $i^* + \frac{\tilde{e} - e}{e}$. So the opportunity cost of holding cash is the weighted average of the interest earnings in domestic currency forgone on the two types of assets with weights being the proportions m and (1-m) of wealth holding being allocated on domestic currency assets and foreign currency assets respectively:

$$m(.)i + [1 - m(.)]\left[i^* + \frac{\tilde{e} - e}{e}\right] \qquad (4.8a)$$

While a ceteris paribus rise in the domestic interest rate (i) or in the foreign interest rate (i^*) will raise the opportunity cost of holding cash and induce a fall in cash holding, depreciation of the exchange rate, i.e. a rise in value of e, will lower the expected domestic currency return on foreign currency deposits and make it more worthwhile to raise cash holding. Accordingly the proportion of wealth held in cash would vary inversely with these interest earnings:

$$l = l\left(i, i^* + E\right), l_i < 0, l_{i^*} < 0, l_e > 0 \qquad (4.8b)$$

where, $E = \frac{\tilde{e} - e}{e}$ is the expected rate of depreciation of the domestic currency; and $l_j, j = i, i^*, e,$ is the partial derivative with respect to variable j.

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[38]I am not concerned here about the distribution of wealth (and bequests) and implications of inequality in wealth distribution for the consumption of goods, the wages of skilled and unskilled workers, and possibly for the export-quality. So, this assumption of homothetic preferences not only for the goods consumed but also for portfolio allocation over cash holding and other interest-bearing assets is purpose-specific and is intended to rule out implications, whatsoever, of an unequal distribution of wealth.

[39] By the small country assumption, any change in domestic demand for foreign assets will have no effect whatsoever on this i^* and so it is given exogenously to the domestic wealth-holders. On the other hand, a unit of DCDB will yield a return of i (in home currency).

The optimal allocation of fund over domestic and foreign bonds is determined solely by comparing the expected returns from these two types of assets, i.e. by the following (uncovered) interest parity condition[40]:

$$i = i^* + E \tag{4.9}$$

A ceteris paribus increase in the domestic interest rate (or a fall in the foreign interest rate) induces a larger proportion of wealth being put in domestic bonds i.e. *m* rises. On the other hand, for any given interest rates and expectations about the future exchange rate, a depreciation of a country's currency lowers the expected domestic currency return on foreign currency deposits. This will also induce *m* to rise. Thus,

$$m = m(i, i^*, e), \;\; m_i > 0, \; m_{i^*} < 0, m_e > 0 \tag{4.10}$$

Given these optimal allocations, the aggregate stock of wealth of the economy (W) and identical and homothetic preferences, the *aggregate* demand for cash, for domestic bonds and for foreign bonds can be written as:

$$M_d = l(i, i^* + E)W \tag{4.11}$$

$$B^D = m(i, i^*, e)[1 - l(i, i^* + E)]W \tag{4.12a}$$

$$FB^D = [1 - m(i, i^*, e)][1 - l(i, i^* + E)]W \tag{4.12b}$$

The aggregate stock of wealth of the economy consists of the stock of domestic money (M) supplied exogenously by the Central bank, and the sum of bequests (Ω) that some of the citizens are endowed with:[41]

[40] I assume that the two types of assets are otherwise perfect substitutes. When assets are imperfect substitutes, they are differentiated by the element of *risk* and its degree, and this will become an additional reason for the expected returns to differ. Here I abstract from this dimension to keep the analysis simple, and shall return to implications of imperfect asset substitutability in Section 4.6.2

[41] I assume that the bequests are received by the wealth-holders in the form of domestic financial assets which, depending on their portfolio choice, can be converted into cash and/or foreign assets. Large magnitudes of bequests in aggregate wealth have been observed by many studies (Kotlikoff and Summers (1981), Lord (1992), Modigliani (1988), Piketty (2011)). Kotlikoff and Summers (1981), for example, observed the share of bequests and other intergenerational transfers in total household wealth in the United States ranging between 46 and 81 percent depending on the calculation method used. Boserup et al. (2016) found that bequests account for 26 percent of average post-bequest wealth in Denmark. Barthold and Ito (1992) calculated this share for both Japan and the United States in the range of 25-40%. Campbell (1997) and Horioka, et al. (2002) also arrived at similar figures for Japan.

$$W = M + \Omega \qquad (4.13)$$

Two comments are warranted at this point. First, at equilibrium, the domestic interest rate must be such that the cash in domestic currency that the domestic residents intend to hold is equal to their actual holding of cash, which is essentially the domestic money supplied by the central bank. So, by the portfolio choice in (12), the money market equilibrium can be stated as:

$$M = \frac{l(i, i^* + E)}{1 - l(i, i^* + E)}\Omega \qquad (4.14)$$

Second, by (4.9) and (4.12b), the exchange rate for the domestic currency varies with the changes in i, i^* and the stock of wealth for any given value of $\tilde{e}$:

$$e = e(i, i^*, W),\ \frac{\partial e}{\partial i} < 0,\ \frac{\partial e}{\partial i^*} > 0,\ \frac{\partial e}{\partial W} > 0 \qquad (4.15)$$

The larger is the stock of wealth of the economy, the larger is the demand for foreign-currency denominated assets or bonds, and consequently the larger is the demand for foreign currency. This causes the domestic currency to depreciate. On the other hand, a higher domestic interest rate and/or a lower foreign interest rate will cause the domestic currency to appreciate by lowering the demand for foreign assets through the portfolio-allocation effect. Essentially (4.15) reflects how the central bank can influence the nominal exchange rate by adopting expansionary or contractionary monetary policies.

I complete the characterization of the real sector of the economy with the following full employment conditions for the skilled labour, capital and unskilled labour as follows:

$$\bar{S} = a_{SZ}(Q) X_Z \qquad (4.16)$$

$$K = a_{KT} X_T + a_{KN} X_N + a_{KZ}(Q) X_Z \qquad (4.17)$$

$$\bar{L} = a_{LT} X_T + a_{LN} X_N + L_b \qquad (4.18)$$

where, L_b is the employment in the banking sector, which, by the simplifying assumption, is equal to the total loanable funds held by this sector, or total investment I.

For early surveys on such estimates one may refer to Davies and Shorrocks (2000) and Horioka, et al. (2002).

Given the values of the technology and policy parameters, the equation system (4.1) - (4.7), (4.12a), and (4.14) - (4.18), comprising of thirteen independent equations, determines the thirteen variables – $r,\ w, w_S,\ i,\ e,\ P_N,\ Q,\ \alpha,\ I,\ K,\ X_T,\ X_N$, and X_Z. The market clearing condition for the non-traded good given in (4.3), the money market equilibrium condition given in (4.14) and the asset market (or foreign exchange market) equilibrium condition in (4.9) along with the marginal condition for quality choice given by (4.5), are the four key conditions of the model from which I determine the four variables of our interest – domestic interest rate *i*, price of the non-traded good P_N, the nominal exchange rate e, and the level of quality Q of the export good-Z.

In this neo-classical production framework with prices of all factors and the non-traded good fully flexible to ensure full employment of both labour and capital, any change in money supply can have an effect on the export-quality, only if the exchange rate, along with the price of non-traded good, changes *non-proportionately*. Here, even without rigid unskilled money wage as in the Keynesian model, speculative motive of wealth-holders for holding idle cash is enough to generate these non-proportional changes so that money is not neutral in the Classical sense. This will be evident from the discussions below regarding how the exchange rate, price of the non-traded good and factor prices change. At this point, it is important to note that the domestic interest rate and the nominal value of the exchange rate are determined simultaneously from the money market equilibrium condition given by (4.14) and the asset market equilibrium condition given by (4.9) *regardless of the value of* P_N. To see how, first observe that a positive relationship between *i* and *e* follows directly from the money market equilibrium condition, for any given level of domestic money supply and foreign interest rate. A rise in value of e, lowers the domestic currency return on foreign assets and therefore the opportunity cost of holding cash falls, causing wealth holders to reduce their foreign bond holding and demand more of domestic bonds as well as like to hold more cash. This rise in the desired cash holdings over and above their actual cash holdings leads to an excess demand situation in the domestic money market for any given level of domestic money supply. This in turn raises the domestic interest rate and restores the money-market equilibrium.

Algebraically, this positive relationship between e and i can be obtained from the money market clearing condition (13) as follows:

$$\hat{M} + \tilde{\mu}_{i*}\hat{i}^* = -\tilde{\mu}_i\hat{i} + \tilde{\mu}_e\hat{e} \qquad (4.19)$$

where, "hat" over a variable denotes its proportional change; $\tilde{\mu}_j = \frac{l(i,i^* + E)\mu_j}{1 - l(i)} > 0$ and $\mu_j = -\frac{l'(.)j}{l(.)}$, $j = i, i^*$, is the absolute value of domestic interest, and foreign interest rate elasticity of the proportion of wealth held in cash respectively; and $\mu_e = \frac{l'(.)e}{l(.)}$ is the absolute value of exchange rate elasticity of the proportion of wealth held in cash.

This positive relationship between e and i, for any given level of domestic money supply and foreign interest rate is denoted by the *ii* schedule in Figure 4.1 which is the locus of combinations of e and i for which the domestic money market is in equilibrium. The other relationship between these two variables can be obtained from (4.9) using the uncovered interest parity condition. As mentioned earlier, a higher domestic interest rate will cause the domestic currency to appreciate by lowering the demand for foreign assets through the portfolio-allocation effect. This negative relationship between e and i is denoted by the *ee* schedule in Figure 4.1 which is the locus of combinations of e and i for which the asset market is in equilibrium. Any change in the level of wealth or the foreign interest rate will affect the value of e through both the wealth effect as well as the portfolio-allocation effect. From (4.15) we can check this:

$$\hat{e} + e_i\hat{i} = e_{i*}\hat{i}^* + e_W W_M \hat{M} \qquad (4.20)$$

where, e_i, e_{i*} and e_W are the absolute values of elasticity of nominal value of exchange rate with respect to change in the domestic rate of interest, foreign interest rate and the value of wealth respectively; and W_M is the share of money stock in total wealth.

Thus, for any given money supply, and the foreign interest rate, the nominal exchange rate and the domestic interest rate are determined simultaneously at the point of intersection between the *ee* and *ii* curves.

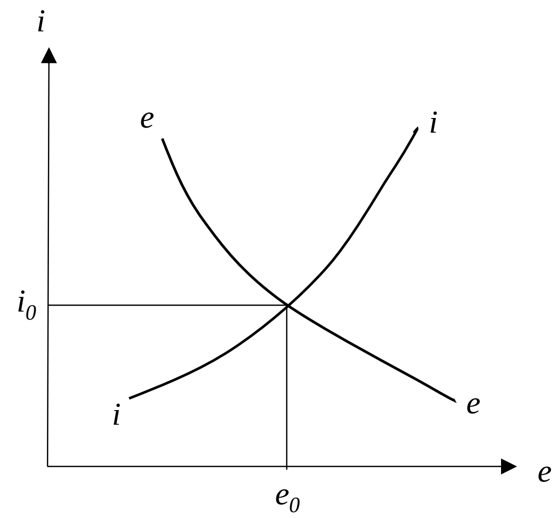

Figure 4.1: Simultaneous Determination of *i* and *e*

Now, P_N and Q are also interdependent, causing each other *for any given level of wealth*, and therefore, should be determined simultaneously. Understanding this interdependence is important since it is through a change in P_N and corresponding changes in the factor prices and the domestic factor cost of the quality differentiated good Z, that the monetary policy affects export-quality. Consider a ceteris paribus rise in the level of quality of the export good Z. As shown in the appendix, this will raise the capital requirement in the Z sector (denoted by K_Z) if the higher qualities of it are relatively more capital intensive than skilled labour, and lower it in the opposite case. Let us first consider the case when $\gamma_{KZ} < \gamma_{SZ}$ so that $\hat{K}_Z < 0$. The capital released from production of Z thus increases the net capital stock available for the production of other goods. This triggers an output magnification effect by which the output of T rises and that of N falls under the assumption that the former uses capital more intensively than labour per unit of output relative to the latter in the following sense:

$$\frac{a_{KT}}{a_{LT}} > \frac{a_{KN}}{a_{LN}} \tag{4.21}$$

The emerging excess demand for the non-traded good, at the initial P_N, will cause the market for it to clear at a higher price. By similar reasoning, an increase in the export-quality will lower P_N when $\gamma_{KZ} > \gamma_{SZ}$. These relationships are represented by the curve labelled $P_N(Q)$ in Figure 4.2, which is the locus of all combinations of Q and P_N for which the non-traded market clears and all the zero-profit conditions are fulfilled.

On the other hand, from the marginal condition for quality choice (4.4) emerges how a change in P_N will affect the quality choice through changes in the factor prices. By the standard price magnification effect, a ceteris paribus increase in P_N, *for any given value of the nominal exchange rate,* will raise the unskilled wage (w) and lower the rate of return to capital (r) under the assumption in (4.21). The fall in *r* lowers the cost of production of Z for any given quality of it, and thereby encourages the producers to expand the scale of production of Z. The demand for skilled workers and their wages thus rise. Accordingly, the marginal cost of quality falls (or, rises) if the higher qualities are relatively capital (or, skill) intensive, which in turn induces the producers to upgrade (or, downgrade) the quality of good Z. Note, as the marginal revenue from quality is unchanged for any given *Q at an initial value of the nominal exchange rate*, so what matters for the producers of export-good Z is how the marginal cost of quality changes when P_N rises ceteris paribus. This locus of all combinations of Q and P_N for which the marginal condition for quality choice is satisfied is represented by the curve labelled $Q(P_N)$ in Figure 4.2. Thus, the relative skill-intensity of higher quality varieties of good Z determines the nature of both the causal relationships, but in exactly the opposite ways. Under $\gamma_{KZ} < \gamma_{SZ}$, whereas the $P_N(Q)$ curve slopes upward, the $Q(P_N)$ curve slopes downward. For $\gamma_{KZ} > \gamma_{SZ}$, these slopes reverse. Given these two relationships, for any given level of aggregate wealth, equilibrium P_N and Q are determined simultaneously at the intersection of $Q(P_N)$ and $P_N(Q)$ schedules in Figure 4.2. These in turn determine the output levels and correspondingly the aggregate level of employment of the unskilled workers.

Given this initial equilibrium, in the following sections I discuss implications of a higher money stock and/or a higher level of bequests on the choice of export-quality and consequently on the wage inequality between skilled and unskilled workers.

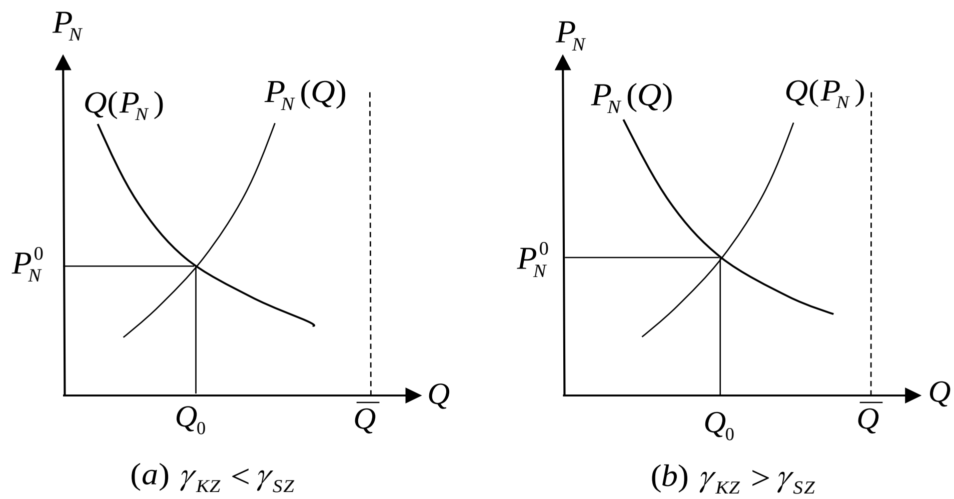

Figure 4.2: Simultaneous determination of Q and P_N

4.2.2 Expansionary Monetary Policy and Export Quality

Given the initial equilibrium values of domestic rate and nominal value of the exchange rate are determined at point *A* in Figure 4.3, consider now an expansionary monetary policy pursued by the central bank through printing new currency notes and puts them into circulation, which increases the aggregate wealth of the economy proportionately. Accordingly, at the initial equilibrium domestic interest rate, the cash holding and demand for domestic and foreign assets all increase equi-proportionately. Thus, by the wealth-effect the supply of loanable funds in the banks increases. At the initial rate of return to capital, consequent excess supply of loanable funds forces the banks to lower the premium α to generate the demand from the investment-firms. The level of investment and capital formation thus increase. There are also subsequent portfolio-allocation effects triggered by these wealth-effects. First, a larger demand for foreign assets raises the demand for foreign currency and thereby causes the domestic currency to depreciate in value. This is captured through a rightward shift of the *ee* curve as shown in Figure 4.3. Given the expectations about the future exchange rate, this lowers the expected domestic-currency return on foreign currency deposits and induces the domestic wealth-holders to substitute foreign assets by domestic assets thereby dampening the initial increase in the demand for foreign assets to some extent. Thus, a larger *proportion* of wealth will now be held in domestic assets, which raises the investment further. I label this effect as the *asset-portfolio allocation effect*. Second, the increase in the demand for domestic bonds *due to wealth effect* raises the bond price and correspondingly lowers the domestic interest rate and changes portfolio-allocation towards foreign assets and away from the domestic asset, That is, through another asset-portfolio effect, now triggered by the fall in the domestic interest rate, a smaller proportion of wealth will be held in domestic assets on account of the fall in interest rate. Note that this fall in domestic interest rate and rise in nominal value of exchange rate, as captured through rightward shift of the *ee* curve and downward shift of the *ii* curves, are the direct effects of the initial rise in domestic money supply. These initial changes in *i* and *e* will again induce a secondary feedback effects upon each other, which will be observed as movements along the *ii* and *ee* curves. The initial fall in domestic interest rate will cause the nominal exchange rate to rise along the *ee* curve and the initial rise in *e* will cause *i* to rise along the *ii* curve. So the overall change in the values of exchange rate and the domestic interest rate are given as follows (see appendix):

$$\hat{e} = \frac{(e_i + e_W W_M \tilde{\mu}_i)}{\tilde{\mu}_i + \tilde{\mu}_e e_i} \hat{M} > 0 \tag{4.22}$$

$$\hat{i} = -\frac{(1 - \tilde{\mu}_e e_W W_M)}{\tilde{\mu}_i + \tilde{\mu}_e e_i} \hat{M} < 0 \tag{4.23}$$

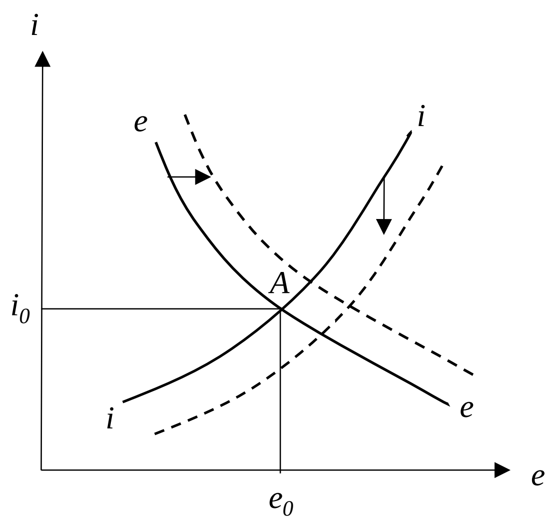

Figure 4.3: Monetary Policy and Changes in *i* and *e*

In case of the exchange rate, note that it rises on both counts, initially with the rise in money supply as well as due to the consequent lowering of the domestic interest rate. So there is an unambiguous increase in the value of e. However, in case of the domestic interest rate, there are two opposing effects. Assuming the interest rate lowering initial effect of the rise in money supply to be stronger in magnitude than the interest rate raising indirect effect generated through rise in the value of exchange rate, i.e. $(1 > \tilde{\mu}_e e_W W_M)$, we can expect that overall, the domestic interest rate falls with the rise in money supply. Hence, even after taking into account all the sequences of changes in *e* and *i*, increase in the value of *e* causes a larger proportion of wealth to be held in domestic assets or bonds, whereas fall in the domestic interest rate causes a smaller proportion to be held in domestic bonds. Accordingly, the supply of loanable funds (and correspondingly, investment level) increases on account of exchange rate depreciation and declines on account of lower domestic interest rate. However, since initial depreciation of the exchange rate is magnified whereas the initial fall in the domestic interest rate is dampened by interactions between these changes, so the favourable asset-portfolio allocation effects due to the former may be larger than the adverse asset-portfolio allocation effect due to the latter. In addition to these asset-portfolio allocation effects, changes in *e* and *i* also triggers a *cash-asset-portfolio allocation effect* by changing the proportion *l*(.) and [1 – *l*(.)] in which wealth is allocated over cash holdings and asset holding. From (4.8b) it follows that the proportion of cash holding will increase due to both depreciation of the exchange rate and fall in the domestic interest rate due to increase in money supply. Accordingly, demand for domestic bonds (as well as demand for foreign bonds) and correspondingly supply of loanable funds decreases due to this cash-asset portfolio allocation effect. Taking into account all these portfolio-allocation effects – both the allocation of total wealth over cash and assets labelled as *cash-asset-portfolio allocation effect*, and the allocation of [1 – *l*(.)] proportion of wealth over domestic and foreign assets labelled as *asset-portfolio allocation effect* – overall change in the demand for domestic bonds may go in either direction. Two comments are warranted at this point. First, even if demand for domestic bonds falls on account of all these portfolio allocation effects taken together, the magnitude of such fall will be smaller than if there had not been any favourable asset-portfolio allocation effect. Second, since all these portfolio allocation effects are triggered by the wealth-effect that initially raised the demand for domestic bonds, so even if the *net* portfolio allocation effect is adverse, it is likely to be weaker so that, overall, an increase in the money supply raises the investment. Yet, to rule out any paradoxical case, in which the initial wealth effect is outweighed by the adverse net portfolio-allocation effects taken together, if at all, I assume the following condition to ensure that an increase in money supply raises the demand for domestic bonds and supply of loanable funds (see appendix):

$$m_e[e_i + e_W W_M \tilde{\mu}_i] > m_i[1 - e_W W_M \tilde{\mu}_e] \qquad (4.24)$$

where, the parameters are as defined earlier.

Thus, at the initial rate of return to capital and corresponding demand for investment funds, a larger supply of loanable funds by the domestic wealth-holders under the assumption in (4.24) forces the commercial banks to lower the premium α to generate the additional demand from the investment-firms. The level of investment and capital formation in the economy thus increases. The consequent increase in the capital stock triggers an output magnification effect by which output of the composite traded rises and that of the non-traded good falls under the assumption in (4.21). The emerging excess demand for the non-traded good causes its price to rise, for all values of Q. Since this occurs irrespective of the relative skill intensity of higher qualities of Z, it is captured through an upward shift of the $P_N(Q)$ schedule in both panels of Figure 4.4. On the other hand, the rise in value of the nominal exchange rate induced by the money supply expansion will lead to reallocation of resources in the (T, N) nugget *for any given price of the non-traded good*. This will raise the rate of return to capital and lower that of unskilled labour. As the cost of production of good Z rises for any given level of quality, producers will lower output and the demand as well as wage to skilled labour will fall. From the marginal condition for quality choice, the quality of export good Z will be upgraded when higher quality varieties of good Z is relatively skill intensive than capital and downgraded otherwise. In Figure 4.4, this effect on Q *for all values of* P_N is captured through a rightward shift of the $Q(P_N)$ schedule in panel-*a*, and a leftward shift in panel-*b*.

Thus, whereas the equilibrium price of the non-traded good rises unambiguously, change in the export quality is ambiguous and depends on the relative magnitude of shifts of the two loci. As shown in the appendix, if the composite traded good employs relatively more capital per unit of output than labour in the sense as defined in (4.21), then the vertical shift of the $P_N(Q)$ curve will always be larger than the vertical shift of the $Q(P_N)$ curve, for all possible values of price elasticity of the demand for non-traded good. In such a case, export quality is upgraded when $\gamma_{KZ} > \gamma_{SZ}$ and downgraded when $\gamma_{KZ} < \gamma_{SZ}$. These cases are illustrated in Figure 4.4.

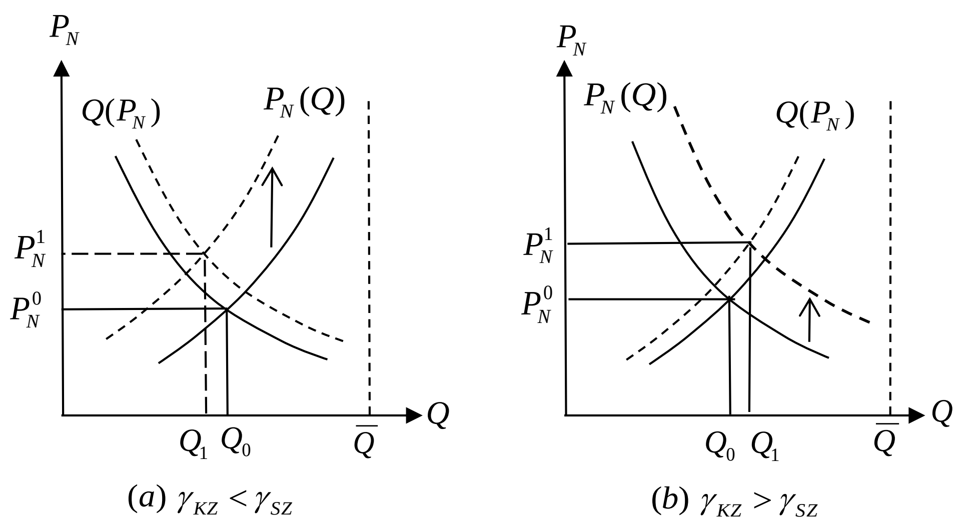

Figure 4.4: Increase in Money Supply and Export Quality

The intuition is simple. As explained earlier, an increase in the money supply raises the value of the exchange rate, on the one hand, and, given the condition in (4.21), P_N on the other hand. These have contrasting effects on the rate of return to capital and the skilled wage, and consequently on the marginal cost of quality at the initial level of *export-quality*. While the increase in P_N lowers the rate of return to capital (under the factor intensity assumption in (4.21)) and raises the skilled wage, the increase in e changes those in the opposite directions. Thus, overall, the change in the marginal cost of quality depends on two things. First, whether the impacts of the increase in P_N is larger than that of the increase in e or not; and, second, whether higher quality varieties of Z are relatively skill or capital intensive. The vertical shift of the $Q(P_N)$ curve indicates the extent to which P_N must rise to offset exactly the contrasting effects of the increase in e so that the export quality remains the same. But, this will characterize the new equilibrium only when the $P_N(Q)$ curve shifts up to the same extent, for reasons spelled out earlier. However, the price of the non-traded good will rise more than proportionately to the rise in the nominal exchange rate. This is because, while the rise in e is a one-time direct effect of the rise in money supply, the change in P_N is the outcome of an output magnification effect that follows from the rise in investment and capital formation which are driven by wealth effects and portfolio allocation effects of the rise in money supply (with the change in exchange rate being only one part of those effects) as explained above. This can be verified from the following algebraic expression (see equation (A.4.15a) in the appendix):

$$\hat{P}_N - \hat{e} = -\frac{\tilde{\lambda}\beta_M}{\varepsilon_N \,|\,\lambda\,|}\hat{M} \tag{4.25}$$

where, $\beta_M \equiv \left[\frac{m_e(e_i + e_W W_M \tilde{\mu}_i) - m_i(1 - \tilde{\mu}_e e_W W_M)}{\tilde{\mu}_i + \tilde{\mu}_e e_i}\right] W_M > 0$ under the assumption (4.24); $\tilde{\lambda} = \lambda_{LT} + \lambda_{LN} + \lambda_{Lb}(\lambda_{KT} + \lambda_{KN})$; ε_N is the price elasticity of demand for the non-traded good and $|\,\lambda\,|$ is the determinant of the employment-share matrix in the (T, N) nugget which is negative under assumption in (4.21).

The above result stated in (4.25) implies that money in this Walrasian general equilibrium model is not neutral, such that all the nominal variables, price of the non-traded good and factor prices, will change non-proportionately to the change in money supply. So, as the rate of return to capital and the skilled wage will change non-proportionately, this also ensures that quality of Z exports will actually respond to the change in money supply. Consequently, overall, the rate of return to capital would fall and the skilled wage would rise, thereby lowering the marginal cost of quality if $\gamma_{KZ} > \gamma_{SZ}$ and raising it when $\gamma_{KZ} <$ γ_{SZ}. Hence quality is upgraded in the former case and downgraded in the latter by the producers.

On the other hand, if the composite traded sector employs relatively less capital than unskilled labour per unit of output so that the reverse inequality in (4.21) holds, then an increase in the capital stock due to larger investment as a consequence of an increase in the money supply lowers P_N due to the output magnification effect. This in turn lowers the rate of return to capital and raises the unskilled wage, thereby reinforcing similar effects of the exchange rate depreciation and corresponding increase in the domestic-currency price of the composite traded good. Since for reasons spelled out earlier, a lower rate of return to capital raises the skilled wage, so again the marginal cost of quality rises and consequently the export-quality is upgraded when $\gamma_{KZ} > \gamma_{SZ}$. But when $\gamma_{KZ} < \gamma_{SZ}$, the export-quality is downgraded. Referring back to Figure 4.4, it can be easily verified that the slopes of $P_N(Q)$ and $Q(P_N)$ curves in both the panels now gets reversed. That is, panel-a now holds for $\gamma_{KZ} > \gamma_{SZ}$, and panel-b for $\gamma_{KZ} < \gamma_{SZ}$. While an increase in the money supply shifts down the $P_N(Q)$ curve in both panels, it shifts the $Q(P_N)$ curve to the left when $\gamma_{KZ} < \gamma_{SZ}$, and to the right when $\gamma_{KZ} > \gamma_{SZ}$.

To sum up the above discussions, the factor-intensity ranking between T and N *does not* matter for how an expansionary monetary policy affects export-quality. All these can be verified from the following algebraic expression for change in the export quality:

$$\hat{Q} = -\frac{\theta_{KZ}\theta_{LT}\tilde{\lambda}}{\Delta\phi\delta\varepsilon_N \,|\,\theta\,|\,|\lambda|}(\gamma_{KZ} - \gamma_{SZ})\beta_M \hat{M} \qquad (4.26)$$

where, $\Delta \equiv \left[1 - \frac{\theta_{KZ}\theta_{LT}\bar{\lambda}}{\phi\delta\varepsilon_N \,|\,\theta\,|\,|\lambda|}(\gamma_{SZ} - \gamma_{KZ})^2\right] > 0$.

The above discussions can be summarized as follows,

Proposition 4.1: *Given* (*4.24*), *an increase in the domestic money supply upgrades the export quality when higher quality varieties of the export good are relatively capital intensive, and downgrades the export quality otherwise.*

Proof: Follows from the discussions above and (4.26). See appendix for algebraic details.□

Proposition 4.1 implies that the impact of an expansionary monetary policy on quality of an export good, once again, essentially depends on its nature, as observed in Chapter 2. Exactly similar to the effects of tariff reduction on the final import good, expansionary monetary policy also favours quality upgrading for quality-differentiated manufacturing exports whose higher qualities of it are relatively more capital intensive but is expected to downgrade the quality of software based services and ITeS, whose higher quality varieties of which are more skill-intensive. These results as stated in Proposition 4.1 also imply that monetary expansion can be another plausible explanation for the observed asymmetric quality variations across different product groups in countries like Brazil, China and India documented in Chapter 1 and explained in terms of tariff reduction policies in Chapter 2.

4.2.3 Wage Inequality

From the above discussions it is apparent that an expansionary monetary policy changes the skilled and unskilled wages in the same direction both on account of the rise in the nominal exchange rate as well as the price of the non-traded good. The direction, however, depends on the factor intensity condition (4.21). Both wages increase when this condition holds, but decrease otherwise. This reflects the complementarity between skilled and unskilled wages established in Beladi and Marjit (1992) and Acharyya, Beladi and Kar (2019) in different contexts. Change in wage inequality is thus ambiguous and depends on the relative magnitudes of the two wage movements. As the following expression reveals (see appendix), the cost-shares of unskilled and skilled workers are relevant for this:

$$\hat{w}_S - \hat{w} = \frac{\tilde{\lambda}(\theta_{LT} - \theta_{SZ})}{\varepsilon_N \Delta\theta_{SZ}|\lambda||\theta|}\beta_M \hat{M} \tag{4.27}$$

So given the condition in (4.24) for which $\beta_M > 0$, an expansionary monetary policy will widen the wage gap if:

$$\theta_{LT} > \theta_{SZ} \tag{4.28}$$

As shown in the appendix, since θ_{SZ} varies positively with the quality level of export-good Z if higher quality varieties of it are relatively skill-intensive (i.e., $\gamma_{SZ} > \gamma_{KZ}$), and inversely with the quality level if higher quality varieties are relatively capital-intensive (i.e., $\gamma_{SZ} < \gamma_{KZ}$), so the level of quality at the initial equilibrium may matter for condition (4.28) to hold. More precisely, suppose $\gamma_{SZ} > \gamma_{KZ}$. Then if $\theta_{LT} > \theta_{SZ}(0)$ and $\theta_{LT} < \theta_{SZ}(\overline{Q})$, condition (4.28) holds and the wage inequality widens for any initial equilibrium level of quality less than $\tilde{Q}$, where $\tilde{Q}$ is such that $\theta_{LT} = \theta_{SZ}(\tilde{Q})$. But, if $\theta_{LT} < \theta_{SZ}(0)$ then condition (4.28) can never be satisfied and thus the wage inequality will decline following an increase in the money supply regardless of the initial equilibrium level of export-quality. These possibilities are shown in Figure 4.5. Similarly, when $\gamma_{SZ} < \gamma_{KZ}$, the initial equilibrium level of export-quality will matter if $\theta_{LT} < \theta_{SZ}(\underline{Q})$ and $\theta_{LT} > \theta_{SZ}(\overline{Q})$. But, now the wage inequality will worsen for any initial equilibrium level of quality higher than $\tilde{Q}$.

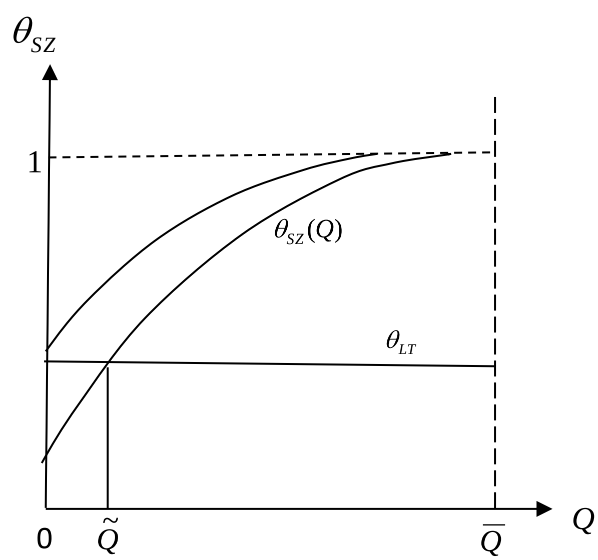

Figure 4.5: Initial Quality and Validity of Condition (4.28)

These results are summarized in the following Proposition:

Proposition 4.2: (a) *For $\gamma_{SZ} > \gamma_{KZ}$, and $\theta_{LT} \in [\theta_{SZ}(0), \theta_{SZ}(\overline{Q})]$, an increase in money supply worsens the wage inequality if the initial equilibrium level of quality is less than*

$\tilde{Q}$ *where* $\tilde{Q}$ *is such that* $\theta_{LT} = \theta_{SZ}(\tilde{Q})$. *Wage inequality declines regardless of the initial level of export-quality if* $\theta_{LT} < \theta_{SZ}(0)$.

(b) *For* $\gamma_{SZ} < \gamma_{KZ}$, *and* $\theta_{LT} \in \left[\theta_{SZ}(\overline{Q}), \theta_{SZ}(0)\right]$, *an increase in money supply worsens the wage inequality if the initial equilibrium level of quality is higher than* $\tilde{Q}$. *Wage inequality declines regardless of the initial level of export-quality if* $\theta_{LT} > \theta_{SZ}(0)$.

Proof: Follows from the above discussion.

Two comments are warranted at this point. First, Proposition 4.2 concerns the wage inequality between skilled workers and unskilled workers employed in the non-banking sectors, or the production sectors. Second, since I assume that the premium α charged by the banks on per unit value of the investment-fund borrowed by the investment firms is paid to each unskilled worker employed in the banking sector, so she gets a higher income $w + \alpha$ than an unskilled worker employed in the production sectors earn. Thus, whether the banks lower or raise α following a monetary policy shock determine the relative position of banking-sector workers vis-a-vis other unskilled workers as well as skilled workers. As explained earlier, an increase in the money supply raises supply of loanable funds by the domestic wealth-holders under the assumption in (4.24), at the initial rate of return to capital and corresponding demand for investment funds. This excess supply of funds forces the commercial banks to lower the premium α to generate the additional demand from the investment-firms. Thus, the unskilled (or, semi-skilled after being trained by the banks to handle investment funds) bank employees experience a smaller increase in their per-capita income than the unskilled production workers under the factor intensity condition (4.21): $\hat{w} > \hat{w} + \hat{\alpha}$. Thus, the wage inequality between these two types of unskilled workers – or between unskilled and semi-skilled workers – decline in the sense that the unskilled production workers gain relatively. [42] On the other hand, with $\hat{\alpha} < 0$ at the new equilibrium, expansionary monetary policy may accentuate the wage inequality between skilled workers and semi-skilled bank employees even when $\theta_{LT} < \theta_{SZ}$.

[42] It can be verified that $\hat{w} > \hat{\alpha}$ at the new equilibrium so that the bank employees do not lose in absolute terms.

4.2.4 Role of Bequest

To capture the importance of the initial level or size of the bequest in the present context, consider a larger sum of bequest held by the domestic wealth-holders. Given a particular stock of money, this larger sum of bequest would increase the supply of loanable funds and therefore level of investment in the economy through the wealth effect, similar to the one spelled out in the earlier section. But, now the portfolio-allocation effects induced by this wealth effect would be different. First, the domestic interest rate will now be higher since larger wealth due to larger bequests would increase the demand for cash holding. This is evident from (4.14) for any given money stock and capturing larger bequests by $\hat{\Omega} > 0$. This would cause a smaller proportion of wealth to be held in cash and a larger proportion in domestic bonds. Higher domestic interest rate will also cause domestic wealth holders to substitute foreign assets by domestic assets. Supply of loanable funds for investment thus increases on both counts. Second, a larger size of bequests also means a higher demand for foreign assets by wealth effect for any given *i* and *e*. This raises the demand for foreign currency and causes the domestic currency to depreciate. On the other hand, as higher domestic interest rate corresponding to larger bequests leads to substitution of foreign assets by the domestic assets, the demand for foreign currency declines, thereby causing the domestic currency to appreciate. This will dampen to some extent the larger proportion of wealth being held in domestic assets. Overall, initial level of bequests being larger will imply larger holding of domestic assets and supply of loanable funds, and a sufficient condition, though not a necessary one, to ensure this is that the value of the exchange rate is higher. That is, we assume the wealth effect on *e* is stronger than the portfolio allocation effect due to higher domestic interest rate:

$$e_W(1-W_M) > \frac{e_i}{\tilde{\mu}_i} \qquad (4.29)$$

Given this assumption, it is straightforward to comprehend that the implications of a larger initial size of bequests for the export quality and wage inequality would be similar to that of an increase in money supply.

The above discussion gives us the following Proposition:

Proposition 4.3: *Larger initial size of bequest will have the same implications for the choice of export quality and wage inequality as an expansionary monetary policy.*

Proof: Follows from the discussion above. □

The above implications of the size of the bequests for export quality have some interesting policy dimensions. Bequests are often taxed by the government. Denote the post-tax value of bequests as $\Pi = (1-\tau)\Omega$, where $0 < \tau < 1$ is the proportional tax imposed on the value of bequest, such that $\hat{\Pi} = (1-\hat{\xi}) + \hat{\Omega}$. It then follows from the above discussion that such a tax on bequest may lower export quality.

4.3 Export Quality and Wage Inequality under Segmented unskilled labour market

In this sub-section, I revisit the effect of an expansionary monetary policy on export quality and wage inequality in the context of a segmented unskilled labour market, a typical factor market imperfection prevalent in the developing countries. As mentioned earlier in Section 2.2, the consideration of segmented labour markets enables us to focus on three dimensions of wage inequality: wage inequality between skilled and informal unskilled workers, wage inequality between skilled and formal unskilled workers, and wage inequality among unskilled workers themselves consequent on informalization. The present analysis will also shed light on whether raising domestic currency in circulation aggravates the problem of informalization of the domestic economy by expanding the size of the informal sector.

Let the production of the composite traded good (T) be organised in the formal sector and that of the non-traded good in the informal setting. With a rigid minimum wage $\overline{w}$ paid to the unskilled workers in the formal sector, the zero-profit condition in the T sector changes as follows:

$$P_T = eP_T^W = a_{LT}\overline{w} + a_{KT}r \tag{4.30}$$

As explained in Chapter 2, the informal sector absorbs unskilled workers who do not find job in the formal sector (and, now also in the banking sector). Hence, the coexistence of formal and informal labour markets ensures that there is no open unemployment in the economy. All the other equations that describe the analytical structure remain unchanged as in the previous sub-section.

The foremost change that the introduction of segmented unskilled labour market causes is that the rigid unskilled wage in the T sector breaks the link through which a change in money supply was influencing all the domestic factor prices – i.e. through changing the price of the non-traded good. Now, once the money supply determines the nominal value of the exchange rate (along with the domestic interest rate), the rate of return to capital is solely and uniquely determined by the value of *e*, given the state of technology and the world price of the composite traded good, from the zero-profit condition in the T sector. As the value of *r* gets determined, this will then direct the change in the skilled wage from the zero-profit condition in the skill intensive Z sector (given by (4.3)). So it is only the unskilled wage that will be determined through the price of the non-traded good from the price-average cost condition of good N. However, the causation is not one-way, as changes in *w*, ceteris paribus, will also affect the price of the non-traded good by changing its cost of production. Thus, *w* and P_N are simultaneously determined by the zero-profit condition (4.2) and the market clearing condition of non-traded good (4.5), for any given level of wealth and export quality of Z.

The choice of export quality, on the other hand, will be determined solely from the marginal condition for quality choice, given by (4.4). That is, the effect of a change in monetary policy upon the choice of quality will not be channelized through changes in the price of non-traded good, but entirely through changes in the value of the exchange rate, and correspondingly, the rate of return to capital and the skilled wage. However, quality variations will still have a feedback effect on the price of the non-traded good by affecting capital availability and output changes in the (T, N) nugget as earlier. Consequently, the effect on the informal unskilled wage will be determined depending on whether the change in the level of investment on account of the monetary policy and the induced quality variations causes the non-traded informal sector to expand or contract. Therefore, changes in factor prices, other than the unskilled informal wage, are delinked from both output and quality changes and, for any given state of technology and world price of the composite traded good, are monetary policy determined.

Recall that an expansionary monetary policy causes the exchange rate to depreciate, both on account of the direct wealth effect as well as the fall in the domestic interest rate (see (4.22)). This raises the domestic currency price per unit of output received by producers of good T and induces a scale expansion in its output. The consequent rise in demand for capital raises its rate of return more than proportionately to the rise in the value of the exchange rate:

$$\hat{r} = \frac{\hat{e}}{\theta_{KT}} = \frac{1}{\theta_{KT}} \frac{(e_i + e_W W_M \tilde{\mu}_i)}{\tilde{\mu}_i + \tilde{\mu}_e e_i} \hat{M} \qquad (4.31)$$

In the quality differentiated export sector Z, on one hand the domestic currency price obtained by the producers of good Z rises proportionately by $\hat{e}$, at the initial level of export quality; on the other hand, the capital cost of producing the Z good rises. While higher marginal revenue incentivizes output expansion, higher marginal cost of production disincentivizes such expansion. Accordingly, whether more skilled workers are demanded or not, and consequently, change in the skilled wage is ambiguous. As shown in the appendix, the skilled wage will rise if capital cost share in the composite traded sector is more than that in the Z sector ($\theta_{KT} > \theta_{KZ}$) and fall otherwise:

$$\hat{w}_S = \frac{\hat{e}}{\theta_{SZ}} - \frac{\theta_{KZ}}{\theta_{SZ}} \hat{r} = \frac{(\theta_{KT} - \theta_{KZ})}{\theta_{KT}\theta_{SZ}} \frac{(e_i + e_W W_M \tilde{\mu}_i)}{\tilde{\mu}_i + \tilde{\mu}_e e_i} \hat{M} \qquad (4.32)$$

However, even if the skilled wage rises, it will increase only less than proportionate to the rate of depreciation of *e*:

$$\hat{w}_S - \hat{e} = \frac{-\theta_{LT}\theta_{KZ}}{\theta_{KT}\theta_{SZ}} \frac{(e_i + e_W W_M \tilde{\mu}_i)}{\tilde{\mu}_i + \tilde{\mu}_e e_i} \hat{M} < 0 \qquad (4.33)$$

So bringing together (4.31) and (4.32), the following inequality holds:

$$\hat{r} > \hat{e} > \hat{w}_S \qquad (4.34)$$

Now for the effect of an expansionary monetary policy on choice of export quality, what matters is whether marginal cost of quality (at the initial level of quality given by the RHS in (4.4)), rises more than or less than proportionately to marginal revenue from quality. As evident from the marginal condition for quality choice, (4.4), the marginal revenue from quality rises by the rate of depreciation in exchange rate ($\hat{e}$). So given the inequalities in (4.34), whether marginal cost of quality rises less than or more than proportionately to $\hat{e}$, depends on the relative skill intensity of the higher quality varieties of export good Z (see appendix). In particular, in case the rise in money supply raises the marginal cost of quality at the initial level of quality, it raises the marginal cost less than proportionately and hence raises the export quality if $\gamma_{SZ} > \gamma_{KZ}$; and more than proportionately, resulting in a downgrading of export quality, if $\gamma_{SZ} < \gamma_{KZ}$. Therefore, whether the export quality is upgraded or downgraded following an expansionary monetary policy depends on the skill intensity of higher quality varieties. This can be verified from the following algebraic expression (see appendix):

$$\hat{Q} = \frac{\theta_{LT}}{\phi\delta\theta_{KT}}\theta_{KZ}(\gamma_{KZ} - \gamma_{SZ})\hat{e} = \frac{\theta_{KZ}\theta_{LT}}{\delta\phi\theta_{KT}}\frac{(e_i + e_W W_M \tilde{\mu}_i)}{\tilde{\mu}_i + \tilde{\mu}_e e_i}(\gamma_{KZ} - \gamma_{SZ})\hat{M} \qquad (4.35)$$

where, $\delta \equiv \left[P_Z^{W''}(Q) - w_S a''_{SZ}(Q) - r a''_{KZ}(Q) \right] < 0$ by the second order condition for profit maximization.

I summarise this result in the following Proposition:

Proposition 4.4: *In the presence of segmented domestic market for unskilled labour, an expansionary monetary policy induces export quality upgrading when higher quality varieties of the export product are relatively more skill intensive than capital and induces downgrading of quality otherwise.*

Proof: Follows from the condition in (4.35) and the discussion above.

Note that this result shows that quality will be upgraded in the exact opposite situation than what we obtained in Proposition 4.1. This essentially brings out two implications of a segmented labour market for assessing the effect of monetary policy for choice of export quality. One is the fact that the same expansionary monetary policy that proved to be favourable for quality upgrading when it is relatively more capital than skill intensive under fully flexible wages across the board, becomes unfavourable under that relative skill intensity ranking when we account for the existence of a fixed formal wage and a flexible informal wage to unskilled labour. The second is that, for any given money supply and other parameters, once the government sets a minimum wage in the composite traded sector at a higher level, then it will lead to the worsening of quality if higher quality varieties of the export product are relative more skill intensive than capital. This is because, the unskilled wages set at a higher level lowers the rate of return to capital and raises the skilled wage at any given level of money supply and corresponding value of the exchange rate. Thus, the marginal cost of quality rises if $\gamma_{KZ} < \gamma_{SZ}$ in which case quality will be downgraded.

Let me now turn to sectoral output changes, or more precisely, changes in the size of the formal and informal sectors and change in the informal unskilled wage. A monetary expansion changes sectoral output levels in two ways. First is through larger investment and capital formation under the assumption in (4.21). By the output magnification effect, larger amount of capital will raise output of the T good and lower that of good N under (4.22). The informal sector does contracts on this account. Second is through quality variations which will lead to capital reallocation across the Z sector and the (T, N) nugget. As explained earlier, quality upgrading will raise the capital requirement in the Z sector (K_Z) if higher qualities are relatively more capital intensive than skilled labour, and lower it in the opposite case:

$$\begin{aligned} \hat{K}_Z = \hat{a}_{KZ} + \hat{Z} = (\gamma_{KZ} - \gamma_{SZ})\hat{Q} &> 0 \; if \;\; \gamma_{KZ} > \gamma_{SZ} \\ &< 0 \; if \;\; \gamma_{KZ} < \gamma_{SZ} \end{aligned} \tag{4.36}$$

Note however, that we have just now derived that quality is upgraded under $\gamma_{KZ} < \gamma_{SZ}$ and downgraded otherwise. So by (4.36), irrespective of whether export quality is upgraded or downgraded, capital requirement in the Z sector will always decrease, i.e., $\hat{K}_Z < 0$. This will release capital and raise its availability for production of the other goods in the (T, N) nugget. Thus, once again, by output magnification effect, the output of T rises and further lowers the size of the informal sector (N) under the factor intensity assumption in (4.21). The consequent excess demand for the non-traded good, on account of these two effects, raises its price. There is also a third effect of a monetary expansion on price of the non-traded good, and this is through the depreciation of the exchange rate. At the initial level of P_N, depreciation of the nominal exchange rate raises the real exchange rate, eP_T^W / P_N. This lowers the domestic demand for the composite traded good and raises that for N and thereby raises P_N. But under fixed coefficients production functions, at the initial level of investment and quality of the Z good and correspondingly at the initial level of capital available for production in the (T, N) nugget, the production of N (and T) remains unchanged. Hence, P_N rises proportionately with the exchange rate to bring back the real exchange rate at its initial level and with it the relative demand for the non-traded good also at its initial level. Thus, these three effects triggered by a monetary expansion reinforce each other to raise P_N and the magnitude of the rise is given by the following expression (see appendix):

$$\hat{P}_N = \left[-\frac{1}{\varepsilon_N \,|\,\lambda\,|} \left\{ \tilde{\lambda} - \bar{\lambda}\, \frac{eP_Z^W \theta_{KZ} \theta_{LT} (\gamma_{SZ} - \gamma_{KZ})^2}{\delta Q^2 \theta_{KT}} \frac{(e_i + e_W W_M \tilde{\mu}_i)}{\tilde{\mu}_i + \tilde{\mu}_e e_i} \right\} + \frac{(e_i + e_W W_M \tilde{\mu}_i)}{\tilde{\mu}_i + \tilde{\mu}_e e_i} \right] \hat{M} \quad (4.37)$$

Note, $|\lambda| < 0$ *by* (4.21), $\delta < 0$; $\tilde{\lambda} = \lambda_{LT} + \lambda_{LN} + \lambda_{Lb}(\lambda_{KT} + \lambda_{KN})$ *and* $\bar{\lambda} = \lambda_{KZ}(\lambda_{LT} + \lambda_{LN})$.

The first term on the right hand side of (4.37) captures the capital formation effect; the second term captures the quality variation induced effect; and the third term captures the exchange rate effect of a monetary expansion.

Therefore, the above result may be summarised in the following Lemma:

Lemma 4.1: *An expansionary monetary policy leads to formalization of the segmented unskilled labour market as the informal sector contracts on account of larger investment and capital formation and induced export quality variations.*

Proof: Follows from (4.35), (4.36) and the discussion above.

Regarding the effect on wage inequality, let us first assimilate the changes in the unskilled informal wage. At the initial level of export quality, expansionary monetary policy raises the price of the non-traded good (as shown in (4.37)) that raises the unskilled wage at initial rate of return to capital. At the same time, at the initial P_N, rise in the rate of return to capital, on account of the rise in exchange rate, lowers the unskilled informal wage. Note that, $\hat{r} > \hat{e} = \hat{P}_N$, at the initial level of export quality and domestic interest rate. So by the exchange rate effect, ceteris paribus, unskilled informal wage will rise by the magnitude of $\frac{\hat{e}}{\theta_{LN}}$ if $\theta_{KT} > \theta_{KN}$. And the rise in r lowers w by the magnitude of $\frac{\theta_{KN}}{\theta_{LN}\theta_{KT}}\hat{e}$. So the unskilled informal wage will rise on account of the rise in exchange rate if $\frac{\theta_{KN}}{\theta_{KT}} < 1$. And under the factor intensity assumption in (4.21), $\theta_{KN} < \theta_{KT}$. Thus, at initial level of quality of Z, rise in monetary policy raises the informal unskilled wage. Now export quality variations, as observed above, by releasing capital from the Z sector, changes the output composition in the (T, N) nugget in favour of the T sector. Thus expansion of the formal T sector will draw more workers from the informal N sector. Increasing competition will pull up the wages in the informal labour market further. Therefore, quality variations reinforce the informal unskilled wage raising effect of an expansionary monetary policy. The overall change in *w* is given by the following expression (see appendix):

$$\hat{w} = \frac{1}{\theta_{LN}}\left[-\frac{1}{\varepsilon_N |\lambda|}\left\{\tilde{\lambda} - \bar{\lambda}\,\frac{eP_Z^W \theta_{KZ}\theta_{LT}(\gamma_{SZ}-\gamma_{KZ})^2}{\delta Q^2 \theta_{KT}}\,\frac{(e_i + e_W W_M \tilde{\mu}_i)}{\tilde{\mu}_i + \tilde{\mu}_e e_i}\right\} + \left[\frac{\theta_{KT}-\theta_{KN}}{\theta_{KT}}\right]\frac{(e_i + e_W W_M \tilde{\mu}_i)}{\tilde{\mu}_i + \tilde{\mu}_e e_i}\right]\hat{M} \qquad (4.38)$$

Note that the first term in {} on the right-hand side of the above expression and third term are the direct effects of a rise in money supply on the informal wage; whereas the second term in {} captures the induced effect through quality variations in Z. If we recall from the observation made in Section 2.2, one may comment that an expansionary monetary policy generates the exact opposite effect on the informal unskilled wage as against an import tariff liberalization policy. While the rise in domestic money supply raises the informal wage by expanding the formal sector and correspondingly reducing the extent of informalization of the economy, a tariff cut lowered the informal wage contraction of the formal sector and informalization of the economy.

So a monetary expansion unambiguously lowers wage inequality among the unskilled workers themselves, that is, between unskilled workers employed in the formal sector and those employed in the informal sector. Wage inequality between skilled workers and formal unskilled workers, captured through change in the skilled wage, and between skilled workers and informal unskilled workers, captured through $\hat{w}_S - \hat{w}$, depends on whether the skilled wage rises or falls. As given in (4.32), if the skilled wage falls, under the assumption that the capital cost share in the composite traded sector is less than in the quality differentiated export sector i.e. $\theta_{KT} < \theta_{KZ}$, then wage inequality will improve in all its three dimensions. If the skilled wage also rises, in the alternative case when the capital cost share in the T sector is greater than in the Z sector ($\theta_{KT} > \theta_{KZ}$), then the wage gap between skilled and unskilled workers in the formal sector rises, whereas, the wage gap between skilled and the informal unskilled workers may go either way. As shown in the appendix, the change in wage inequality between skilled and formal unskilled workers is given by:

$$\hat{w}_S - \hat{w} = \left[\left\{ \frac{\theta_{LT}(\theta_{KN} - \theta_{KZ})}{\theta_{SZ}\theta_{KT}\theta_{LN}} \right\} \frac{(e_i + e_W W_M \tilde{\mu}_i)}{\tilde{\mu}_i + \tilde{\mu}_e e_i} + \frac{1}{\varepsilon_N \theta_{LN} |\lambda|} \left\{ \tilde{\lambda} - \bar{\lambda} \frac{e P_Z^W \theta_{KZ} \theta_{LT} (\gamma_{SZ} - \gamma_{KZ})^2}{\delta Q^2 \theta_{KT}} \frac{(e_i + e_W W_M \tilde{\mu}_i)}{\tilde{\mu}_i + \tilde{\mu}_e e_i} \right\} \right] \hat{M} \quad (4.39)$$

Hence, a sufficient condition for wage inequality to decline is that the capital cost share in the Z sector is larger than that in the non-traded sector:

$$\theta_{KZ} > \theta_{KN} \quad (4.40)$$

Again, following a similar logic as in the previous section, we can note that validity of this condition depends on the initial level of quality of good Z since θ_{KZ} varies inversely with the quality level when $\gamma_{SZ} > \gamma_{KZ}$, and positively with the quality level when $\gamma_{SZ} < \gamma_{KZ}$. A more precise statement is made in Lemma 4.2 below:

Lemma 4.2: *For* $\gamma_{SZ} > \gamma_{KZ}$ *and* $\theta_{KN} \in [\theta_{KZ}(\overline{Q}), \theta_{KZ}(0),]$, $\hat{w}_S - \hat{w} < 0$ *if the initial equilibrium level of quality is less than* $\tilde{\tilde{Q}}$ *where* $\tilde{\tilde{Q}}$ *is such that* $\theta_{KN} = \theta_{KZ}(\tilde{\tilde{Q}})$. *For* $\gamma_{SZ} < \gamma_{KZ}$ *and* $\theta_{KN} \in [\theta_{KZ}(0), \theta_{KZ}(\overline{Q}),]$, $\hat{w}_S - \hat{w} < 0$ *if the initial equilibrium level of quality is higher than* $\tilde{\tilde{Q}}$.

Proof: It is sufficient to note that $\frac{\partial \theta_{KZ}}{\partial Q} > 0$ if $\gamma_{SZ} > \gamma_{KZ}$. See appendix for algebraic details. □

Before proceeding further, two observations are in order. First, note that since the non-traded goods like hair cut, nursing and other kinds of contact-based services are highly labour-intensive, and accordingly cost-shares of labour is much higher than the cost share of capital in average cost of producing/ providing such services, so we can expect the condition (4.40) to be satisfied in most of the cases. At the same time, since by definition, condition (4.40) can be rewritten as $\theta_{LN} > \theta_{SZ}$, and the assumption in (4.21) implies that $\theta_{LN} > \theta_{LT}$, so if the condition $\theta_{LT} > \theta_{SZ}$ stated in (4.28) holds, then condition (4.40) will also hold. This is an interesting result which indicates that *the condition under which wage inequality worsens when the unskilled wage is flexible all around will lead to a decline in the wage inequality under segmented labour markets*. This complete reversal of the change in wage inequality follows from the result that the quality-effects of a monetary expansion are polar opposites in the two cases. However, as Lemma 4.1 states, condition (4.28) is not guaranteed. Though condition (4.40) may hold even when (4.28) does not hold, yet it cannot be guaranteed a priori in which case Lemma 4.2 brings out the importance of the initial level of export-quality.

Second, even if the condition (4.40) does not hold when the conditions in Lemma 4.2 are not satisfied, the wage inequality can still decline provided the elasticity of relative demand for the non-traded good is sufficiently small in the following sense:

$$\varepsilon_N < \tilde{\varepsilon}_N = -\frac{\theta_{SZ}\theta_{KT}(\tilde{\mu}_i + \tilde{\mu}_e e_i)}{(e_i + e_W W_M \tilde{\mu}_i)(\theta_{KN} - \theta_{KZ})\theta_{LT}\,|\lambda|}\left\{\tilde{\lambda} - \frac{eP_Z^W \theta_{KZ}\theta_{LT}(\gamma_{SZ} - \gamma_{KZ})^2 \bar{\lambda}}{\delta Q^2 \theta_{KT}} \frac{(e_i + e_W W_M \tilde{\mu}_i)}{\tilde{\mu}_i + \tilde{\mu}_e e_i}\right\} \quad (4.41)$$

The condition in (4.41) may be interpreted as follows. We know that an increase in the money supply lowers the supply of the non-traded good and the consequent excess demand for N necessitates the price P_N to rise to restore equilibrium in the non-traded market. Smaller is the price elasticity of demand for the non-traded good, the larger will be the required increase in P_N, and accordingly larger will be the rise in the informal unskilled wage. Since the skilled wage also rises, for wage inequality to decline, the magnitude of this rise in the informal unskilled wage must exceed that of the skilled wage.

Therefore,

Lemma 4.3: $\hat{w}_S - \hat{w} < 0 \quad when\, \theta_{KZ} < \theta_{KN}\, if\; \varepsilon_N < \tilde{\varepsilon}_N$.

Proof: Follows from (4.39) and (4.41).

Thus, the above discussion on effect on wage inequality can be summarised as follows:

Proposition 4.5: *With segmented labour market, an expansionary monetary policy mitigates wage inequality under the sufficient condition that capital cost share in the quality differentiated export sector is larger than that in the non-traded sector. Validity of this condition depends on the parametric configurations stated in Lemma 4.2. In cases where this condition does not hold, wage inequality declines for sufficiently low values of price elasticity of the non-traded good as defined in (4.41).*

Proof: Follows from Lemma 4.2 and 4.3.

Finally, note that when the banking sector is taken into account, informalization result still holds. In any developing country, the banking sector is not an informal sector even if it pays a flexible wage (plus a premium α).[43] Since, under the assumption that a monetary expansion raises the demand for domestic bonds and consequently the supply of loanable funds, so the banking sector expands and it also employs more unskilled workers (along with the composite traded sector), drawing such workers from the informal non-traded sector. On the other hand, the wage inequality between unskilled (or, semi-skilled) bank employees and unskilled production workers can similarly be analyzed by looking into how the banks change α, as explained in the earlier section. More precisely, since the rise in domestic money supply raises the informal wage by (4.38), and lowers α, so again the bank-employees are worse off relative to the unskilled production workers. Their position relative to the skilled workers, however, is ambiguous once again.

[43] The results derived above would remain unchanged even if I had considered the unskilled/semi-skilled bank employees were paid a fixed wage (as paid in the composite traded-good sector) plus the premium as assumed in Ganguly and Acharyya (2022).

4.4 Monetary Expansion, Export Quality and Aggregate Employment under Uniform Minimum wage

In this Section, I consider implications of minimum (and rigid) unskilled money wage in all relevant sectors. The banks also employ the unskilled workers at Banks pay each unskilled workers a fixed wage, $\overline{w}$, plus α, and the interest rate it charges to the investment firms for borrowing funds equal $i_b = (\alpha + \overline{w} + \psi + i)$.

Whereas the justification of implementation of such uniform minimum wage for the unskilled workers can be put forward as ensuring for the unskilled workers at least the subsistence level of earnings, the flip side of this policy is that all workers will not be employed now. An obvious question that crops up in such a context is how a monetary expansion affects the aggregate level of employment of unskilled workers through its effects on the composition aggregate output and variations in the export-quality.

In the macroeconomic literature, for example in a rigid money wage Keynesian model, an expansionary monetary policy raises the effective demand for domestically produced goods and accordingly raises the aggregate level of production and lowers the level of (involuntary) unemployment. However, when the economy produces many goods that differ in terms of their unskilled labour intensity relative to capital, and the existing capital stock has already been exhausted, then a monetary expansion can have a completely different effect on the aggregate employment. With factors like capital (or land) constraining the production of these goods – traded and non-traded alike – there is essentially a trade-off between the sectoral output growth, and therefore aggregate employment may rise or fall depending on the relative unskilled labour intensity of the expanding sectors vis-à-vis the contracting sectors. Thus, in such situations, like the general equilibrium production structure I have considered so far, the nature of a change in the composition of aggregate output induced by a monetary expansion is crucially important and makes our analysis important and distinctively different from the *aggregative* macroeconomic analysis. In this backdrop, a monetary expansion has two important implications. First, the aggregate level of employment can be affected through investment and capital formation, though the direction of change would depend on how the composition of aggregate output changes. Second, since higher quality of the export-good require larger capital per unit, so quality upgrading may adversely affect the output of the composite-traded and the non-traded good, and correspondingly the aggregate level of employment of unskilled workers. Thus, there *may* be a potential policy conflict between augmenting exports through quality upgrading and generating larger employment for the unskilled workers.

Let me first discuss the significant ways in which the working of the model changes under the rigidity of unskilled money wage across both the traded and the non-traded sectors. As observed in section 4.3, once the money supply determines the value of nominal exchange rate, the rate of return to capital gets solely and uniquely determined by the exchange rate, given the state of technology and the world price of the composite traded good (see 4.31). Further, now the domestic price of the non-traded good becomes cost determined, whereas its output is domestic demand determined as before. These can be verified from the zero-profit condition for the N sector, revised for the rigid unskilled wage as follows:

$$P_N = a_{LN}\overline{w} + a_{KN}r \qquad (4.2a)$$

Thus, the price of the non-traded good also becomes independent of the market clearing conditions and changes in the quality of export good Z. They will have no impact on P_N whatsoever and will change only the output of the non-traded good and hence the aggregate level of employment of unskilled labour.

Once the rate of return to capital is determined, the skilled wage will also be determined correspondingly, independent of changes in the export quality as derived in (4.32). So now all the factor prices are entirely policy determined and unlike in the situation with flexible wages, they are delinked from both output and export quality changes. That is, the interdependence (or, two-way causality) between export quality and price of the non-traded good which was no longer relevant when we have segmented labour markets, holds true here as well. At the same time, since the non-proportionate changes in rate of return to capital and skilled wage with respect to the exchange rate depreciation caused by the monetary expansion, as specified in (4.31) and (4.32) would still hold, quality of the export good Z will be upgraded when quality upgrading is relatively more skill intensive than capital ($\gamma_{SZ} > \gamma_{KZ}$) and downgraded otherwise. So the effect of an expansionary monetary policy on choice of export quality under uniform minimum wage laws is exactly the same as under formal-informal segmentation of unskilled labour market and as stated in Proposition 4.4.

It may be imperative from the discussions so far that an expansionary monetary policy affects the aggregate level of employment of unskilled labour primarily in three ways. First, by changing the level of investment and capital formation at the initial level of export quality; second, by changing the relative price of the composite traded good (P_T/P_N) or the real exchange rate, and correspondingly changing the relative demand, and third, by reallocating capital between the export-sector Z and the (T, N) nugget through the variation in the quality of good Z. As mentioned earlier, raises the rate of return to capital by $\frac{1}{\theta_{KT}}\hat{e}$ (see (4.31)) through the depreciation in the exchange rate. Thus the capital cost increases in the non-traded sector, which in turn raises the price of the non-traded good by $\frac{\theta_{KN}}{\theta_{KT}}\hat{e}$. Thus given $P_T = eP_T^W$, so that, $\hat{P}_T = \hat{e}$, the real exchange rate changes in the following way:

$$\hat{P}_T - \hat{P}_N = \hat{e} - \frac{\theta_{KT}}{\theta_{KT}}\hat{e} = \frac{(\theta_{KT} - \theta_{KN})}{\theta_{KT}}\hat{e} \qquad (4.42)$$

By (4.21), $\theta_{KN} < \theta_{KT}$, such that $\hat{P}_T - \hat{P}_N > 0$, that is, the relative price of the non-traded good falls, causing its relative demand to rise. Output of non-traded good thus rises and that of good T falls. Accordingly, employment of unskilled labour falls in the T sector and rises in the non-traded sector; but the expanding *N* sector being relatively labour intensive by (4.21), it absorbs more labour than what is released by the contracting composite traded sector. So, aggregate employment of unskilled labour rises as a result of the rise in the real exchange rate consequent upon the expansionary monetary policy. Other than this, as spelled out above, at initial *Q*, the rise in the money supply raises the level of investment both by the primary wealth effect as well as secondary portfolio allocation effect under the condition in (4.22). Consequent capital formation in turn, raises output levels in the (T, N) nugget of both the composite traded and the non-traded good. This further raises the level of unskilled labour employment. There will also be an additional employment expansion in the banking sector due to larger banking activity as the increase in the money supply raises the supply of loanable funds. Thus, overall the aggregate employment will increase on all these three accounts, at the initial level of quality. Note here that the employment expansion in the banking sector should not be so large that it becomes binding and constrains the output expansion of the two goods in the (T, N) nugget. Turning now to the employment effect coming from quality variations, note that by (4.33) and as laid down in Proposition 4.4, the capital requirement in Z sector rises, regardless of whether the quality of good Z is upgraded or downgraded. So this additional capital requirement due to quality variation following the rise in the domestic money supply is met by withdrawing some capital from the (T, N) nugget. This goes on to change the composition of output herein, *now* in favour of the non-traded good. Thus, the aggregate employment of unskilled workers further increases due to quality variation and reinforces the initial favourable effect. The increase in the total employment in the (T, N) nugget due to these three effects is shown in Figure 4.6. The initial less than full employment equilibrium is at E_0, which is the intersection point between the capital-availability line $\tilde{K}(Q_0)$ at the export-quality Q_0 and the relative demand-ray for N at the initial relative price of the non-traded good. The rise in aggregate employment of unskilled labour by the real exchange rate effect (that is, due to a fall in the relative price of N) is indicated by the intersection point of steeper relative demand-ray for N and the $\tilde{K}(Q_0)$ line. The rise in employment through rise in investment and capital formation is given by the intersection of the $\tilde{K}^+(Q_0)$ line with the steeper relative demand-ray for N. Finally, the third favourable effect through quality variations is indicated by the intersection point of the outward shifted $\tilde{K}(Q_1)$ line with the steeper relative demand-ray for N. Overall, the increase in the total employment in the (T, N) nugget is shown by the movement from the L_e^0-line to the higher and parallel L_e^1-line.

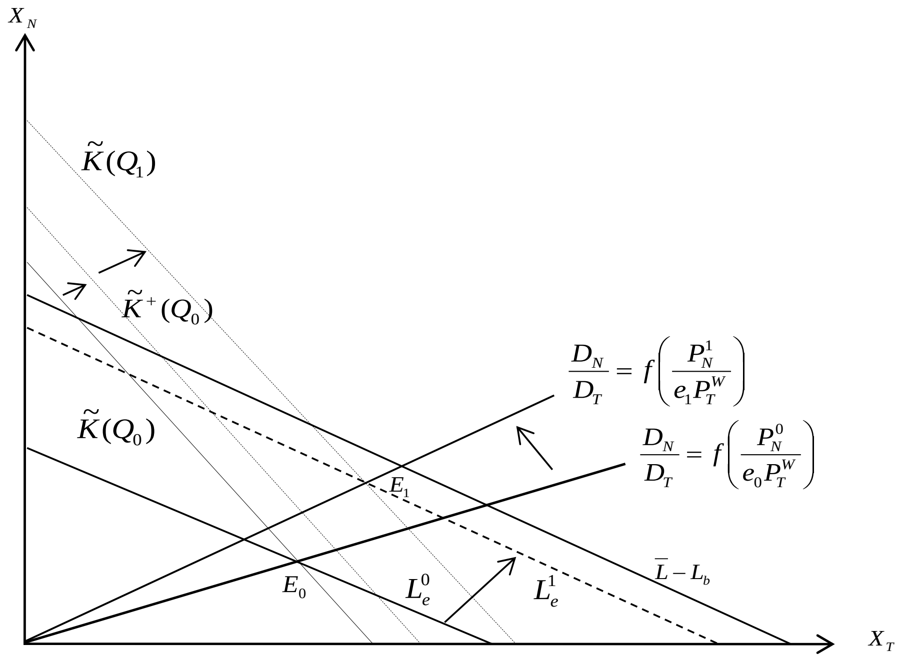

Figure 4.6: Increase in Money Supply and Total Employment in (T, N) Nugget

All these can be further verified from the following algebraic expression:

$$\hat{L}_e = \left[\frac{|\lambda||\theta|\varepsilon_N}{(\lambda_{KT}+\lambda_{KN})\theta_{KT}}\left(\frac{e_i}{\tilde{\mu}}+e_W W_M\right)+\frac{\tilde{\lambda}\beta_M}{(\lambda_{KT}+\lambda_{KN})}-\frac{(\lambda_{LT}+\lambda_{LN})}{(\lambda_{KT}+\lambda_{KN})}\frac{\lambda_{KZ}\theta_{LT}\theta_{KZ}}{\phi\delta\theta_{KT}}\frac{(e_i+e_W W_M\tilde{\mu}_i)}{\tilde{\mu}_i+\tilde{\mu}_e e_i}(\gamma_{KZ}-\gamma_{SZ})^2\right]\hat{M} \quad (4.43)$$

The first and second terms in the right-hand-side capture the direct effect of expansionary monetary policy – the relative price or real exchange rate effect and the investment expansion effect. The first term also shows that the employment raising effect of the rise in relative price of N is independent of the factor intensity assumptions in the (T, N) nugget. Similar result is derived in Ganguly and Acharyya (2022) in the context of a nominal devaluation of the domestic currency. That is, $|\lambda|(\theta_{KN}-\theta_{KT})$ is positive both under the condition in (4.21) and also under the opposite case. The third term in (4.43) captures the induced or the indirect effect of export quality variations and is positive by Proposition 4.4 regardless of whether $\gamma_{KZ} > \gamma_{SZ}$ or not.

The above discussion can be summarized in the following Proposition:

Proposition 4.6: *Under uniform rigid unskilled money wage, an expansionary monetary policy raises the aggregate level of employment of unskilled workers at the initial level of export quality. Quality variations, irrespective of its direction, reinforce the employment expansionary effect further.*

Proof: Follows from discussion above. See appendix for algebraic details. □

Proposition 4.6 and the underlying discussions have some win-win implications for policy makers and governments. An expansionary monetary policy can promote exports at the extensive margin as well as generate more employment for the unskilled workers.

4.5 Inflation-targeting Monetary policy in Foreign Country

Flexible exchange rates, asset substitutability and no restrictions on domestic wealth-holders for buying and selling of foreign assets, make monetary policy shocks originating in one country to transmit to another. Since the domestic economy under consideration is assumed to be small enough in the asset market to influence the rate of return on foreign assets, so its monetary policy such as the one considered in the previous sections, transmits to its trading partner only through impact that such a policy has on the exchange rate. However, this will be inconsequential for the asset market equilibrium and money market equilibrium conditions for the domestic economy since I have assumed that foreign wealth-holders do not hold assets issued by the domestic economy in their portfolio. While this assumption can certainly be relaxed to look into its implications, more pertinent issue perhaps is the policy shock originating in rest of the world, or in a large trading partner of our small domestic economy, that affects i^* and consequently the portfolio-choice of the domestic wealth-holders. This issue assumes relevance in the current scenario of US Federal Bank tightening its monetary policies and/or raising interest rates on dollar-denominated assets as it engages in inflation targeting. In this section, I examine how such a foreign policy shock affects the domestic country's level of investment, capital formation and the choice of export quality.

Since in this comparative static analysis, I hold the domestic money supply fixed at its initial level, and with no change in the amount of bequest either, so an increase in the foreign interest rate i^* will generate *only* portfolio-allocation effects. First, given everything else, it will raise the opportunity cost of holding cash and thereby lower the demand for cash holdings. At the initial allocation of the [1 –*l*(.)] proportion of wealth over domestic and foreign assets (or, bonds) at the rate *m* and (1- *m*) respectively, the excess cash holdings will be spent on both these assets, thereby raising their demands equi-proportionately. Second, a higher interest rate on foreign bonds will lower the *m* proportion of [1 –*l*(.)] fraction of wealth held in domestic assets, and raise the (1- *m*) proportion held in foreign assets. This is what I had termed earlier in Section 4.4 as the asset-portfolio allocation effect. However, despite m being smaller due to the rise in i^*, as long as it is positive (that is, the domestic wealth-holders hold a "portfolio" of interest-bearing assets), a part of the holding of cash now becoming undesired due to the rise in will still be spent on buying domestic bonds. In other words, fall in the demand for domestic bond due to re-allocation of [1 –*l*(.)] fraction of wealth – the so-called asset-portfolio allocation effect – will be smaller than the rise in the demand for domestic bond due to increase in the [1 –*l*(.)] fraction of wealth spent on all assets taken together – which I had labelled earlier as the cash-asset-portfolio allocation effect. So, at the initial value of the exchange rate, on account of these two contrasting asset-portfolio and cash-asset-portfolio allocation effects, the demand for domestic bonds increases as a consequence of an increase in the foreign interest rate i^*. This in turn raises the price of domestic bonds and lowers the domestic interest rate. This adverse impact of an increase in i^* on *i*, at the initial value of *e*, can be verified from (4.19): $\tilde{\mu}_{i*}\hat{i}^* = -\tilde{\mu}_i\hat{i}$. In Figure 4.7, this is shown by the downward shift of the *ii* curve.

On the other hand, a larger demand for foreign assets by these two types of portfolio allocation effects – a fall in *l* proportion and a fall in *m* proportion – raises the demand for foreign currency and thereby causes the domestic currency to depreciate in value. This initial impact of an increase in i^* on *e*, at the initial value of *i*, can be verified from (4.20): $\hat{e} = e_{i*}\hat{i}^*$. In Figure 4.7, this is shown by the rightward shift of the *ee* curve. Given the expectations about the future exchange rate, this lowers the expected domestic currency return on foreign assets and induces the domestic wealth-holders to substitute foreign assets by domestic assets dampening the initial increase in the demand for foreign assets to some extent. The rise in the value of e also lowers the opportunity cost of cash holding, thereby raising the l proportion of wealth held in cash, leading to a fall in the demand for domestic bonds due to this cash-asset-portfolio allocation effect. Thus, the rise in the value of e causes the domestic interest rate to rise, and this is shown by the movement along the ii curve in Figure 4.7. Thus, overall, the change in the domestic interest appears to be ambiguous:

$$\hat{i} = -\frac{(\tilde{\mu}_{i*} - \tilde{\mu}_e e_{i*})}{\tilde{\mu}_i + \tilde{\mu}_e e_i}\hat{i}^* \quad (4.44)$$

However, it may be more likely that an increase in the foreign interest rate i^* lowers the domestic interest rate, since usually the initial or direct effect of an increase in i^* that lowers i is stronger than its subsequent or induced effect that raises i. But, again this cannot be guaranteed, and thus to rule out any possibility on the contrary, I assume that $\tilde{\mu}_{i*} > \tilde{\mu}_e e_{i*}$. From Figure 4.7 it appears that the exchange rate depreciates unambiguously as a consequence of an increase in i^*. Algebraically, this can be verified from the following:

$$\hat{e} = \frac{e_i \tilde{\mu}_{i*} + \tilde{\mu}_i e_{i*}}{\tilde{\mu}_i + \tilde{\mu}_e e_i}\hat{i}^* \quad (4.45)$$

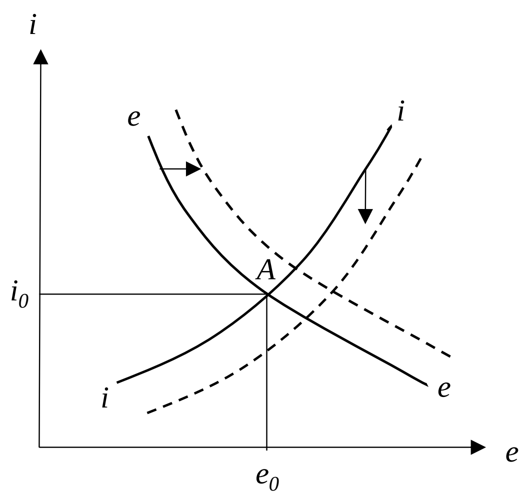

Figure 4.7: Rise in Foreign Interest Rate and Changes in *i* and *e*

From the above argument it follows that the demand for domestic bonds and consequently the supply of loanable funds change in several ways – through cash-asset-portfolio allocation effects as well as asset-portfolio allocation effects. Whereas cash-asset-portfolio allocation effect of increase in i^* on the demand for domestic bonds net of the asset-portfolio allocation effect, *at the initial equilibrium values of i and e*, is positive, subsequent rise in the value of *e* raises the demand for domestic bond and fall in *i* lowers it through further cash-asset-portfolio and asset-portfolio allocation effects. Overall the demand for domestic bond increases if the favourable portfolio allocation effects are stronger. Algebraically, this is the case if (see appendix, (A.4.4) and (A.4.6)):

$$m_e\left[e_{i*}\tilde{\mu}_i + e_i\tilde{\mu}_{i*}\right] > m_i\left[\tilde{\mu}_{i*} - e_{i*}\tilde{\mu}_i\right] - m_{i*}\left[\tilde{\mu}_i + e_i\tilde{\mu}_e\right] \qquad (4.46)$$

where, the parameters are as defined earlier.

Coming to the effect on wage inequality, as rise in $\hat{i}^*$ lowers both the skilled as well as unskilled wages, whether wage inequality rises or declines will depend on the relative magnitudes of the two wage movements, which is again related to the cost shares as in case of a domestic monetary policy.

In the context of a segmented unskilled labour market, as explained earlier, changes in P_N is no longer relevant for *r* and w_S to change. Accordingly, rise in domestic demand for bonds and consequently investment as a consequence of an increase in i^* is inconsequential for changes in the export-quality. What matters for factor prices is the change in the exchange rate, and as the value of exchange rate on account of the rise in foreign interest rate rises, so does the rate of return to capital given the fixed formal unskilled wage in the composite traded sector. In the Z sector, the skilled wage will rise if capital cost share in the composite traded sector is more than that in the Z sector and fall otherwise. However, even if the skilled wage rises, it will increase only less than proportionate to the rate of depreciation. So once again we have the following inequality: $\hat{r} > \hat{e} > \hat{w}_S$ as obtained in (4.34). Thus, given that the marginal revenue from quality rises by the rate of depreciation in exchange rate (given by (4.45)), the marginal cost of quality increases less than proportionately and thereby raises the export quality if $\gamma_{SZ} > \gamma_{KZ}$; and more than proportionately, resulting in a downgrading of export quality, if $\gamma_{SZ} < \gamma_{KZ}$.

Therefore, rise in $\hat{i}^*$ affects export quality exactly the same way as a domestic monetary expansion in the context of segmented unskilled labour market.

To look at how the informal unskilled wage changes and therefore the effect on wage inequality, note that rise in $\hat{i}^*$ causes the informal non-traded sector to contract through larger investment and capital formation under the assumption (4.46), given the factor intensity assumption in (4.21). On the other hand, as spelled out earlier, the induced export quality variations, irrespective of whether export quality is upgraded or downgraded, lowers the capital requirement in the Z sector, and accordingly changes output composition in the (T, N) nugget such that the size of the informal sector (N) is lowered *further*. Thus, contraction of the production of non-traded good causes its price to rise and accordingly raises the unskilled wage. At the same time, at the initial P_N, rise in the rate of return to capital, on account of the rise in exchange rate, lowers the unskilled informal wage. Thus, overall, effect of a rise in $\hat{i}^*$ on the informal unskilled wage is ambiguous, and will depend on the capital cost shares in T and N sectors as well as on the price elasticity of demand for N as explained earlier.

Finally, coming to the scenario when there are minimum wage laws implemented uniformly, the non-proportionate changes in rate of return to capital and skilled wage with respect to the exchange rate depreciation caused by the rise in $\hat{i}^*$, as observed under segmented unskilled labour market would still hold, quality of the export good Z will be upgraded when quality upgrading is relatively more skill intensive than capital ($\gamma_{SZ} > \gamma_{KZ}$) and downgraded otherwise. With respect to the effect on the aggregate level of employment of unskilled labour, rise in $\hat{i}^*$ also generates the three effects: by changing the level of investment and capital formation at the initial level of export quality; second, by changing the real exchange rate, and third, by reallocating capital between the export-sector Z and the (T, N) nugget through the variation in the quality of good Z. At initial Q, the rise in rise in $\hat{i}^*$ raises the level of investment and capital formation under the assumption (4.46), which raises output levels of both goods in the (T, N) nugget and consequently raises the level of unskilled labour employment. Employment also rises in the banking sector due to greater banking activity as the supply of loanable funds rises. Now, since under uniform unskilled money wage rigidity the price of the non-traded good cannot change, so depreciation of the exchange rate following an increase in i^* unambiguously raises the real exchange rate, causing demand for the non-traded good to rise. This raises total employment in the (T, N) nugget under the assumption (4.21). Finally turning to the employment effect coming from quality variations, it lowers the capital requirement in Z sector regardless of whether the quality of good Z is upgraded or downgraded. So this releases additional capital into the (T, N) nugget that changes the composition of output therein, *now* in favour of the composite traded good. Thus, the aggregate employment of unskilled workers falls due to quality variations. Thus, overall, rise in i^* may raise the level of aggregate employment if the adverse quality-effect is weaker.

4.6 Robustness/Extensions: Some informal discussions

In this section I consider two extensions of the benchmark analytical structure by relaxing certain assumptions to analyse how it may affect the choice of export quality. First in 4.6.1, I introduce transaction demand for money and second, in sub-section 4.6.2, I relax the assumption of perfect substitutability between the two types of assets and revisit how export quality would be affected in the presence of an asset-substitutability parameter.

4.6.1 Transactions demand for money

To incorporate demand for cash for transactions purposes that depends on their income (or expenditure) levels in the simplest possible manner in the portfolio choice model, suppose the proportion of wealth that each domestic wealth-holder holds in cash also varies positively with the level of her income. Given the assumption of identical and homothetic preferences, the aggregate demand for money equals $M_d = l(i, i^* + E, y)W$, and accordingly the money market equilibrium condition (4.14) is rewritten as:

$$M = \frac{l(i, i^* + E, y)}{1 - l(i, i^* + E, y)}\Omega, \; l_i < 0, \; l_{i^*} < 0, l_e > 0, l_y > 0 \qquad (4.47)$$

where, $y = w_S\bar{S} + w\bar{L} + \alpha L_b$ is the total factor income, or the national income.

Since the change in aggregate factor income is partly driven by P_N, so now *i, e* and P_N are inter-dependent. This is in contrast to the analysis of the earlier sections in which *i* and *e* were inter-dependent, but did not depend on P_N. To see this dependence of *i* and *e* on P_N, note that an increase in P_N, *at initial value of the exchange rate,* raises both *w* and w_S. On both these accounts the national income rises. This rise in *y* raises the demand for money and consequently raises the domestic interest rate, at the initial value of the exchange rate and parameter values *M* and i^*. Algebraically, the magnitude of such increase in *i* can be obtained from (4.47):

$$\hat{i} = \frac{\tilde{\mu}_y}{\tilde{\mu}_i}\hat{y} \qquad (4.48)$$

In Figure 4.8, this is shown by the upward shift of the *ii* curve.[44] On the other hand, as an increase in *y* (due to a ceteris paribus increase in P_N) raises the *l*-proportion of wealth held in cash to rise, the demand for foreign assets falls due to the cash-asset-portfolio allocation effect at the initial value of *i* and *e*. Consequently, the demand for foreign currency falls and the exchange rate appreciates. This is shown by the leftward movement of *ee* curve in Figure 4.8. Overall, the domestic interest rate may again raise or fall, but the exchange rate unambiguously appreciates. This explains how P_N affects *e* and *i*. The effect of changes in e and *i*, on the other hand, affects P_N through changes in the investment level and correspondingly the output of the non-traded good.

The central point to make from these informal discussions is the inter-dependence between *i, e* and P_N when the Keynesian transaction demand for money is incorporated into the specification. The effects of an expansionary monetary policy on the export-quality and wage inequality can be worked out similarly as spelled out in Section 4.4, with similar kinds of results obtained but now those may be contingent upon one or two additional restrictions on the parameters. I avoid here a full blown algebraic analysis, and plan to take up such an analysis as a possible future extension.

[44] Alternatively, this positive relationship between *y* and *i*, for any given value of *e*, can be captured through a positively sloped curve in (*y, i*) space with slope equal to $\frac{di}{dy} = \frac{\tilde{\mu}_y}{\tilde{\mu}_i}.\frac{i}{y}$, which is similar to the LM curve of a typical Keynesian macroeconomic model.

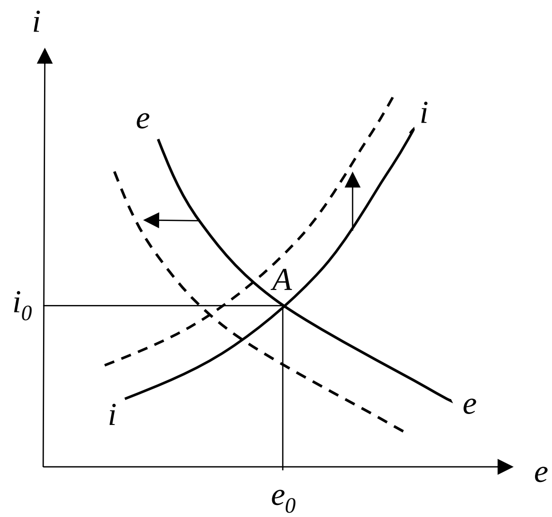

Figure 4.8: Rise in Income and Changes in *i* and *e*

4.6.2 Imperfect substitutability between the two types of assets

Another key feature of the benchmark analytical structure is the assumption that the interest-bearing domestic and foreign assets are perfect substitutes as captured through the uncovered interest parity condition as given by (4.9). Two assets are perfect substitutes when the only concern that drives the wealth holders to allocate their portfolio between them is that both yield the same expected rates of return in a common currency. With perfect asset substitutability in the foreign exchange market, the exchange rate is therefore determined so that the (uncovered) interest parity condition holds. In such a situation, there is nothing a central bank can do through foreign exchange intervention that it could not do as well through purely domestic money market operations. So exchange rate changes were entirely the endogenized managed outcome of wealth and portfolio allocation effects that a domestic monetary expansion by the central bank led to. An alternative to the case of perfect asset substitutability is imperfect asset substitutability where it is possible for the expected returns on the two types of assets to differ even in equilibrium. And this difference will arise in the presence of a risk factor in the foreign exchange market. If bonds denominated in different currencies have different degrees of risk, investors may be willing to allocate a greater proportion of their wealth in the lesser risky asset even if they get to earn lower expected returns on such assets. Correspondingly, they will hold a very risky asset only if its expected return is relatively very high. When domestic and foreign currency bonds are *imperfect* substitutes, the equilibrium in the foreign exchange market requires that the domestic interest rate equal the expected domestic currency return on foreign assets *plus* a *risk premium*, say ρ, that reflects the difference between the riskiness of domestic and foreign assets. So the condition in (4.9) can be rewritten as follows:

$$i = i^* + \frac{\tilde{e} - e}{e} + \rho \qquad (4.9a)$$

A ceteris paribus rise in the risk premium with domestic money supply fixed at its initial level, would generate portfolio allocation effects similar to those observed when there is a contractionary monetary policy adopted in the foreign country (i^* increases). Consequently, the choice of export quality and its implications for wage inequality or aggregate level of unskilled employment would be affected in a similar manner as elaborated upon in Section 4.5.[45]

4.7 Concluding Remarks and Scope of Future Extensions

The competitive general equilibrium analysis of the effects of an expansionary monetary policy adopted by a small open economy on the quality of its exports and its implications for the domestic labour market have been the focal points of the present Chapter. After integrating the real sectors of the economy with the domestic money market and the foreign exchange market, I have discussed the importance of monetary policy-induced changes in the composition of aggregate output and consequent re-allocation of scarce resources for the export-quality choice. This issue assumes relevance since monetary policies are often pursued by the central bank of an economy to manage exchange rate fluctuations under a managed float regime, which may have adverse consequences for export-quality choices and thereby for export growth given the growing preference of buyers in richer nations for higher qualities of goods they consume. An increase in the domestic money supply upgrades the export quality when higher quality varieties of the export good are relatively capital intensive, and downgrades the export quality otherwise.

[45] This also opens up an additional policy instrument for the central bank of the domestic economy since the risk premium on domestic bonds depends, among other things, on the stock of government's debt net of domestic assets held by the central bank.

With regards to effect on wage inequality under flexible wages that ensures full employment of labour, an expansionary monetary policy changes the skilled and unskilled wages in the same direction. Thus, wage inequality widens if the unskilled-labour cost share in the composite traded sector is larger than the skilled-labour cost share in the quality differentiated export sector, which, however, depends on the initial level of export-quality.

In the context of formal-informal segmentation of the unskilled labour market, the two-way causality between the level of export quality and price of the non-traded good breaks down. In such a context, an expansionary monetary policy induces export quality upgrading when higher quality varieties of the export product are relative more skill intensive than capital and induces downgrading of quality otherwise. These results are in the exact opposite direction than what can be obtained under flexible wages everywhere. Finally, when the unskilled wage is fixed across the board under minimum wage laws, rise in money supply will cause quality variations exactly in the same way as under a segmented unskilled labour market. On the other hand, the aggregate level of employment of unskilled workers increases both at the initial level of export quality as well as due to export quality variations. I have informally discussed how the benchmark analytical structure can be extended by incorporating transaction demand for money and imperfect substitutability of assets. Implications of imperfect credit market with credit rationing, and other instruments of monetary policy such as credit expansion through banks can also be examined.

Appendix

A.4.1. Money supply and changes in *i* and *e*

Recall the money-market and asset market equilibrium conditions in proportional change form as in (4.19) and (4.20) in the text, reproduced below:

$$\hat{M} + \tilde{\mu}_{i*}\hat{i}^* = -\tilde{\mu}_i\hat{i} + \tilde{\mu}_e\hat{e}$$

$$\hat{e} + e_i\hat{i} = e_{i*}\hat{i}^* + e_W W_M \hat{M}$$

Writing these simultaneous equations in matrix notation, I obtain:

$$\begin{bmatrix} -\tilde{\mu}_i & \tilde{\mu}_e \\ e_i & 1 \end{bmatrix}\begin{bmatrix} \hat{i} \\ \hat{e} \end{bmatrix} = \begin{bmatrix} \hat{M} + \tilde{\mu}_{i*}\hat{i}^* \\ e_W W_M \hat{M} + e_{i*}\hat{i}^* \end{bmatrix}$$

Solving by Cramer's Rule, I get:

$$\hat{e} = \frac{(e_i + e_W W_M \tilde{\mu}_i)}{\tilde{\mu}_i + \tilde{\mu}_e e_i}\hat{M} + \frac{(e_{i*}\tilde{\mu}_i + e_i\tilde{\mu}_{i*})}{\tilde{\mu}_i + \tilde{\mu}_e e_i}\hat{i}^* \qquad (A.4.1)$$

$$\hat{i} = -\frac{(1 - \tilde{\mu}_e e_W W_M)}{\tilde{\mu}_i + \tilde{\mu}_e e_i}\hat{M} - \frac{(\tilde{\mu}_{i*} - e_{i*}\tilde{\mu}_e)}{\tilde{\mu}_i + \tilde{\mu}_e e_i}\hat{i}^* \qquad (A.4.2)$$

For $\hat{i}^* = 0$, changes in *i* and *e* due to an increase in money supply can be obtained from (A.4.1) and (A.4.2) as given in the text.

A.4.2 Effect of rise in money supply on Investment

As investment is given by the supply of loanable funds or demand for domestic bonds in the economy, total differentiation of the expression for B^D given by (4.12a) yields:

$$dI = \left(\frac{\partial m}{\partial i}di + \frac{\partial m}{\partial i^*}di^* + \frac{\partial m}{\partial e}de\right)[1 - l(i)]W$$

$$+ m(i, i^*, e)W\left[-\frac{\partial l}{\partial i}di - \frac{\partial l}{\partial i^*}di^* - \frac{\partial l}{\partial e}de\right] + m(i, i^*, e)[1 - l(i)]dW$$

$$\Rightarrow \hat{I} = m_i\hat{i} + m_{i^*}\hat{i}^* + m_e\hat{e} + \frac{l(.)}{1 - l(.)}\left[\mu_i\hat{i} + \mu_{i*}\hat{i}^* - -\mu_e\hat{e}\right] + \hat{W}$$

$$\Rightarrow \hat{I} = (m_i + \tilde{\mu}_i)\hat{i} + (m_{i^*} + \tilde{\mu}_{i*})\hat{i}^* + (m_e - \tilde{\mu}_e)\hat{e} + \hat{W} \qquad (A.4.3)$$

Substitution of the expression for change in wealth as $\hat{W} = W_M\hat{M}$ at initial unchanged level of bequest such that $\hat{\Omega} = 0$ and (A.4.1) and (A.4.2) in (A.4.3) yields:

$$\Rightarrow \hat{I} = (m_i + \tilde{\mu}_i)\left[-\frac{(1-\tilde{\mu}_e e_W W_M)}{\tilde{\mu}_i + \tilde{\mu}_e e_i}\hat{W} - \frac{(\tilde{\mu}_{i*} - e_{i*}\tilde{\mu}_e)}{\tilde{\mu}_i + \tilde{\mu}_e e_i}\hat{i}^*\right] + (m_{i^*} + \tilde{\mu}_{i*})\hat{i}^* + \hat{W}$$

$$+ (m_e - \tilde{\mu}_e)\left[\frac{(e_i + e_W W_M \tilde{\mu}_i)}{\tilde{\mu}_i + \tilde{\mu}_e e_i}\hat{W} + \frac{(e_{i*}\tilde{\mu}_i + e_i\tilde{\mu}_{i*})}{\tilde{\mu}_i + \tilde{\mu}_e e_i}\hat{i}^*\right]$$

$$\Rightarrow \hat{I} = \left[-\frac{(m_i + \tilde{\mu}_i)(1-\tilde{\mu}_e e_W W_M)}{\tilde{\mu}_i + \tilde{\mu}_e e_i} + \frac{(m_e - \tilde{\mu}_e)(e_i + e_W W_M \tilde{\mu}_i)}{\tilde{\mu}_i + \tilde{\mu}_e e_i} + 1\right]\hat{W}$$

$$+\left[-\frac{(m_i + \tilde{\mu}_i)(\tilde{\mu}_{i*} - e_{i*}\tilde{\mu}_e)}{\tilde{\mu}_i + \tilde{\mu}_e e_i} + (m_{i^*} + \tilde{\mu}_{i*}) + \frac{(m_e - \tilde{\mu}_e)(e_{i*}\tilde{\mu}_i + e_i\tilde{\mu}_{i*})}{\tilde{\mu}_i + \tilde{\mu}_e e_i}\right]\hat{i}^*$$

$$\Rightarrow \hat{I} = \left[\frac{-m_i(1-\tilde{\mu}_e e_W W_M) + m_e(e_i + e_W W_M \tilde{\mu}_i)}{\tilde{\mu}_i + \tilde{\mu}_e e_i}\right] W_M \hat{M}$$

$$+ \frac{\{-m_i(\tilde{\mu}_{i*} - e_{i*}\tilde{\mu}_e) + m_{i^*}(\tilde{\mu}_i + \tilde{\mu}_e e_i)\} + m_e(e_{i*}\tilde{\mu}_i + e_i\tilde{\mu}_{i*})}{\tilde{\mu}_i + \tilde{\mu}_e e_i}\hat{i}^* \qquad \text{(A.4.4)}$$

For $\hat{i}^* = 0$, the condition for an increase in money supply raising domestic investment can be obtained from (A.4.4) as:

$$m_e[e_i + e_W W_M \tilde{\mu}_i] > m_i[1 - e_W W_M \tilde{\mu}_e]$$

which is the condition stated in (4.24) in the text.

Let:

$$\beta_M \equiv \left[\frac{m_e(e_i + e_W W_M \tilde{\mu}_i) - m_i(1-\tilde{\mu}_e e_W W_M)}{\tilde{\mu}_i + \tilde{\mu}_e e_i}\right] W_M \qquad \text{(A.4.5)}$$

$$\beta_{i*} \equiv \left[\frac{m_e(e_{i*}\tilde{\mu}_i + e_i\tilde{\mu}_{i*}) - \{m_i(\tilde{\mu}_{i*} - e_{i*}\tilde{\mu}_e) - m_{i^*}(\tilde{\mu}_i + \tilde{\mu}_e e_i)\}}{\tilde{\mu}_i + \tilde{\mu}_e e_i}\right] \qquad \text{(A.4.6)}$$

Note that $\beta_M > 0$ by the condition stated above (and in (4.24) in the text), and $\beta_{i*} > 0$ by the condition stated in (4.46) in the text.

A.3 Derivation of $P_N(Q)$ schedule

Using (4.6) in the text, the percentage change form of the capital constraint (4.17) gives us:

$$\hat{I} = \frac{a_{KT}X_T}{\overline{K}}\hat{X}_T + \frac{a_{KN}X_N}{\overline{K}}\hat{X}_N + \frac{a_{SZ}(Q)X_Z}{\overline{K}}\left(\frac{\partial a_{KZ}(Q)}{\partial Q}\frac{Q}{a_{KZ}(Q)}\hat{Q} + \hat{X}_Z\right)$$

$$\Rightarrow \hat{I} = \lambda_{KT}\hat{X}_T + \lambda_{KN}\hat{X}_N + \lambda_{KZ}(\gamma_{KZ}\hat{Q} + \hat{X}_Z) \qquad \text{(A.4.7)}$$

Percentage change form of the skilled labour constraint (4.16) gives us the rate at which output of Z changes with its quality:

$$0=\left(\frac{\partial a_{SZ}(Q)}{\partial Q}\frac{Q}{a_{SZ}(Q)}\hat{Q}+\hat{X}_Z\right)\frac{a_{SZ}(Q)X_Z}{\bar{S}}$$
$$\Rightarrow \hat{X}_Z=-\gamma_{SZ}\hat{Q} \quad \text{(A.4.8)}$$

Note that the term in the parenthesis on the right hand side in (A.4.7) is the proportional change in the capital requirement in the Z sector, which using (A.4.8) boils down to the following expression:

$$\hat{K}_Z=\gamma_{KZ}\hat{Q}+\hat{Z}=(\gamma_{KZ}-\gamma_{SZ})\hat{Q} \quad \text{(A.4.9)}$$

Now, substituting (A.4.4) – using (A.4.5) and (A.4.6) – and (A.4.9) back in (A.4.7) gives:

$$\lambda_{KT}\hat{X}_T+\lambda_{KN}\hat{X}_N=\beta_M\hat{M}+\beta_{i*}\hat{i}^*+\lambda_{KZ}(\gamma_{SZ}-\gamma_{KZ})\hat{Q} \quad \text{(A.4.10)}$$

Percentage change form of the labour constraint (4.18), using $L_b=I$, will give:

$$\lambda_{LT}\hat{X}_T+\lambda_{LN}\hat{X}_N+\lambda_{Lb}\hat{I}=0$$
$$\Rightarrow \lambda_{LT}\hat{X}_T+\lambda_{LN}\hat{X}_N=-\lambda_{Lb}\left\{\beta_M\hat{M}+\beta_{i*}\hat{i}^*\right\} \quad \text{(A.4.11)}$$

Representing (A.4.11) and (A.4.10) in matrix notation, I obtain:

$$\begin{bmatrix}\lambda_{LT} & \lambda_{LN}\\ \lambda_{KT} & \lambda_{KN}\end{bmatrix}\begin{bmatrix}\hat{X}_T\\ \hat{X}_N\end{bmatrix}=\begin{bmatrix}-\lambda_{Lb}\left\{\beta_M\hat{M}+\beta_{i*}\hat{i}^*\right\}\\ \beta_M\hat{M}+\beta_{i*}\hat{i}^*+\lambda_{KZ}(\gamma_{SZ}-\gamma_{KZ})\hat{Q}\end{bmatrix}$$

Solving for the values of $\hat{X}_T$ and $\hat{X}_N$ by Cramer's rule yields output changes as:

$$\hat{X}_T=\frac{-\lambda_{KN}\lambda_{Lb}\left\{\beta_M\hat{M}+\beta_{i*}\hat{i}^*\right\}-\lambda_{LN}\left[\beta_M\hat{M}+\beta_{i*}\hat{i}^*+\lambda_{KZ}(\gamma_{SZ}-\gamma_{KZ})\right]\hat{Q}}{|\lambda|}$$

$$\Rightarrow \hat{X}_T=\frac{-\left[\lambda_{KN}\lambda_{Lb}+\lambda_{LN}\right]\beta_M\hat{M}-\left[\lambda_{KN}\lambda_{Lb}+\lambda_{LN}\right]\beta_{i*}\hat{i}^*-\lambda_{LN}\lambda_{KZ}(\gamma_{SZ}-\gamma_{KZ})\hat{Q}}{|\lambda|} \quad \text{(A.4.12)}$$

$$\hat{X}_N=\frac{\left[\lambda_{KT}\lambda_{Lb}+\lambda_{LT}\right]\beta_M\hat{M}+\left[\lambda_{KT}\lambda_{Lb}+\lambda_{LT}\right]\beta_{i*}\hat{i}^*+\lambda_{LT}\lambda_{KZ}(\gamma_{SZ}-\gamma_{KZ})\hat{Q}}{|\lambda|} \quad \text{(A.4.13)}$$

The market clearing condition in the non traded sector under homothetic tastes gives the following relationship:

$$-\varepsilon_N(\hat{P}_N-\hat{e})=\hat{X}_N-\hat{X}_T \quad \text{(A.4.14)}$$

Using (A.4.12) and (A.4.13), this boils down to:

$$-\varepsilon_N\left(\hat{P}_N-\hat{e}\right)=\frac{1}{|\lambda|}\left[\left\{\lambda_{LT}+\lambda_{LN}+\lambda_{Lb}(\lambda_{KT}+\lambda_{KN})\right\}\left(\beta_M\hat{M}+\beta_{i*}\hat{i}^*\right)+\lambda_{KZ}(\lambda_{LN}+\lambda_{LT})(\gamma_{SZ}-\gamma_{KZ})\hat{Q}\right]$$

Letting $\tilde{\lambda} = \lambda_{LT} + \lambda_{LN} + \lambda_{Lb}(\lambda_{KT} + \lambda_{KN})$ and $\bar{\lambda} = \lambda_{KZ}(\lambda_{LT} + \lambda_{LN})$, this can further be reduced to:

$$-\varepsilon_N\left(\hat{P}_N - \hat{e}\right) = \frac{1}{|\lambda|}\left[\tilde{\lambda}\left(\beta_M \hat{M} + \beta_{i*}\hat{i}^*\right) + \bar{\lambda}(\gamma_{SZ} - \gamma_{KZ})\hat{Q}\right]$$

$$\Rightarrow \hat{P}_N - \hat{e} = -\frac{1}{\varepsilon_N|\lambda|}\left[\tilde{\lambda}\left(\beta_M \hat{M} + \beta_{i*}\hat{i}^*\right) + \bar{\lambda}(\gamma_{SZ} - \gamma_{KZ})\hat{Q}\right] \qquad \text{(A.4.15)}$$

Finally substituting expression for $\hat{e}$ as given in (A.4.1) above, the change in the price of the non-traded good can be obtained as follows:

$$\hat{P}_N - \left[\frac{(e_i + e_W W_M \tilde{\mu}_i)}{\tilde{\mu}_i + \tilde{\mu}_e e_i}\hat{M} + \frac{(e_{i*}\tilde{\mu}_i + e_i \tilde{\mu}_{i*})}{\tilde{\mu}_i + \tilde{\mu}_e e_i}\hat{i}^*\right] = -\frac{1}{\varepsilon_N|\lambda|}\left[\tilde{\lambda}\left(\beta_M \hat{M} + \beta_{i*}\hat{i}^*\right) + \bar{\lambda}(\gamma_{SZ} - \gamma_{KZ})\hat{Q}\right]$$

$$\Rightarrow \hat{P}_N = \left[\frac{(e_i + e_W W_M \tilde{\mu}_i)}{\tilde{\mu}_i + \tilde{\mu}_e e_i} - \frac{\tilde{\lambda}\beta_M}{\varepsilon_N|\lambda|}\right]\hat{M} + \left[\frac{(e_{i*}\tilde{\mu}_i + e_i \tilde{\mu}_{i*})}{\tilde{\mu}_i + \tilde{\mu}_e e_i} - \frac{\tilde{\lambda}\beta_{i*}}{\varepsilon_N|\lambda|}\right]\hat{i}^* - \frac{\bar{\lambda}(\gamma_{SZ} - \gamma_{KZ})}{\varepsilon_N|\lambda|}\hat{Q}$$

(A.4.16)

For $\hat{M} = 0$ and $\hat{i}^* = 0$, (A.4.16) gives us a relationship between Q and P_N consistent with the market-clearing condition for the non-traded good as captured by the $P_N(Q)$ curve in the text:

$$\hat{P}_N = -\frac{\bar{\lambda}(\gamma_{SZ} - \gamma_{KZ})}{\varepsilon_N\,|\,\lambda\,|}\hat{Q} \qquad \text{(A.4.16a)}$$

A.4. <u>Derivation of $Q(P_N)$ schedule</u>

From the zero profit conditions for good T and good N we can obtain:

$$\hat{w} = \frac{\theta_{KN}\hat{e} - \theta_{KT}\hat{P}_N}{|\,\theta\,|} \;;\; \hat{r} = \frac{\theta_{LT}\hat{P}_N - \theta_{LN}\hat{e}}{|\,\theta\,|} \qquad \text{(A.4.17)}$$

Note, $|\theta| < 0$ by the factor-intensity condition (4.21) in the text.

From the zero profit condition in the Z sector we get:

$$eP_Z^{W'}(Q)dQ + P_Z^W(Q)de = w_S\,\frac{\partial a_{SZ}(Q)}{\partial Q}dQ + a_{SZ}(Q)dw_S + r\,\frac{\partial a_{KZ}(Q)}{\partial Q}dQ + a_{KZ}(Q)dr \qquad \text{(A.4.18)}$$

Using the marginal condition for quality choice given by (4.4) in (A.4.18), the change in skilled wage can be obtained as:

$$\hat{w}_S = \frac{\hat{e}}{\theta_{SZ}} - \frac{\theta_{KZ}\hat{r}}{\theta_{SZ}} \qquad \text{(A.4.19)}$$

The change in quality can be obtained from total differentiation of the marginal condition:

$$eP_Z^{W''}(Q)dQ + P_Z^{W'}de = a''_{SZ}(Q)dQw_S + a'_{SZ}(Q)dw_S + ra''_{KZ}(Q)dQ + a'_{KZ}(Q)dr$$

$$\Rightarrow \frac{Q^2}{eP_Z^W}\delta\hat{Q} + \frac{QP_Z^{W'}}{P_Z^W}\hat{e} = \frac{a_{SZ}(Q)w_S}{eP_Z^W}\left[\frac{Qa'_{SZ}(Q)}{a_{SZ}(Q)}\right]\hat{w}_S + \frac{a_{KZ}(Q)r}{eP_Z^W}\left[\frac{Qa'_{KZ}(Q)}{a_{KZ}(Q)}\right]\hat{r}$$

$$\Rightarrow \frac{Q^2}{eP_Z^W}\delta\hat{Q} + \gamma_Z\hat{e} = \theta_{SZ}\gamma_{SZ}\hat{w}_S + \theta_{KZ}\gamma_{KZ}\hat{r}$$

where, $\delta \equiv \left[eP_Z^{W''}(Q) - w_S a''_{SZ}(Q)dQ - ra''_{KZ}(Q)dQ\right] < 0$ by the second order condition for profit maximization, and $\gamma_Z \equiv \frac{QP_Z^{W'}(Q)}{P_Z^W}$ is the quality elasticity of the foreign-currency price of good Z.

Using $\gamma_Z = \theta_{SZ}\gamma_{SZ} + \theta_{KZ}\gamma_{KZ}$ and substitution of (A.4.17), the above expression can be written as:

$$\frac{Q^2}{eP_Z^W}\delta\hat{Q} + (\gamma_{KZ}\theta_{KZ} + \gamma_{SZ}\theta_{SZ})\hat{e} = \theta_{SZ}\gamma_{SZ}\left[\frac{\hat{e}}{\theta_{SZ}} - \frac{\theta_{KZ}\hat{r}}{\theta_{SZ}}\right] + \theta_{KZ}\gamma_{KZ}\hat{r}$$

$$\Rightarrow \frac{Q^2}{eP_Z^W}\delta\hat{Q} + (\gamma_{KZ}\theta_{KZ} + \gamma_{SZ}\theta_{SZ})\hat{e} = \gamma_{SZ}\hat{e} + \theta_{KZ}(\gamma_{KZ} - \gamma_{SZ})\hat{r}$$

$$\Rightarrow \frac{Q^2}{eP_Z^W}\delta\hat{Q} = \theta_{KZ}(\gamma_{SZ} - \gamma_{KZ})\hat{e} + \theta_{KZ}(\gamma_{KZ} - \gamma_{SZ})\left[\frac{\theta_{LT}\hat{P}_N - \theta_{LN}\hat{e}}{|\theta|}\right]$$

$$\Rightarrow \frac{Q^2}{eP_Z^W}\delta\hat{Q} = \theta_{KZ}(\gamma_{SZ} - \gamma_{KZ})\left[1 + \frac{\theta_{LN}}{|\theta|}\right]\hat{e} + \theta_{KZ}(\gamma_{KZ} - \gamma_{SZ})\frac{\theta_{LT}\hat{P}_N}{|\theta|}$$

$$\Rightarrow \frac{Q^2}{eP_Z^W}\delta\hat{Q} = \theta_{KZ}(\gamma_{SZ} - \gamma_{KZ})\frac{\theta_{LT}}{|\theta|}\hat{e} + \theta_{KZ}(\gamma_{KZ} - \gamma_{SZ})\frac{\theta_{LT}}{|\theta|}\hat{P}_N$$

$$\Rightarrow \hat{Q} = \frac{\theta_{KZ}\theta_{LT}}{\phi\delta\,|\theta|}(\gamma_{KZ} - \gamma_{SZ})\left[\hat{P}_N - \hat{e}\right] \qquad \text{(A.4.20)}$$

where, $\phi \equiv \frac{Q^2}{eP_Z^W}$.

For any given exchange rate, (A.4.20) gives us the slope of the $Q(P_N)$ schedule, which is positive if $\gamma_{KZ} > \gamma_{SZ}$ and negative if $\gamma_{KZ} < \gamma_{SZ}$ since $\delta < 0$ and $|\theta| < 0$, as shown in Figure 4.2 in the text.

A.5 An Increase in Money Supply and Export Quality

Substitution of (A.4.1) in (A.4.20) yields:

$$\hat{Q} = \frac{\theta_{KZ}\theta_{LT}}{\phi\delta\,|\theta|}(\gamma_{KZ} - \gamma_{SZ})\hat{P}_N - \frac{\theta_{KZ}\theta_{LT}}{\phi\delta\,|\theta|}(\gamma_{KZ} - \gamma_{SZ})\left\{\frac{(e_i + e_W W_M \tilde{\mu}_i)}{\tilde{\mu}_i + \tilde{\mu}_e e_i}\hat{M} + \frac{(e_{i*}\tilde{\mu}_i + e_i\tilde{\mu}_{i*})}{\tilde{\mu}_i + \tilde{\mu}_e e_i}\hat{i}^*\right\} \quad \text{(A.4.20a)}$$

Write (A.4.16) and (A.4.20a) in matrix notation:

$$\begin{bmatrix} 1 & \dfrac{\overline{\lambda}(\gamma_{SZ} - \gamma_{KZ})}{\varepsilon_N|\lambda|} \\ -\dfrac{\theta_{KZ}\theta_{LT}}{\phi\delta\,|\theta|}(\gamma_{KZ} - \gamma_{SZ}) & 1 \end{bmatrix}\begin{bmatrix} \hat{P}_N \\ \hat{e} \end{bmatrix} = \begin{bmatrix} \left\{\dfrac{(e_i + e_W W_M \tilde{\mu}_i)}{\tilde{\mu}_i + \tilde{\mu}_e e_i} - \dfrac{\tilde{\lambda}\beta_M}{\varepsilon_N|\lambda|}\right\}\hat{M} + \left\{\dfrac{(e_{i*}\tilde{\mu}_i + e_i\tilde{\mu}_{i*})}{\tilde{\mu}_i + \tilde{\mu}_e e_i} - \dfrac{\tilde{\lambda}\beta_{i*}}{\varepsilon_N|\lambda|}\right\}\hat{i}^* \\ -\dfrac{\theta_{KZ}\theta_{LT}}{\phi\delta\,|\theta|}(\gamma_{KZ} - \gamma_{SZ})\left\{\dfrac{(e_i + e_W W_M \tilde{\mu}_i)}{\tilde{\mu}_i + \tilde{\mu}_e e_i}\hat{M} + \dfrac{(e_{i*}\tilde{\mu}_i + e_i\tilde{\mu}_{i*})}{\tilde{\mu}_i + \tilde{\mu}_e e_i}\hat{i}^*\right\} \end{bmatrix}$$

Note that the determinant of the coefficient matrix is positive:

$$\Delta \equiv \left[1 - \frac{\theta_{KZ}\theta_{LT}\overline{\lambda}}{\phi\delta\varepsilon_N\,|\theta||\lambda|}(\gamma_{SZ} - \gamma_{KZ})^2\right] > 0\,.$$

Solving changes in price of the non-traded good and export-quality I get:

$$\hat{P}_N = \frac{1}{\Delta}\left[\begin{array}{l} \left\{\dfrac{(e_i + e_W W_M \tilde{\mu}_i)}{\tilde{\mu}_i + \tilde{\mu}_e e_i} - \dfrac{\tilde{\lambda}\beta_M}{\varepsilon_N|\lambda|}\right\}\hat{M} + \left\{\dfrac{(e_{i*}\tilde{\mu}_i + e_i\tilde{\mu}_{i*})}{\tilde{\mu}_i + \tilde{\mu}_e e_i} - \dfrac{\tilde{\lambda}\beta_{i*}}{\varepsilon_N|\lambda|}\right\}\hat{i}^* \\ \quad + \dfrac{\overline{\lambda}(\gamma_{SZ} - \gamma_{KZ})}{\varepsilon_N|\lambda|}\dfrac{\theta_{KZ}\theta_{LT}}{\phi\delta\,|\theta|}(\gamma_{KZ} - \gamma_{SZ})\left\{\dfrac{(e_i + e_W W_M \tilde{\mu}_i)}{\tilde{\mu}_i + \tilde{\mu}_e e_i}\hat{M} + \dfrac{(e_{i*}\tilde{\mu}_i + e_i\tilde{\mu}_{i*})}{\tilde{\mu}_i + \tilde{\mu}_e e_i}\hat{i}^*\right\} \end{array}\right]$$

$$\Rightarrow \hat{P}_N = \frac{1}{\Delta}\left[\begin{array}{l} \left\{\dfrac{(e_i + e_W W_M \tilde{\mu}_i)}{\tilde{\mu}_i + \tilde{\mu}_e e_i} - \dfrac{\tilde{\lambda}\beta_M}{\varepsilon_N|\lambda|} - \dfrac{\overline{\lambda}\,\theta_{KZ}\theta_{LT}}{\phi\delta\varepsilon_N\,|\theta||\lambda|}(\gamma_{SZ} - \gamma_{KZ})^2\,\dfrac{(e_i + e_W W_M \tilde{\mu}_i)}{\tilde{\mu}_i + \tilde{\mu}_e e_i}\right\}\hat{M} \\ \quad + \left\{\dfrac{(e_{i*}\tilde{\mu}_i + e_i\tilde{\mu}_{i*})}{\tilde{\mu}_i + \tilde{\mu}_e e_i} - \dfrac{\tilde{\lambda}\beta_{i*}}{\varepsilon_N|\lambda|} - \dfrac{\overline{\lambda}\,\theta_{KZ}\theta_{LT}}{\phi\delta\varepsilon_N\,|\theta||\lambda|}(\gamma_{SZ} - \gamma_{KZ})^2\,\dfrac{(e_{i*}\tilde{\mu}_i + e_i\tilde{\mu}_{i*})}{\tilde{\mu}_i + \tilde{\mu}_e e_i}\right\}\hat{i}^* \end{array}\right] \quad \text{(A.4.21)}$$

$$\hat{Q} = \frac{1}{\Delta}\left[\begin{array}{l} -\dfrac{\theta_{KZ}\theta_{LT}}{\phi\delta\,|\theta|}(\gamma_{KZ} - \gamma_{SZ})\left\{\dfrac{(e_i + e_W W_M \tilde{\mu}_i)}{\tilde{\mu}_i + \tilde{\mu}_e e_i}\hat{M} + \dfrac{(e_{i*}\tilde{\mu}_i + e_i\tilde{\mu}_{i*})}{\tilde{\mu}_i + \tilde{\mu}_e e_i}\hat{i}^*\right\} \\ \quad + \dfrac{\theta_{KZ}\theta_{LT}}{\phi\delta\,|\theta|}(\gamma_{KZ} - \gamma_{SZ})\left[\left\{\dfrac{(e_i + e_W W_M \tilde{\mu}_i)}{\tilde{\mu}_i + \tilde{\mu}_e e_i} - \dfrac{\tilde{\lambda}\beta_M}{\varepsilon_N|\lambda|}\right\}\hat{M} + \left\{\dfrac{(e_{i*}\tilde{\mu}_i + e_i\tilde{\mu}_{i*})}{\tilde{\mu}_i + \tilde{\mu}_e e_i} - \dfrac{\tilde{\lambda}\beta_{i*}}{\varepsilon_N|\lambda|}\right\}\hat{i}^*\right] \end{array}\right]$$

$$\Rightarrow \hat{Q} = \frac{1}{\Delta}\left[-\frac{\tilde{\lambda}\,\theta_{KZ}\theta_{LT}\beta_M}{\phi\delta\varepsilon_N\,|\theta||\lambda|}(\gamma_{KZ} - \gamma_{SZ})\hat{M} - \frac{\tilde{\lambda}\,\theta_{KZ}\theta_{LT}\beta_{i*}}{\phi\delta\varepsilon_N\,|\theta||\lambda|}(\gamma_{KZ} - \gamma_{SZ})\hat{i}^*\right] \quad \text{(A.4.22)}$$

For $\hat{i}^* = 0$, (A.4.22) gives us the change in the export-quality following an increase in the money supply as in (4.26) in the text:

$$\hat{Q} = -\frac{\theta_{KZ}\theta_{LT}\tilde{\lambda}}{\Delta\phi\delta\varepsilon_N |\theta||\lambda|}(\gamma_{KZ} - \gamma_{SZ})\beta_M \hat{M} \tag{A.4.22a}$$

Also note that while for $\hat{i}^* = 0$, it can be seen from (A.4.21) that P_N rises unambiguously as a consequence of the increase in the money supply, from (A.4.15) it can be checked, using $\hat{Q} = 0$, that P_N rises more than *e at the initial export-quality* as mentioned in the text explaining the rise in Q when $\gamma_{KZ} > \gamma_{SZ}$.

$$\hat{P}_N - \hat{e} = -\frac{\tilde{\lambda}}{\varepsilon_N |\lambda|}\beta_M \hat{M} \tag{A.4.15a}$$

A.6 <u>An Increase in Money Supply and Wage Inequality: Flexible unskilled money wage</u>

From (A.4.19), I can obtain the change in the skilled wage as:

$$\hat{w}_S = \frac{\hat{e}}{\theta_{SZ}} - \frac{\theta_{KZ}}{\theta_{SZ}}\left[\frac{\theta_{LT}\hat{P}_N - \theta_{LN}\hat{e}}{|\theta|}\right]$$

Subtracting from it the change in the unskilled wage as given in (A.4.17), the change in wage inequality can be obtained as follows:

$$\hat{w}_S - \hat{w} = \left[\frac{1}{\theta_{SZ}} + \frac{\theta_{KZ}\theta_{LN}}{\theta_{SZ}|\theta|} - \frac{\theta_{KN}}{|\theta|}\right]\hat{e} - \left[\frac{\theta_{KZ}\theta_{LT}}{\theta_{SZ}|\theta|} - \frac{\theta_{KT}}{|\theta|}\right]\hat{P}_N$$

Using $|\theta| = \theta_{LT} - \theta_{LN}$, $\theta_{SZ} + \theta_{KZ} = 1$ and $\theta_{LN} + \theta_{KN} = 1$, this boils down to:

$$\hat{w}_S - \hat{w} = -\frac{(\theta_{LT} - \theta_{SZ})}{\theta_{SZ}|\theta|}(\hat{P}_N - \hat{e}) \tag{A.4.23}$$

Setting $\hat{i}^* = 0$ and subtracting $\hat{e}$ in (A.4.1) from (A.4.21), I obtain change in the reciprocal of real exchange rate following an increase in money supply as:

$$\hat{P}_N - \hat{e} = \frac{1}{\Delta}\left[\left\{\frac{(e_i + e_W W_M \tilde{\mu}_i)}{\tilde{\mu}_i + \tilde{\mu}_e e_i} - \frac{\tilde{\lambda}\beta_M}{\varepsilon_N|\lambda|} - \frac{\bar{\lambda}\,\theta_{KZ}\theta_{LT}}{\phi\delta\varepsilon_N|\theta||\lambda|}(\gamma_{SZ} - \gamma_{KZ})^2\frac{(e_i + e_W W_M \tilde{\mu}_i)}{\tilde{\mu}_i + \tilde{\mu}_e e_i}\right\}\hat{M}\right] - \frac{(e_i + e_W W_M \tilde{\mu}_i)}{\tilde{\mu}_i + \tilde{\mu}_e e_i}\hat{M}$$

$$\Rightarrow \hat{P}_N - \hat{e} = -\frac{\tilde{\lambda}}{\varepsilon_N \Delta|\lambda|}\beta_M \hat{M} \tag{A.4.24}$$

Comparing (A.4.24) and (A.4.15a) it appears that rise in reciprocal of the real exchange rate is mitigated to some extent by the change in the export-quality since $\Delta > 1$ by definition.

Substitution of (A.4.24) in (A.4.23) yields:

$$\hat{w}_S - \hat{w} = \frac{\tilde{\lambda}(\theta_{LT} - \theta_{SZ})}{\varepsilon_N \Delta \theta_{SZ} |\lambda| |\theta|} \beta_M \hat{M} \tag{A.4.25}$$

A.7 <u>Change in θ_{SZ} with change in Q</u>

By definition,

$$\theta_{SZ} = \frac{a_{SZ}(Q) w_S}{P_Z^W(Q)} \Rightarrow P_Z^W(Q)\theta_{SZ} = a_{SZ}(Q) w_S$$

Since, as shown above, by envelope theorem the skilled wage does not change with the quality level, so differentiation of the above yields:

$$P_Z^{W'}(Q)\theta_{SZ} dQ + P_Z^W d\theta_{SZ} = a'_{SZ}(Q) w_S dQ$$

$$\Rightarrow P_Z^W \theta_{SZ} \left[\frac{Q P_Z^{W'}(Q)}{P_Z^W} \frac{dQ}{Q} + \frac{d\theta_{SZ}}{\theta_{SZ}} \right] = a_{SZ} w_S \frac{Q a'_{SZ}(Q)}{a_{SZ}} \frac{dQ}{Q}$$

$$\Rightarrow \left[\gamma_Z \hat{Q} + \hat{\theta}_{SZ} \right] = \gamma_{SZ} \hat{Q}$$

$$\Rightarrow \hat{\theta}_{SZ} = [\gamma_{SZ} - \gamma_Z] \hat{Q} \tag{A.4.26}$$

Since $\gamma_Z = \theta_{SZ}\gamma_{SZ} + \theta_{KZ}\gamma_{KZ}$, so $\gamma_{SZ} > \gamma_Z$ if $\gamma_{SZ} > \gamma_{KZ}$. That is, by (A.4.26), θ_{SZ} rises with a rise in Q if higher quality varieties are more skill-intensive ($\gamma_{SZ} > \gamma_{KZ}$).

A.7 <u>An Increase in Money Supply and Export-Quality: Segmented Labour market</u>

From the marginal condition, I have already derived the following:

$$\phi \delta \hat{Q} = \theta_{KZ}(\gamma_{SZ} - \gamma_{KZ})\hat{e} + \theta_{KZ}(\gamma_{KZ} - \gamma_{SZ})\hat{r}$$

Substitution of $\hat{r} = \frac{\hat{e}}{\theta_{KT}} = \frac{1}{\theta_{KT}} \frac{(e_i + e_W W_M \tilde{\mu}_i)}{\tilde{\mu}_i + \tilde{\mu}_e e_i} \hat{M}$ as in (4.31) in the text, this boils down to:

$$\phi\delta\hat{Q} = \theta_{KZ}(\gamma_{SZ} - \gamma_{KZ})\hat{e} + \theta_{KZ}(\gamma_{KZ} - \gamma_{SZ})\frac{\hat{e}}{\theta_{KT}}$$

$$= \left[\frac{1-\theta_{KT}}{\theta_{KT}}\right]\theta_{KZ}(\gamma_{KZ} - \gamma_{SZ})\hat{e} = \frac{\theta_{LT}\theta_{KZ}}{\theta_{KT}}(\gamma_{KZ} - \gamma_{SZ})\hat{e}$$

$$= \frac{\theta_{LT}\theta_{KZ}}{\theta_{KT}}(\gamma_{KZ} - \gamma_{SZ})\frac{(e_i + e_W W_M \tilde{\mu}_i)}{\tilde{\mu}_i + \tilde{\mu}_e e_i}\hat{M}$$

$$\Rightarrow \hat{Q} = \frac{\theta_{LT}\theta_{KZ}}{\phi\delta\theta_{KT}}(\gamma_{KZ} - \gamma_{SZ})\frac{(e_i + e_W W_M \tilde{\mu}_i)}{\tilde{\mu}_i + \tilde{\mu}_e e_i}\hat{M} \qquad \text{(A.4.27)}$$

This is the expression in (4.35) in the text.

A.8 <u>An Increase in Money Supply and Wage Inequality: Segmented Labour market</u>

Since under rigid unskilled money wage in the formal composite traded sector, export-quality is not affected by changes in P_N and is affected *only* by the exchange rate, whereas P_N is affected by the export quality, so substitution of (A.4.27) in (A.4.16) yields (for $\hat{i}^* = 0$):

$$\hat{P}_N = \left[\frac{(e_i + e_W W_M \tilde{\mu}_i)}{\tilde{\mu}_i + \tilde{\mu}_e e_i} - \frac{\tilde{\lambda}\beta_M}{\varepsilon_N|\lambda|}\right]\hat{M} - \frac{\overline{\lambda}(\gamma_{SZ} - \gamma_{KZ})}{\varepsilon_N|\lambda|}\frac{\theta_{LT}\theta_{KZ}}{\phi\delta\theta_{KT}}(\gamma_{KZ} - \gamma_{SZ})\frac{(e_i + e_W W_M \tilde{\mu}_i)}{\tilde{\mu}_i + \tilde{\mu}_e e_i}\hat{M}$$

Rearranging yields the expression as in (4.37) in the text:

$$\hat{P}_N = \left[-\frac{1}{\varepsilon_N\,|\,\lambda\,|}\left\{\tilde{\lambda} - \overline{\lambda}\,\frac{eP_Z^W\theta_{KZ}\theta_{LT}(\gamma_{SZ} - \gamma_{KZ})^2}{\delta Q^2\theta_{KT}}\frac{(e_i + e_W W_M \tilde{\mu}_i)}{\tilde{\mu}_i + \tilde{\mu}_e e_i}\right\} + \frac{(e_i + e_W W_M \tilde{\mu}_i)}{\tilde{\mu}_i + \tilde{\mu}_e e_i}\right]\hat{M}$$

(A.4.28)

Change in the informal unskilled wage can be obtained from the zero-profit condition for the non-traded good as:

$$\hat{w} = \frac{\hat{P}_N}{\theta_{LN}} - \frac{\theta_{KN}}{\theta_{LN}}\hat{r} = \frac{\hat{P}_N}{\theta_{LN}} - \frac{\theta_{KN}}{\theta_{LN}}\frac{\hat{e}}{\theta_{KT}}$$

Using (A.4.1) for $\hat{i}^* = 0$ and (A.4.28) this boils down to:

$$\hat{w} = \frac{1}{\theta_{LN}}\left[-\frac{1}{\varepsilon_N \mid \lambda \mid}\left\{\tilde{\lambda} - \bar{\lambda}\,\frac{eP_Z^W\theta_{KZ}\theta_{LT}(\gamma_{SZ}-\gamma_{KZ})^2}{\delta Q^2\theta_{KT}}\,\frac{(e_i + e_W W_M\tilde{\mu}_i)}{\tilde{\mu}_i + \tilde{\mu}_e e_i}\right\} + \frac{(e_i + e_W W_M\tilde{\mu}_i)}{\tilde{\mu}_i + \tilde{\mu}_e e_i}\right]\hat{M}$$
$$- \frac{\theta_{KN}}{\theta_{LN}\theta_{KT}}\frac{(e_i + e_W W_M\tilde{\mu}_i)}{\tilde{\mu}_i + \tilde{\mu}_e e_i}\hat{M}$$

$$\hat{w} = \frac{1}{\theta_{LN}}\left[\begin{array}{l} -\dfrac{1}{\varepsilon_N \mid \lambda \mid}\left\{\tilde{\lambda} - \bar{\lambda}\,\dfrac{eP_Z^W\theta_{KZ}\theta_{LT}(\gamma_{SZ}-\gamma_{KZ})^2}{\delta Q^2\theta_{KT}}\,\dfrac{(e_i + e_W W_M\tilde{\mu}_i)}{\tilde{\mu}_i + \tilde{\mu}_e e_i}\right\} \\ \qquad + \left[\dfrac{\theta_{KT}-\theta_{KN}}{\theta_{KT}}\right]\dfrac{(e_i + e_W W_M\tilde{\mu}_i)}{\tilde{\mu}_i + \tilde{\mu}_e e_i} \end{array}\right]\hat{M}$$

This is the expression in (4.38) in the text. Finally, subtracting this from $\hat{w}_S = \left[\frac{\theta_{KT}-\theta_{KZ}}{\theta_{SZ}\theta_{KT}}\right]\hat{e}$, the change in wage inequality is obtained as:

$$\hat{w}_S - \hat{w} = \left[\frac{\theta_{KT}-\theta_{KZ}}{\theta_{SZ}\theta_{KT}}\right]\frac{(e_i + e_W W_M\tilde{\mu}_i)}{\tilde{\mu}_i + \tilde{\mu}_e e_i}\hat{M}$$
$$-\frac{1}{\theta_{LN}}\left[-\frac{1}{\varepsilon_N \mid \lambda \mid}\left\{\tilde{\lambda} - \bar{\lambda}\,\frac{eP_Z^W\theta_{KZ}\theta_{LT}(\gamma_{SZ}-\gamma_{KZ})^2}{\delta Q^2\theta_{KT}}\,\frac{(e_i + e_W W_M\tilde{\mu}_i)}{\tilde{\mu}_i + \tilde{\mu}_e e_i}\right\} + \left[\frac{\theta_{KT}-\theta_{KN}}{\theta_{KT}}\right]\frac{(e_i + e_W W_M\tilde{\mu}_i)}{\tilde{\mu}_i + \tilde{\mu}_e e_i}\right]\hat{M}$$

$$\hat{w}_S - \hat{w} = \left[\frac{\theta_{KT}-\theta_{KZ}}{\theta_{SZ}\theta_{KT}} - \frac{\theta_{KT}-\theta_{KN}}{\theta_{LN}\theta_{KT}}\right]\frac{(e_i + e_W W_M\tilde{\mu}_i)}{\tilde{\mu}_i + \tilde{\mu}_e e_i}\hat{M}$$
$$+\frac{1}{\theta_{LN}}\left[\frac{1}{\varepsilon_N \mid \lambda \mid}\left\{\tilde{\lambda} - \bar{\lambda}\,\frac{eP_Z^W\theta_{KZ}\theta_{LT}(\gamma_{SZ}-\gamma_{KZ})^2}{\delta Q^2\theta_{KT}}\,\frac{(e_i + e_W W_M\tilde{\mu}_i)}{\tilde{\mu}_i + \tilde{\mu}_e e_i}\right\}\right]\hat{M}$$

Now, simplification of the first term on the right hand side yields:

$$\frac{\theta_{KT}-\theta_{KZ}}{\theta_{SZ}\theta_{KT}} - \frac{\theta_{KT}-\theta_{KN}}{\theta_{LN}\theta_{KT}} = \frac{\theta_{LN}\theta_{KT} - \theta_{LN}\theta_{KZ} - \theta_{SZ}\theta_{KT} + \theta_{SZ}\theta_{KN}}{\theta_{SZ}\theta_{KT}\theta_{LN}}$$
$$= \frac{(1-\theta_{KN})\theta_{KT} - (1-\theta_{KN})\theta_{KZ} - (1-\theta_{KZ})\theta_{KT} + (1-\theta_{KZ})\theta_{KN}}{\theta_{SZ}\theta_{KT}\theta_{LN}}$$
$$= \frac{\theta_{KT} - \theta_{KT}\theta_{KN} - \theta_{KZ} + \theta_{KN}\theta_{KZ} - \theta_{KT} + \theta_{KZ}\theta_{KT} + \theta_{KN} - \theta_{KZ}\theta_{KN}}{\theta_{SZ}\theta_{KT}\theta_{LN}}$$
$$= \frac{-\theta_{KT}(\theta_{KN}-\theta_{KZ}) + (\theta_{KN}-\theta_{KZ})}{\theta_{SZ}\theta_{KT}\theta_{LN}} = \frac{\theta_{LT}(\theta_{KN}-\theta_{KZ})}{\theta_{SZ}\theta_{KT}\theta_{LN}}$$

Substitution of this expression reduces the change in wage inequality to:

$$\hat{w}_S - \hat{w} = \left[\left\{ \frac{\theta_{LT}(\theta_{KN} - \theta_{KZ})}{\theta_{SZ}\theta_{KT}\theta_{LN}} \right\} \frac{(e_i + e_W W_M \tilde{\mu}_i)}{\tilde{\mu}_i + \tilde{\mu}_e e_i} + \frac{1}{\varepsilon_N \theta_{LN} |\lambda|} \left\{ \tilde{\lambda} - \bar{\lambda} \frac{eP_Z^W \theta_{KZ}\theta_{LT}(\gamma_{SZ} - \gamma_{KZ})^2}{\delta Q^2 \theta_{KT}} \frac{(e_i + e_W W_M \tilde{\mu}_i)}{\tilde{\mu}_i + \tilde{\mu}_e e_i} \right\} \right] \hat{M}$$

This is the expression in (4.39) in the text.

A.9. <u>Money Supply increase, export quality and employment: Fixed wage case</u>

Under uniform minimum unskilled wage, unskilled labour will not be fully employed. The change in aggregate employment in such a case will be weighted average of changes in the output levels of T, N and in the banking activity (or, the level of investment). Using (A.4.4) and $\hat{i}^* = 0$, this can be written as:

$$\hat{L}_e = \lambda_{LT}\hat{X}_T + \lambda_{LN}\hat{X}_N + \lambda_{Lb}\hat{I}$$

$$\Rightarrow \hat{L}_e = \lambda_{LT}\hat{X}_T + \lambda_{LN}\hat{X}_N + \lambda_{Lb}\beta_M\hat{M} \qquad \text{(A.4.28)}$$

Since the change in quality following an increase in the money supply is the same as under the segmented labour market case, so substitution of (A.4.27) in (A.4.10) for $\hat{i}^* = 0$ yields:

$$\lambda_{KT}\hat{X}_T + \lambda_{KN}\hat{X}_N = \beta_M\hat{M} - \frac{\lambda_{KZ}\theta_{LT}\theta_{KZ}}{\phi\delta\theta_{KT}} \frac{(e_i + e_W W_M \tilde{\mu}_i)}{\tilde{\mu}_i + \tilde{\mu}_e e_i} (\gamma_{KZ} - \gamma_{SZ})^2 \hat{M} \qquad \text{(A.4.29)}$$

Now, using (4.42) in the text, the market clearing condition (A.4.14) can be rewritten as:

$$\hat{X}_N - \hat{X}_T = \frac{-\varepsilon_N(\theta_{KN} - \theta_{KT})}{\theta_{KT}}\hat{e} = \frac{-\varepsilon_N|\theta|}{\theta_{KT}}\hat{e} = \frac{-\varepsilon_N|\theta|}{\theta_{KT}} \left\{ \frac{(e_i + e_W W_M \tilde{\mu}_i)}{\tilde{\mu}_i + \tilde{\mu}_e e_i} \right\} \hat{M} \qquad \text{(A.4.14a)}$$

Representing (A.4.29) and (A.4.14a) in matrix notation,

$$\begin{bmatrix} \lambda_{KT} & \lambda_{KN} \\ -1 & 1 \end{bmatrix} \begin{bmatrix} \hat{X}_T \\ \hat{X}_N \end{bmatrix} = \begin{bmatrix} \left\{ \beta_M - \frac{\lambda_{KZ}\theta_{LT}\theta_{KZ}}{\phi\delta\theta_{KT}} \frac{(e_i + e_W W_M \tilde{\mu}_i)}{\tilde{\mu}_i + \tilde{\mu}_e e_i} (\gamma_{KZ} - \gamma_{SZ})^2 \right\} \hat{M} \\ -\frac{\varepsilon_N|\theta|}{\theta_{KT}} \left\{ \frac{(e_i + e_W W_M \tilde{\mu}_i)}{\tilde{\mu}_i + \tilde{\mu}_e e_i} \right\} \hat{M} \end{bmatrix}$$

and solving for the values of $\hat{X}_T$ and $\hat{X}_N$ by applying Cramer's rule yields:

$$\hat{X}_T = \frac{\left[\left\{ \beta_M - \frac{\lambda_{KZ}\theta_{LT}\theta_{KZ}}{\phi\delta\theta_{KT}} \frac{(e_i + e_W W_M \tilde{\mu}_i)}{\tilde{\mu}_i + \tilde{\mu}_e e_i} (\gamma_{KZ} - \gamma_{SZ})^2 \right\} + \lambda_{KN} \frac{\varepsilon_N|\theta|}{\theta_{KT}} \frac{(e_i + e_W W_M \tilde{\mu}_i)}{\tilde{\mu}_i + \tilde{\mu}_e e_i} \right]}{\lambda_{KT} + \lambda_{KN}} \hat{M}$$

(A.4.30)

$$\hat{X}_N = \frac{\left[\left\{\beta_M - \frac{\lambda_{KZ}\theta_{LT}\theta_{KZ}}{\phi\delta\theta_{KT}}\frac{(e_i + e_W W_M \tilde{\mu}_i)}{\tilde{\mu}_i + \tilde{\mu}_e e_i}\left(\gamma_{KZ} - \gamma_{SZ}\right)^2\right\} - \lambda_{KT}\frac{\varepsilon_N\,|\,\theta\,|}{\theta_{KT}}\frac{(e_i + e_W W_M \tilde{\mu}_i)}{\tilde{\mu}_i + \tilde{\mu}_e e_i}\right]}{\lambda_{KT} + \lambda_{KN}}\hat{M}$$

(A.4.31)

Substitution of (A.4.30) and (A.4.31) in (A.4.28) yields the change in aggregate employment following an increase in the money supply:

$$\hat{L}_e = \frac{\lambda_{LT}\left[\left\{\beta_M - \frac{\lambda_{KZ}\theta_{LT}\theta_{KZ}}{\phi\delta\theta_{KT}}\frac{(e_i + e_W W_M \tilde{\mu}_i)}{\tilde{\mu}_i + \tilde{\mu}_e e_i}\left(\gamma_{KZ} - \gamma_{SZ}\right)^2\right\} + \lambda_{KN}\frac{\varepsilon_N\,|\,\theta\,|}{\theta_{KT}}\frac{(e_i + e_W W_M \tilde{\mu}_i)}{\tilde{\mu}_i + \tilde{\mu}_e e_i}\right]\hat{M}}{\lambda_{KT} + \lambda_{KN}} + \lambda_{Lb}\beta_M\hat{M}$$

$$+ \frac{\lambda_{LN}\left[\left\{\beta_M - \frac{\lambda_{KZ}\theta_{LT}\theta_{KZ}}{\phi\delta\theta_{KT}}\frac{(e_i + e_W W_M \tilde{\mu}_i)}{\tilde{\mu}_i + \tilde{\mu}_e e_i}\left(\gamma_{KZ} - \gamma_{SZ}\right)^2\right\} - \lambda_{KT}\frac{\varepsilon_N\,|\,\theta\,|}{\theta_{KT}}\frac{(e_i + e_W W_M \tilde{\mu}_i)}{\tilde{\mu}_i + \tilde{\mu}_e e_i}\right]\hat{M}}{\lambda_{KT} + \lambda_{KN}}$$

$$\hat{L}_e = \left[\frac{|\,\lambda\,||\theta|\varepsilon_N}{(\lambda_{KT} + \lambda_{KN})\theta_{KT}}\left(\frac{e_i}{\tilde{\mu}} + e_W W_M\right) + \frac{\tilde{\lambda}\beta_M}{(\lambda_{KT} + \lambda_{KN})} - \frac{(\lambda_{LT} + \lambda_{LN})}{(\lambda_{KT} + \lambda_{KN})}\frac{\lambda_{KZ}\theta_{LT}\theta_{KZ}}{\phi\delta\theta_{KT}}\frac{(e_i + e_W W_M \tilde{\mu}_i)}{\tilde{\mu}_i + \tilde{\mu}_e e_i}\left(\gamma_{KZ} - \gamma_{SZ}\right)^2\right]\hat{M}$$

This is the expression in (4.43) in the text.

Chapter 5

Summary of Results and Future Research Agenda

In this dissertation, I have examined whether and how trade, fiscal and monetary policies incentivise quality upgrading of goods and services exported by a small developing economy. The focal point of my analysis in this context has been the intensity of domestic factors like skilled labour and capital along with imported inputs for quality upgrading, and therefore on the domestic factor-costs effects that the policies under consideration generate. This highlights the scarcity of domestic factors like skilled labour and/or capital as an underlying cause of the poor quality of exports. At the same time, it provides theoretical explanations for the observed asymmetric quality variations across export-product groups that differ from each other in terms of relative intensities of skilled-labour and capital of their higher quality varieties. Further, I studied the implications of such export-quality variations for the wage inequality among skilled and unskilled workers, and/or for the aggregate employment of unskilled workers. This issue assumes relevance because, if quality-upgrading export-promotion policies distributes labour incomes in favour of the skilled workers or causes large scale displacements of unskilled workers, then potential conflicts and political risks there from may make it difficult for governments in the developing to pursue such policies to promote growth. All these broad issues have been addressed theoretically in terms of a competitive general equilibrium framework of a small open economy. The analysis of the effects of the three types of policies has been taken up in the three core chapters of this dissertation and the main results derived therein are summarized in the following section.

5.1 Summary of Results

The central result that I have established in Chapter 2 in the context of a four-sector general equilibrium framework with two quality-differentiated export products, is that a reduction of tariff on imports of a homogeneous consumption good may adversely affect qualities of the two export-goods. Quality improves for the export-good whose higher quality varieties are more intensive in capital than skilled labour, and deteriorates for the export-good whose higher quality varieties are less intensive in capital than skilled labour. Thus, a reduction of tariff on imports of a homogeneous consumption good provides a plausible theoretical explanation for the observed asymmetric quality variations across different product groups reported in Chapter 1. In face of such asymmetric quality-effects of tariff reduction, a quality-content production subsidy and input-subsidy for use of capital and/or skilled labour, as concurrent policies, can effectively mitigate the adverse effect on quality for those export-product groups whose quality is downgraded on account of tariff cuts. A quality-neutral income tax levied on income earners, except unskilled workers, can be a plausible way to finance these subsidies.

I have also explored the implications of such tariff-reduction induced asymmetric export-quality variations for the wage inequality among skilled and unskilled workers, as well as among the unskilled workers themselves, by taking into account formal-informal segmentation of the labour market. Quality variations have been shown to accentuate wage inequality through informalization and consequent decline in the informal unskilled wage. This reveals a policy dilemma for policymakers to sustain quality-upgrading export-promotion policies.

The robustness of the production structure is checked by allowing the same and mobile capital used in both the formal and informal sectors of production, instead of capital and land being specific factors in these two sectors. While the effect on export quality levels remain the same, the initial equilibrium level of quality now plays an important role in determining if tariff reduction widens wage inequality. Further extension of the benchmark production structure allows for sector-specific imported inputs used in producing the two quality-differentiated export goods. In such a context, I have demonstrated that reduction of tariffs on these inputs generate similar asymmetric quality variations as does the reduction of tariff on a final import good. But, the intensity of the imported input relative to skilled-labour (or, capital) of higher quality varieties of the exported goods now matters. This brings out the joint role of imported inputs and domestic factors, similar in spirit of the empirical observation by Bas and Pavnov (2021).

Finally, I have brought out the role of domestic demand by considering production of a non-traded good in a modified analytical framework that resembles the Gruen-Corden (1976) production structure that is generalized and extended in Acharyya and Jones (2001). The effects on the level of export-quality and wage inequality now depend on the value of price elasticity of demand for the non-traded good.

In Chapter 3, I have analysed the role of government expenditure on infrastructure development for export-quality upgrading. First of all, I have demonstrated that higher quality of an ICT infrastructure improves quality of an ITeS exports if its skilled-labour productivity improvement is larger than its skilled-wage increasing effect. This brings out the fact that in a resource constrained economy, if the production of goods and infrastructure development compete for some common scarce resources, then infrastructure development has a factor-cost cascading effect which, if large enough, may cause export-quality to degrade. This cost-cascading effect even leads to a trade-off between different types of infrastructure projects. This has been studied in the context of ICT infrastructure used in ITeS exports and quality of ICT augmenting productivity of skilled workers there, on the one hand; and better and paved roads facilitating movement of unskilled workers employed in traditional production sectors and skilled workers engaged in producing a quality-differentiated manufactured export good, on the other hand. Due to the factor-cost cascading effect, a ceteris paribus increase in the budget provision for road development, or a reallocation of a fixed budget in favour of road development, lowers the quality of the ICT infrastructure and service provided by the government. Consequently, the quality of ITeS exports may be degraded by the service providers. On the other hand, a ceteris paribus increase in the budget provision for ICT infrastructure, or a reallocation of a fixed budget in favour of it, worsens road infrastructure. This, by raising the capital-costs relative to the skilled wage cost, worsens the quality of the manufactured export good if its high-quality varieties are relatively capital intensive, Interestingly, when the high-quality varieties are relatively skilled-labour intensive, quality may improve depending on the value of infrastructure-elasticity of skilled and unskilled labour productivities.

In Chapter 4, I have made an attempt to integrate the real sectors of the economy with the domestic money market and the foreign exchange market, to study the effects of an expansionary monetary policy on the export quality. Once again the skilled labour intensity relative to capital for higher quality varieties matter. More precisely, an increase in the domestic money supply upgrades the export quality when higher quality varieties of the export good are relatively more capital intensive, and downgrades the export quality otherwise. On the other hand, an expansionary monetary policy changes the skilled and unskilled wages in the same direction: both wages rise if the composite traded sector is relatively more capital intensive than the non-traded sector. Thus, wage inequality may accentuate or decline. The labour-cost shares in the composite traded sector and in the quality differentiated export sector, and the initial level of export-quality matter in this context. In case of segmented unskilled labour market, an expansionary monetary policy induces export quality upgrading when higher quality varieties of the export product are relative more skill intensive than capital and induces downgrading of quality otherwise. These results are in the exact opposite direction than what can be obtained under flexible wages everywhere. Similar results have been obtained when the wage paid to all unskilled workers employed in all the sectors is fixed under minimum wage law. However, uniform fixed wage leads to unemployment of unskilled labour. The aggregate level of employment of unskilled workers increases both at the initial level of export quality as well as on account of the export quality variations.

5.2 Future Research Agenda

The analysis in this Dissertation holds potential to be extended into several directions in the future. The most important of all is an extension of the preliminary empirical analysis that I have made by considering a dynamic panel regression. The fixed effects static panel estimation on the impact of the key policy variables on product quality that I had carried out in Chapter 1 as a motivation of my theoretical study, may be biased on account of endogeneity problem and possibility of omitted variables. Also, disaggregation of the product categories and country groups may be needed to check robustness of these results. So based on the insights gained from the theoretical analyses carried out in this dissertation regarding how the policies affect the choice of export-quality, I shall set up an appropriate specification of dynamic panel regression analysis to estimate the policy impacts on export quality in a more robust way.

The second important extension is the mode of financing of government expenditure on infrastructure development. There exists a substantial literature that compare two types of financing methods of the government expenditures, deficit financing and balanced budget while analysing effects of fiscal policies on different aspects of growth and development. For example, Gardner and Kimbrough (1992) had developed a model of tariffs as the source of government revenue and related the behaviour of tariff rates and revenues to observable macroeconomic variables such as income and government spending to explain stylized facts concerning the changing role of the tariff in US history. Earlier, in the context of Heckscher-Ohlin-Samuelson model, Feehan (1988) examined that trade-off between the distortionary effects of a tariff and the benefits of the public good which it finances. Of late, with only ICT infrastructure and ITeS exports, Ganguly and Acharyya (2021) have examined whether and how the quality of ICT infrastructure and the quality of ITeS exports change under a tariff-revenue-financed balanced-budget infrastructure development, compared to deficit financed infrastructure development. It will be worthwhile to extend their analysis in the present context of trade-off between ICT and road infrastructure.

Further, given the semi-public good nature of ICT, it creates scope for provision of the ICT network and service by private firms, or in public-private partnership mode, which is not at odd with reality. This will also be an effective instrument for the government to resolve its choice problem in allocating a limited budgetary provision on different types of infrastructures and the trade-off that emerges from a reallocation of the fixed budget. The cross cost-cascading effects would still exist though. Paved roads also lower cost of transporting goods which I have not considered in this dissertation. But in the literature, costs of transporting goods affecting both volume of trade and the set of goods traded have been discussed quite extensively. Thus a significant extension of the present analysis would be examining how better roads affect export quality by reducing cost of transporting good instead of, or in addition to, augmenting labour productivities.

The analysis of Chapter 4 can also be extended in several directions. First, implications of alternative instruments of money supply, such as the cash reserve ratio or statutory liquidity ratio, for export quality may be studied. Considerations of imperfect credit market with credit rationing would be another extension highly relevant for developing countries. Finally, how wealth inequality affects export-quality through its impact on domestic consumption of non-traded goods and consequently on factor prices would be another worthwhile future research agenda.

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