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DEVALUATION, EXPORT QUALITY AND EMPLOYMENT IN A SMALL DEPENDENT ECONOMY *

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This paper investigates how currency devaluation by a small open economy affects its export quality when higher qualities are intensive in domestic factors like skilled labour and capital, rather than on imported input; and the ramifications of such quality changes on employment of unskilled labour and real income or welfare of the economy. In a competitive general equilibrium structure with cost of export quality determined endogenously, changes in export quality is shown to be contingent upon whether higher quality is more skill intensive or more capital intensive. Thus, across-the-board devaluation will have asymmetric impact on the quality choice of export goods that differ in relative skill or capital requirement for quality improvement. However, aggregate employment of unskilled labour rises unambiguously under homothetic taste, and under reasonable conditions under non-homothetic tastes. These results qualify several robustness checks.

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1. INTRODUCTION

In the present era of globalization with the buyers in the richer world becoming more sensitive towards non-price dimensions of imported goods that they consume, one major

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impediment faced by the developing countries in promoting their exports, and through it reducing their trade deficits on the one hand and augmenting growth rates on the other, is poor quality of their exports. With rise in income, buyers in the rich world are now willing to pay more for higher quality imports than consuming more of cheaper but low-quality imports. This aspect is captured in several recent studies at the firm level that focus on how quality relates to the performance of exporters (Baldwin and Harrigan, 2011; Hallak, 2006; Sutton, 2001; Manova and Zhang, 2012a; Fan et al., 2018). Further, studies on export-led growth suggest that what matters is not how much a country exports, but what it exports, reiterating the importance of product quality to boost growth rates (Rodrik, 2006; Hausman et al., 2007).

Accordingly, standard trade policies adopted by the developing countries aiming at making exports to the rich world cheaper is no longer succeeding in promoting exports of their low-quality products to any significant extent. The problem is further compounded by minimum quality standards imposed quite often by the rich world on imports coming from the developing countries. In the face of such changes in demand and policy regulations, a shift in focus of export promoting strategies towards quality upgrading and product innovation has become all the more necessary. Among the trade and exchange rate policies used by the developing countries to achieve export-led growth and lower trade deficits is currency devaluation under a pegged regime, or allowing moderate currency depreciations under a managed float. But, for reasons spelled out above, devaluation may not augment world demand for their exports by making these goods cheaper in foreign currencies to any significant extent if there is no commensurate increase in export quality. While currency devaluation – or a depreciation under market intervention by the central bank – raises the marginal revenue in terms of domestic currency from exporting goods of a particular quality, it may also raise the marginal cost of providing that quality. The rise in the marginal cost is obvious when quality upgrading requires import of high-quality inputs from abroad (Bas and Strauss-Khan, 2013; Fan and Li, 2013; Fieler et al., 2018; Feng et al., 2016; Hu, Parsely and Tan, 2017; Kugler and Verhoogen, 2012; Manova and Zhang, 2012b; Verhoogen, 2008). But, the disincentive or cost effect of devaluation is less obvious, though still very much plausible, when higher qualities of export goods require more intensive use of domestic factors of production like capital and/or skilled labour – as has been observed by Brambilla et al. (2012), Brambilla et al. (2014) Brambilla and Porto (2016)[1], whose domestic availability is limited or fixed.

It is thus worthwhile to examine whether currency devaluation creates incentives for exporting firms to upgrade quality of their exports when such quality upgrading require

[1] Kugler and Verhoogen (2012), Manova and Zhang (2012b), and Verhoogen (2008), on the other hand, highlight the correlation between the quality of domestic inputs and of outputs using data on Mexican, Chinese, and Colombian firms, respectively. Of late, Bas and Paunov (2021), observe that in case of Ecuador the firms' choices of imported input quality drive their relative demand for skilled labor and the skill premium and jointly boost firms' output quality.

more intensive use of skilled labour and capital[2], rather than imported inputs. Note that even in the present global scenario this concern has policy relevance since devaluation remains as a feasible policy option to promote exports for a number of countries that still adhere to an overvalued pegged regime, such as, Denmark, Hong Kong and most of the Mediterranean countries. For countries, that have already abandoned the peg and adopted a managed or dirty float, such as Algeria, Egypt, India, and some East Asian countries, on the other hand, policy interventions exist in order to moderate exchange rate appreciations that erodes price competitiveness of exports. Further, countries that are contemplating a switch to a floating regime would experience a one shot jump to a higher value of their exchange rates, equivalent to having a large dose of devaluation. So, our analysis of the implications of devaluation on export quality can be a reference point for ramifications of one-shot hike in the value of exchange rate when a country switches to a (managed) float and depreciations of exchange rates due to external shocks thereafter.

But the policy target of improving export quality may come in direct conflict with employment generation since higher qualities usually require more intensive use of capital and/or skilled labour. In such a case, with significantly large proportion of unskilled workforce in the developing countries already being unemployed, export growth through quality upgrading at the expense further unemployment may not be a desirable policy target for these countries.[3] Moreover, a currency devaluation itself may have a contractionary (or adverse employment effect) as demonstrated by Krugman and Taylor (1977) and, more recently, by Blecker and Razmi (2009). On the other hand, though Helpman (1977) had shown that under real wage rigidity currency devaluation would raise aggregate employment of labour unambiguously in an economy producing traded and non-traded goods, his analysis shed no light on the policy conflict that may arise due to devaluation induced quality upgrading of the export good.[4] Our analysis

[2] In a more recent theoretical work, Yu (2013) considered similar domestic factor cost for quality upgrading and have shown that heterogeneous exporting firms downgrade quality to lower export prices and absorb the shock of an exchange rate appreciation. But he did not decompose domestic factor costs into skill and capital components, which may not move in tandem as a consequence of inter-sectoral re-allocations of these resources following exchange rate shocks, which is central to our general equilibrium analysis.

[3] This is similar to policy conflict in the context of maintaining both external and internal balances (Salter, 1959; Swan, 1955). This concern gains further relevance in the context of recent international pressure on China to revalue its yuan. China's policy that keeps the RMB against the dollar significantly undervalued has caused job losses particularly in the United States (Morrison and Labonte, 2013). But the main reason for such continued undervaluation of the RMB lies in China's concern to ensure a simultaneous external and internal equilibrium (Goujon and Guerineau, 2006). Given high underemployment in China, a major RMB appreciation or revaluation would slow down China's economic growth and induce adverse employment effects on labour intensive export sectors, by lowering cost competitiveness and lowering export volumes (Xu, 2011).

[4] Jones and Corden (1976) and Acharyya (1994) examined the implications of change in the real

bridges this gap in the literature. Finally, we also study implications of quality and employment changes on aggregate real income and welfare since after all, quality upgrading and consequent output growth in the long run would not make much of a sense if it fails to increase (real) incomes of the country and that of different income groups in the short run.

All these issues are examined in a simple general equilibrium structure of a small open economy as developed in Acharyya and Jones (2001) suitably modified and extended for our purpose. The small country assumption eliminates the terms of trade effect and allows us to study implications of devaluation-induced changes in the real exchange rate (relative prices of traded and non-traded goods) and quality of exports on the aggregate employment of unskilled labour.[5] There are two broad sectors - one consisting of all homogenous goods, which is further decomposed into the composite traded good sub sector (T) and the non traded good sub sector (N), produced by capital and unskilled labour. This sector we call the (T, N) nugget. The other sector produces a quality differentiated export good Z, which is not domestically consumed, using skilled labour and capital. With quality of this export good Z selected endogenously, homothetic tastes in the (T, N) nugget and unemployment of unskilled workers under the assumption of fixed money wage in terms of domestic currency we derive the following results. First, currency devaluation increases (decreases) export quality as relative skill intensity of the export good rises (falls) with quality upgrading. Second, aggregate employment of unskilled workers rises unambiguously, regardless of whether devaluation induces export quality upgrading or downgrading. Third, rise in the aggregate real income following devaluation is conditional but independent of whether export quality rises or falls. Most of these results satisfy the robustness check with respect to domestic consumption of good Z and flexible coefficient technology. For non-homothetic tastes of domestic consumers, the effect of devaluation on export quality remain the same qualitatively, but employment change is no longer unambiguous. Devaluation now may be contractionary.

The rest of the paper is organized as follows. In Section 2 we spell out the model, Section 3.1 looks into the effect of devaluation on the choice of export quality, and Sections 3.2 and 3.3 examine respectively the effects of devaluation on aggregate employment of unskilled labour and aggregate real income. Robustness of the basic

exchange rate, brought about by devaluation and other exchange rate policies, on trade balance of a small open economy for any given level of employment. These analyses too did not take into account changes in export quality and implication thereof on the aggregate employment. Sen and Acharyya (2012), on the other hand, demonstrated that a higher minimum environmental standard requiring more intensive use of capital per unit of output would in general lower aggregate employment of unskilled workers.

[5] Alongside, it also rules out the scope of pricing to market under incomplete exchange rate pass through and shift our focus away from world demand to domestic supply as the constraining factor for export volume for a given quality choice. The world demand constraint comes into relevance in our model only through foreign buyers' willingness to pay higher prices for higher quality exports as we explain later.

results for a non-homothetic taste, domestic demand for quality differentiated export good, flexible input coefficients and many quality differentiated export goods are discussed in Section 4. Finally, Section 5 concludes the paper.

2. THE MODEL

The small open economy under consideration has two broad sectors. One sector comprises of all homogenous goods, further decomposed into the composite traded good sub sector (T) formed by clubbing all the homogenous traded goods and the non-traded good sub sector (N), both produced using capital and unskilled labour. This sector we call the (T, N) nugget[6]. The other sector produces a quality differentiated export good Z, only for the export markets using skilled labour and capital with observable quality indexed by $Q \in [0, \bar{Q}]$[7]. Later we will show that neither the domestic consumption of this good, nor consideration of more than one quality differentiated export good varying from each other in terms of skill intensities (in a sense defined later) will alter our results.

Domestic markets for all the commodities and markets for capital and skilled labour are perfectly competitive. Thus, the rate of return to capital (r) and the skilled money wage (w_s), expressed in domestic currency, are fully flexible and adjusts to clear the relevant factor markets. But the money wage to unskilled labour is pegged at the level $\bar{w}$ by the government. This assumption is not at odds with formal labour markets in developing countries to guarantee wage earnings above the subsistence level in manufacturing sectors and is one major reason for unemployment of unskilled labour. This assumption of money wage rigidity leading to an initial equilibrium with less than full employment of unskilled labour provides us a set up to analyse how currency devaluation and changes in export quality that it will bring about will affect the level of employment of unskilled workers.

Perfect competition in the composite traded good and non-traded good sectors lead to the following price- average cost conditions:

$$P_T = e_0 P_T^W = a_{LT}\bar{w} + a_{KT}r, \tag{1}$$

$$P_N = a_{LN}\bar{w} + a_{KN}r, \tag{2}$$

[6] For an earlier exposition of such a production structure see Jones (1974). Subsequently, in the open economy macro-economy literature, similar structure is used to analyse both the role of RER changes on trade balance and productivity changes on RER (Helpman, 1977; Jones and Corden, 1979; Dornbusch, 1980; and Obsfeld and Rogoff, 1996).

[7] By the classification of Nelson (1974), the export good Z is a search good so that there is no asymmetric information and associated *lemons* problem.

where P_T denotes the domestic-currency price of the composite traded good; e_0 is the level of overvalued pegged exchange rate (units of domestic currency per unit of the foreign currency); P_T^W is the foreign currency price determined in the world market and given to this small economy and a_{ij}, $i = L, K$; $j = T, N$, denotes the per unit requirement of input-i in production of good-j, fixed by assumption.

Note that due to money wage rigidity, the rate of return to capital is solely and uniquely determined by the nominal exchange rate, given the state of technology and the world price of the composite traded good. As we will see later, this has some far reaching implication for devaluation to incentivize quality upgrading. Further, the domestic price of the non-traded good is cost determined, whereas its output is domestic demand determined. Thus, availability of capital for production of T and N, and changes in the quality of export good Z as a consequence of any parametric and policy change will have no impact on the price of the non-traded good whatsoever and will change only its output and hence the aggregate level of employment of unskilled labour.

To begin with we assume homothetic tastes. This enables us to set aside the real income effect of devaluation on the demand for non-traded good and focus solely on the devaluation induced effects of quality change on aggregate employment. We will later examine how our results change when we allow for non-homothetic tastes and the consequent real income effects of devaluation. With good Z not being domestically consumed, the market clearing condition of the non-traded good, which also implies that trade is balanced for this small open economy[8], can be specified under homothetic taste as:

$$\frac{D_N}{D_T} = f(p) = \frac{X_N}{X_T}, \tag{3}$$

where $p \equiv \frac{P_N}{P_T}$ denotes the relative price of non tradables, or reciprocal of the real exchange rate as defined in the literature (Jones, 1974).

Turning now to the quality differentiated good, following Acharyya and Jones (2001), we assume that the world price of export good Z, expressed in foreign currency, increases at an increasing rate, $P_T^{W\prime}(Q) > 0$, $P_T^{W\prime\prime}(Q) > 0$. This reflects that foreign buyers' willingness to pay rises at an increasing rate with the quality of this good. Regarding production technology, we assume that a higher quality variety of Z entails more intensive use of both capital and skilled labour, though in different proportions and thereby changing the relative skill intensity of such goods. More precisely, suppose, per

[8] Since in this paper we do not explicitly consider the implication of policy-induced upgrading of quality of the export good Z for external balance, but instead consider implication of such changes for level of employment of unskilled labour, we allow for the local market for non-traded good to clear. However, one may follow policy analysis of Jones and Corden (1976) to allow for external balance to change as a consequence of devaluation with level of employment kept unchanged at the initial level through use of appropriate fiscal policy according to imbalances in the non-traded market that devaluation creates.

unit requirements of both skilled labour and capital, though invariant with respect to output level of Z, are increasing at increasing (but different) rates in quality:

$$a_{KZ} = a_{KZ}(Q),\ a'_{KZ}(Q) > 0,\ a''_{KZ}(Q) > 0, \tag{4}$$

$$a_{SZ} = a_{SZ}(Q),\ a'_{SZ}(Q) > 0,\ a''_{SZ}(Q) > 0. \tag{5}$$

These input requirements for quality upgrading are technologically fixed and does not depend on skilled wage and rate of return to capital. Later, we will study implications of variations in these intensity requirements as wages changes. $a''_{iZ}(Q) > 0,\ i = S, K$, essentially reflects diminishing returns to both capital and skilled labour with respect to quality upgrading. Note that this technological assumption makes the marginal cost of Z invariant with respect to output level but increasing in its quality, which is the standard assumption in partial equilibrium quality choice literature (Mussa and Rosen, 1978; Gabsweicz and Thisse, 1979; Tirole, 1986). So the relative skill intensity of higher quality export good Z, defined as $s_Z = a_{SZ}(Q)/a_{KZ}(Q)$, will be increasing or decreasing with quality upgrading according as whether such quality upgrading requires relatively more skilled or less skilled labour than capital per unit:

$$\hat{s}_Z = (\gamma_{SZ} - \gamma_{KZ})\hat{Q}, \tag{6}$$

where $\gamma_{iZ} = \frac{\partial a_{iZ}}{\partial Q}\frac{Q}{a_{iZ}},\ i = S, K$, denote the quality elasticity of per unit requirements of input i in Z production.

The subset of export baskets of developing countries like China, India and Brazil, containing high value addition quality differentiated goods, display wide variations in skill (or capital) intensities for quality upgrading. Higher quality of goods like aerospace, scientific instruments, defence equipments, household and office equipments, electrical appliances, agro-based products are more capital intensive $(\gamma_{KZ} > \gamma_{SZ})$, whereas, higher qualities of goods and services like software, jewellery, diamond cutting and polishing, ITeS, and financial services are more skill intensive $(\gamma_{KZ} < \gamma_{SZ})$. As we will see later, in which category our export good Z falls has some far reaching implications for devaluation affecting its quality.

Perfect competition in Z production means all firms earn zero profits for any given choice of quality[9]:

$$eP_Z^W(Q) = a_{KZ}(Q)r + a_{SZ}(Q)w_S, \tag{7}$$

Choice of quality is driven by the following marginal condition such that marginal

[9] See Acharyya and Jones (2001), Flam and Helpman (1987) and Matsuyama (2000) for competitive general equilibrium models with quality variations.

revenue from quality equals marginal cost of quality:

$$eP_Z^{W\prime}(Q) = a'_{KZ}(\tilde{Q})r + a'_{SZ}(\tilde{Q})w_S, \tag{8}$$

where $\tilde{Q}$ is the profit maximising quality level for any given rate of return to capital.

Further, we assume that the marginal cost of quality increases faster than marginal willingness to pay for higher quality, which ensures the second-order condition for profit maximising choice of quality, and an interior choice of quality:

$$a''_{KZ}(Q)r + a''_{SZ}(Q)w_S > eP_Z^{W\prime\prime}(Q). \tag{9}$$

Note that like the rate of return to capital, the skilled wage is also determined by the pegged exchange rate and the wage policy, *independent of the export quality*, as evident from the zero-profit condition (7). By envelope theorem, quality changes would be optimally adjusted as per the marginal condition (8), leaving the skilled wage unchanged (see Appendix). So, factor prices are delinked from both output and quality changes and, for any given state of technology and world price of the composite traded good, are policy determined.

Now once the rate of return to capital is determined by initial level of (pegged) exchange rate e_0, it solves for the profit maximizing quality independent of all other variables and changes therein. Solving for the rate of return to capital from (1) and substituting in (8) yields the equilibrium export quality, Q_0 as illustrated in Figure 1. Profit maximising choice of quality will vary inversely or positively depending on γ_{KZ} is greater than or less than γ_{SZ}, as shown in the Appendix:

$$\left.\frac{dr}{dQ}\right|_{\pi_z} = \frac{\left[eP_Z^{W\prime\prime}(Q) - a''_{KZ}(Q)r - a''_{SZ}(Q)w_S\right]Q}{(\gamma_{KZ} - \gamma_{SZ})a_{KZ}}. \tag{10}$$

The horizontal line on the other hand, reflects the rate of return to capital for any given set of policies $(\overline{w}, e_0)$.

The value of Q thus chosen determines the net capital stock available to the (T, N) nugget, $\widetilde{K}(Q)$ denoted by and also the output levels of composite traded (X_T) and non-traded (X_N) goods as evident from the full employment condition for capital:

$$\overline{K} - a_{KZ}(Q)X_z = \widetilde{K}(Q) = a_{KT}X_T + a_{KN}X_N. \tag{11}$$

Given this choice of quality, output (and volume) of exports, will vary *inversely*, with the level of quality chosen:

$$\bar{S} = a_{SZ}(Q)X_z. \tag{12}$$

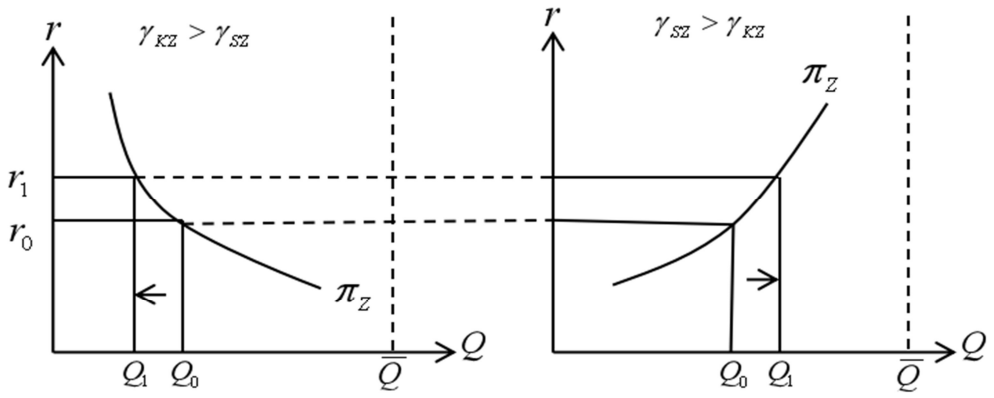

Figure 1. Choice of Equilibrium Export Quality

Substitution of (12) in (11) suggests that capital available for the (T, N) nugget, change in which causes variations in output levels of T and N, depend on the choice of export quality in two ways. First, on the scale or volume of exports, since $Z = \frac{\bar{S}}{a_{SZ}(Q)}$, and second, on the technique or capital intensity, $a_{KZ}(Q)$. The point to observe here is that these effects move in opposite directions which have some far-reaching implications for aggregate employment as we show later. Finally, the market-clearing condition (3) and the full employment condition for capital together give us the levels of output of the composite traded good and the non-traded good which in turn determines the aggregate employment of unskilled labour:

$$\bar{L} > L_e = a_{LT}X_T + a_{LN}X_N. \tag{13}$$

3. ON THE EFFECTS OF DEVALUATION

3.1. Devaluation and Export Quality

In the above set up, we now examine the impact of currency devaluation on export quality, and aggregate employment of unskilled labour. Suppose the small country government devalues its currency. At the stroke of the pen, marginal revenue earned from per unit production of good Z rises by the exact rate of currency devaluation at initial choice of quality and corresponding world price in foreign currency P_Z^W. Coming to how the rate of return to capital and the skilled wage and consequently the cost of quality change. First of all, note that an increase in the per unit domestic currency price of the composite traded good will induce producers to raise output levels of this good. This in turn will entail an increased demand for both unskilled labour and capital. The

unskilled labour can be drawn from the existing pool of unemployed workers at the fixed money wage. But, capital being fully employed, the increased demand for capital causes its rate of return to rise, by a magnitude even greater than the rate of devaluation $\hat{e} > 0$, as can be verified from the zero-profit condition in the T sector:

$$\hat{r} = \frac{\hat{e}}{\theta_{KT}}, \tag{14}$$

where $\theta_{KT} = \frac{a_{KT}r}{P_T}$ is the share of capital in unit cost of production of good T, and hat over a variable denote its proportional change. Now this increased rate of return to capital, at the initial choice of quality, will change the skilled wage from (7) though its direction of change is ambiguous, rising if $\theta_{KT} > \theta_{KZ}$, and falling otherwise:

$$\widehat{w}_s = \left[\frac{\theta_{KT} - \theta_{KZ}}{\theta_{SZ}\theta_{KT}}\right]\hat{e}. \tag{15}$$

However, even when the skilled wage increases (for $\theta_{KT} > \theta_{KZ}$), it increases less than proportionate to the rate of devaluation (see Appendix):

$$\widehat{w}_s - \hat{e} = \left[\frac{-\theta_{KZ}\theta_{LT}}{\theta_{SZ}\theta_{KT}}\right]\hat{e} < 0. \tag{16}$$

Now for change in quality, what matters is whether the marginal cost of quality (at initial Q), rises more or less than proportionately to the marginal revenue (which is the rate of devaluation), at the initial level of quality. Given that $\hat{r} > \hat{e} > \widehat{w}_s$, this in turn depends on the relative skill intensity of the higher quality of export good Z (see appendix). In particular, even when devaluation raises the skilled wage, it raises the marginal cost, at *initial quality*, 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, otherwise. Therefore, the extent to which quality is upgraded or downgraded following devaluation depends on the degree of increase or decrease in skill intensity with quality upgrading, $(\gamma_{KZ} - \gamma_{SZ})$ as can be verified from the following algebraic expression (see Appendix):

$$\hat{Q} = \frac{\alpha}{\delta}(\gamma_{KZ} - \gamma_{SZ})\hat{e}, \tag{17}$$

where $\alpha \equiv \frac{eP_Z^W\theta_{KZ}\theta_{LT}}{Q^2\theta_{KT}} > 0$, θ_{ij} is the share of factor-i in unit production cost of good j; and $\delta \equiv \left[eP_Z^{W\prime\prime}(Q) - w_s a''_{SZ}(Q) - r a''_{KZ}(Q)\right] < 0$ by the second order condition for profit maximization. The following proposition summarises the above discussion.

Proposition 1: Currency devaluation increases (decreases) export quality when relative skill intensity of the export good rises (falls) with quality upgrading, i.e. when

higher qualities are more skill (capital) intensive.

Proof: Follows from (17) and the above discussion.

Implication of this result is as follows. Devaluation is an across the board exchange rate policy that affects all traded goods uniformly by changing their domestic currency prices. However, export basket of any country may be heterogeneous in the sense that the products vary in their use of domestic factors needed to upgrade quality, ranging from low skill to high skill intensity and this causes their marginal cost of raising quality asymmetrically. In such a context, devaluation will incentivise quality improvement asymmetrically for the different export goods depending on relative skill intensities of higher qualities of these goods.

3.2. Effect on Aggregate Employment of Unskilled Labour

Under the assumption of fixed coefficients and homothetic tastes, currency devaluation affects aggregate employment of unskilled labour in two ways. First is by changing the real exchange rate (P_T/P_N), and correspondingly changing relative demand for the non-traded good; and second by changing the quality of the export good Z and correspondingly changing capital availability for the (T, N) nugget. The first effect, which is the direct (or, price) effect, is always favourable, regardless of the factor intensity ranking in the (T, N) nugget. Devaluation lowers (raises) the real exchange rate if the non-traded good is relatively capital (labour) intensive, which in turn lowers (raises) the demand for and output of the non-traded good and raises (lowers) the output of T.[10] Aggregate employment, however, increases in either case (i.e., regardless of whether N is relatively labour or capital intensive) because devaluation always raises the output of the labour intensive good and lowers that of the capital intensive good.

To check, suppose that the composite traded good is relatively unskilled labour intensive in Figure 2. Initial less than full employment equilibrium corresponding to the equilibrium quality Q_0 is given by the intersection of the capital constraint line $\widetilde{K}(Q_0)$ and the ray through the origin labeled $\frac{D_N}{D_T} = f\left(\frac{P_N}{e_0 P_T^W}\right)$ indicating the relative demand for non-traded good under the assumption of homothetic taste, for initial exchange rate e_0. Devaluation raises the return to capital which will now spread with even greater force to the capital intensive non-traded sector, raising costs and price there by a greater percentage than the devaluation. As derived in the Appendix.

Since T is relatively unskilled labour intensive, it means $\theta_{KN} > \theta_{KT}$, such that

[10] This ambiguous change in the price of non-traded good in terms of foreign currency (which is the reciprocal of the RER) is again similar to what Helpman (1977) had derived, but the reasons are altogether different. Under homothetic tastes, the direction of change depends only on the factor intensity of the non-traded good relative to that of the composite traded good.

$\hat{P}_N > \hat{e} = \hat{P}_T$. So, the relative price of the non-traded good rises, pushing down its relative demand which is indicated by the flatter ray through the origin. Output of non-traded good thus falls and that of good T rises as capital is now reallocated towards this sector as a consequence. Accordingly, employment of unskilled labour falls in the N sector, but the expanding T sector absorbs more labour than what is released by the contracting non-traded sector. So, aggregate employment of unskilled labour rises as indicated by the higher broken line passing through the intersection point of this flatter ray and the $\tilde{K}(Q_0)$. Similarly, one can work out how aggregate employment once again rises at the initial level of quality of the non-traditional export good if instead the composite traded sector is relatively capital intensive. This unambiguous increase in aggregate employment is similar to the one established by Helpman (1977).

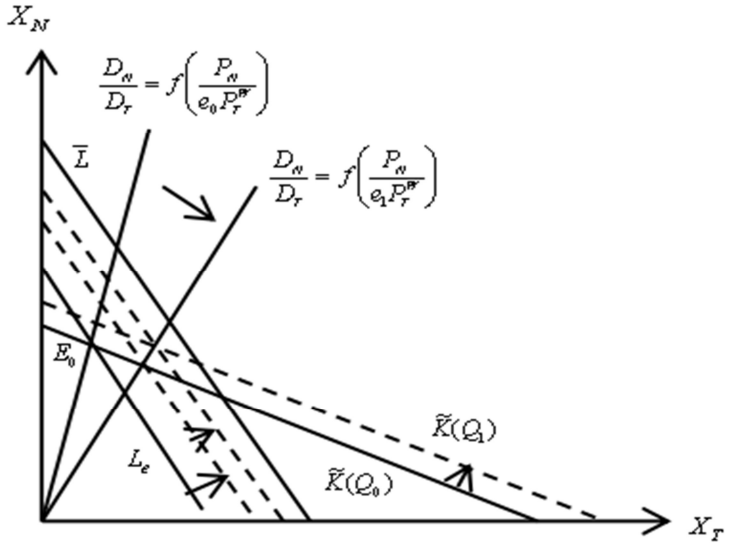

Figure 2. Employment Change When Non-Traded Good is Relatively Capital Intensive

In addition to this price or real exchange rate effect, the change in quality of the non-traditional export good will draw or release some capital which will change its availability to the (T, N) nugget and consequently the output levels of the two commodities.

Turning now to the subsequent effect, as noted earlier, a quality upgrading changes the capital requirement in two ways. On the one hand, less capital is required as quality upgrading causes a fall in output of good Z since higher quality requires more skilled labour which is specific to this sector. From (12), it is immediate that $\hat{Z} = -\gamma_{SZ}\hat{Q}$ captures the extent of such scale contraction when quality is upgraded. On the other

hand, more capital is needed per unit of output as quality is upgraded whose extent is captured by $\hat{a}_{KZ} = \gamma_{KZ}\hat{Q}$. Hence, overall, if $\gamma_{SZ} > \gamma_{KZ}$ then capital requirement in Z production will fall and will increase otherwise as quality is improved following devaluation. But by Proposition 1, quality is upgraded when $\gamma_{SZ} > \gamma_{KZ}$ and so in that case, overall capital requirement $K_Z(Q)$ will fall. The reverse reasoning shows that if $\gamma_{SZ} < \gamma_{KZ}$, as devaluation causes downgrading of quality, less capital requirement per unit of output dominates more capital requirement due to the increase in output of Z. Thus, again the overall capital requirement in Z sector falls. This strong result is summarized in the following Lemma:

Lemma 1: Regardless of whether devaluation upgrades or lowers export quality, capital requirement in Z sector falls.

Proof: Follows from the above discussion. Algebraically, as shown in the Appendix,

$$\hat{K}_Z = \frac{\alpha}{\delta}(\gamma_{KZ} - \gamma_{SZ})^2\hat{e} < 0. \tag{18}$$

The above result implies that quality variation caused by devaluation, regardless of whether it is upgraded or lowered, releases some capital to the (*T, N*) nugget. This larger availability of capital causes output of both composite traded good and non-traded good to rise proportionately thereby generating more employment of unskilled labour. Thus, quality variation induced by devaluation reinforces initial employment expansion due to change in the real exchange rate. Algebraically, the unambiguous increase in aggregate employment of unskilled labour is given as,

$$\hat{L}_e = \left[-\frac{\alpha}{\delta}(\gamma_{KZ} - \gamma_{SZ})^2 + \frac{\varepsilon_N|\theta|\lambda||}{\theta_{KT}}\right]\hat{e}. \tag{19}$$

The following Proposition summarizes the discussion in the current section:

Proposition 2: Under homothetic tastes, currency devaluation unambiguously raises aggregate employment of unskilled labour regardless of whether export quality is upgraded or degraded.

Proof: Follows from (19), and the above discussion.

Two comments are warranted at this point. First, though relative skill intensities of higher quality varieties of a good matters for whether devaluation will incentivise producers to upgrade its quality, this does not matter for causing an employment expansion. Second, the policy dilemma does not arise when quality of the export good is upgraded as it is also accompanied by an expansion of aggregate employment of unskilled labour.

3.3. Change in Real Income and Welfare

The aggregate real income of our small open economy is simply the sum of wage earnings of unskilled workers ($\overline{w}L_e$), that of skilled labour ($w_S\bar{S}$) and the total return to capital ($r\overline{K}$) deflated by the domestic currency price of the composite traded good (eP_T^W):

$$y = \frac{Y}{eP_T^W} = \frac{[\overline{w}L_e + w_S\bar{S} + r\overline{K}]}{eP_T^W}. \tag{20}$$

The real income also measures the welfare of the economy since by assumption the quality differentiated export good Z is not domestically consumed. So quality changes whatsoever have no direct bearing on the welfare of the consumers in our economy. Note that changes in quality level will affect the real income (and welfare) only by changing aggregate employment, as factor returns are invariant with quality changes. Total differentiation of (20) yields:

$$\hat{y} = \theta_L\hat{L}_e + \theta_K\hat{r} + \theta_S\widehat{W}_S - \hat{e}, \tag{21}$$

where $\theta_i,\ i = L, S, K$, is the share of factor i in aggregate income Y.

Now, devaluation raises aggregate income, first, by raising the rate of return to capital and therefore the capital income; and second by raising the aggregate employment of unskilled labour and therefore the total wage earnings of unskilled workers. At the same time, devaluation lowers aggregate real income of the economy by raising the domestic currency price of the composite traded good proportionately. On the other hand, although total wage earnings of the skilled workers is ambiguous, even when the skilled wage increases it increases less than proportionate to the rate of devaluation as explained previously (16).

Given that consequent change in aggregate real income is only by a fraction of such non-proportional increase (if at all) in skilled wage, it along with increased employment and higher rate of return to capital may not still raise the aggregate real income. Therefore, the overall change in aggregate real income is ambiguous. Upon substitution of relevant values, the expression for change in the aggregate real income boils down to:

$$\hat{y} = \left[\frac{\varepsilon_N|\theta||\lambda|}{\theta_{KT}} - \gamma_{KZ}^2\lambda_{KZ}\frac{eP_Z^W}{\delta_K Q^2}\frac{\theta_{KZ}\theta_{LT}}{\theta_{KT}}\right]\hat{e} + \left[\frac{\theta_K + [\theta_{KT} - \theta_{KZ}]\theta_S - \theta_{KT}\theta_{SZ}}{\theta_{SZ}\theta_{KT}}\right]\hat{e}. \tag{22}$$

For example, if $\theta_S > \theta_{Sz}$, a sufficient condition for aggregate real income to increase ($\hat{y} > 0$) is given by the following cost share conditions:

$$\theta_{KT}\left[\frac{\theta_S - \theta_{Sz}}{\theta_S}\right] > \theta_{KZ}. \tag{23}$$

Note that this sufficient condition is more stringent than the condition for an increase

in the skilled wage following devaluation. Thus, this condition not only ensures that the skilled wage increases but also that the aggregate real income increases. Hence,

Proposition 3: Under homothetic tastes, condition (23) along with $\theta_S > \theta_{Sz}$ ensures that devaluation raises aggregate real income measured in domestic currency.

Proof: Follows from (22) and (23).

It is not surprising to see that for real income to increase following devaluation, whether quality is upgraded or downgraded, which in turn is contingent upon relative skill intensity of higher qualities, does not matter. This is because quality variations do not affect the factor returns, whereas it raises aggregate employment unambiguously (see Proposition 2).

4. EXTENSIONS

For robustness check for the above results, we consider four cases here. First is non-homothetic taste; second, domestic demand for good Z; third, flexible coefficient production technology and fourth, more than one quality differentiated export good.

4.1. Non-Homothetic Tastes

Under non homothetic tastes, the demand for the non-traded good would depend on real income (y) as defined in (20), in addition to the real exchange rate so the market-clearing condition now is stated as:

$$D_N(p, y) = X_N. \tag{26}$$

Given the rigidity of money wage to unskilled labour, this, however, will have no bearing on how devaluation affects the rate of return to capital and thereby skilled wage. Since, it is through these two factor costs that devaluation works its effect on the level of quality chosen in the Z sector, so it is imperative that non-homothetic tastes will leave the effect of devaluation on export quality unaltered.

The only effect that non homothetic tastes will have is on the aggregate employment of unskilled labour through the (real) *income effects* of devaluation. To see this, note that under the condition stated in (18), the aggregate real income increases at the initial level of employment. This raises the demand and output of the non-traded good and correspondingly lowers the output of the composite traded good due to scarcity of capital. A fall in output in the T sector lays off some of the unskilled workers, while expansion in the non-traded sector will provide additional employment. Hence, if the non-traded sector is relatively labour intensive, aggregate employment will increase on

account of the real income effect. On the other hand, when non-traded sector is relatively capital intensive, the expanding N sector is unable to absorb the total number of workers laid off by the contracting traded sector, lowering aggregate employment level in the economy on this account. It is in this latter case that devaluation can be contractionary if the income elasticity of demand for non-traded good is sufficiently large as can be verified from the following algebraic expression:

$$\hat{L}_e = \left[\frac{-\tilde{\varepsilon}_N|\theta||\lambda|}{\theta_{KT}\Delta} + \frac{\eta|\lambda|\beta_y}{\theta_{KT}\theta_{SZ}\Delta} + \frac{\psi\lambda_{LT}}{\Delta}\right]\hat{e}, \tag{27}$$

where $\beta_y = \eta\left[\frac{\theta_S(\theta_{KT}-\theta_{KZ})+\theta_K\theta_{SZ}-\theta_{KT}\theta_{SZ}}{\theta_{KT}\theta_{SZ}}\hat{e}\right]$, $\psi = \frac{\alpha\lambda_{KZ}}{\delta}(\lambda_{KZ}-\lambda_{SZ})^2 < 0$, $\tilde{\varepsilon}_N$ is the absolute price elasticity of demand for non-traded good, is the income elasticity of demand for non-traded good, and

$$\Delta = \eta\theta_L\lambda_{LT}\lambda_{KN} - (1-\eta\theta_L\lambda_{LN})\lambda_{KT} = -[\lambda_{KT} + \eta\theta_L|\lambda|].$$

Note that, when the composite traded good is relatively labour intensive, i.e., $|\lambda| > 0$, then $\Delta < 0$; otherwise, i.e., for $|\lambda| < 0$, $\Delta < 0$ if $\eta < \frac{-\lambda_{KT}}{\theta_L|\lambda|} \equiv \bar{\eta}$. Also note that since $\bar{\eta} > 1$, so the above restriction (when $|\lambda| < 0$) will be satisfied even for income elastic demand for the non-traded good. For $|\lambda| < 0$ and $\eta < \bar{\eta}$, $\Delta < 0$ and hence under the assumption that $\beta_y > 0$, aggregate employment increases following currency devaluation. On the other hand, for $|\lambda| > 0$ given that $\Delta < 0$, aggregate employment increases if the income elasticity of demand for the non-traded good (η) is not sufficiently large in the following sense:

$$\eta < \frac{\tilde{\varepsilon}_N|\theta||\lambda| - \psi\lambda_{LT}\theta_{KT}\theta_{SZ}}{\beta_y|\lambda|} \equiv \tilde{\eta}. \tag{28}$$

Finally, the proportionate change in real income in this case can be worked out as:

$$\hat{y} = \theta_L\left[\frac{-\tilde{\varepsilon}_N|\theta||\lambda|}{\theta_{KT}\Delta} + \frac{\eta|\lambda|\beta_y}{\theta_{KT}\theta_{SZ}\Delta} + \frac{\psi\lambda_{LT}}{\Delta}\right]\hat{e} + \frac{\beta_y}{\theta_{KT}\theta_{SZ}}. \tag{29}$$

Now under the assumption that $\beta_y > 0$, aggregate real income will increase as a result of a currency devaluation under the same conditions for an improvement in aggregate employment, i.e, if $|\lambda| < 0$ and $\eta < \bar{\eta}$, or $|\lambda| > 0$ and $\eta < \tilde{\eta}$.[11]

[11] Note that for $|\lambda| > 0$, $\bar{\eta} < 0$ and hence is not relevant whereas for $||\lambda| < 0$, $\tilde{\eta} < 0$ making it not a relevant threshold value. That is, any one of these two threshold values is relevant and binding depending on the factor intensity of good T relative to good N.

4.2. Domestic Demand for Good Z

For reasons similar to the non-homothetic taste, the domestic demand for good Z will have no effect on the selection of export quality either. So again, it is only the employment of unskilled labour (and real income of the economy) that would be affected, and such effect would be similar in essence as an exogenous reduction in real income of the consumers (such as through an income tax). Thus, good Z being domestically consumed may have a contractionary effect on the aggregate employment. The reason is simple. When good Z is also domestically consumed, a smaller fraction of the (real) income is now spent on the non-traded good, which in turn lowers the output of the non-traded good and, to maintain full employment of capital for any given quality level, correspondingly raises the output of the composite traded good. Therefore, *at the initial equilibrium aggregate employment of unskilled labour will be higher (lower) when good Z is domestically consumed than when it is not if* $|\lambda| > 0$ (< 0).

To exemplify, suppose only skilled workers consume good Z along with T and N, and they spend $b_z(Q)$ fraction of their income on Z where $b_Z'(Q) > 0$ and $b_z(1) = \bar{b}_z < \bar{Q}$. Of the remaining income, $[1 - b_z(Q)]w_S\bar{S}$, suppose α_S fraction is spent by them on the non-traded good. Capital owners and unskilled workers, on the other hand, spend respectively α_K and α_L fraction of their incomes on the non-traded good. In such a set-up, it is straight forward to check that for any given skilled wage, $\hat{b}_z < \xi\hat{Q} = \xi\frac{\alpha}{\delta}(\gamma_{KZ} - \gamma_{SZ})\hat{e}$, where $\xi = \frac{\partial b_z(Q)}{\partial Q}\frac{Q}{b_z(Q)} > 0$ is the elasticity of demand for Z with a change in quality. The proportion of income spent on Z falls (rises) and correspondingly the proportion of income spent on non-traded good by skilled workers rises (falls) when devaluation lowers (raises) export quality. Thus now, direction of quality change will matter for employment change. There will be a contractionary effect of devaluation on this account if $\gamma_{KZ} < \gamma_{SZ}$ and the non-traded good is relatively labour intensive, or $\gamma_{KZ} > \gamma_{SZ}$ and the non-traded good is relatively capital intensive.

4.3. Flexible Coefficients Technology

Flexible coefficients technology only in the (T, N) nugget, for reasons similar to the above two cases will leave quality changes following devaluation the same as under fixed coefficients. On the other hand, expansionary effect of devaluation will only be reinforced. Given money wage rigidity, increase in rate of return to capital following devaluation will induce producers in both sectors to substitute capital by unskilled labour per unit of output, thus raising employment levels in the economy.

More interesting prospect, however, arises when we allow flexible coefficients in the quality differentiated Z sector, as this would create scope for quality to change as well. As explained earlier, devaluation always raises rate of return to capital relative to the skilled wage. Under fixed coefficients in the Z sector, producers would respond to this by downgrading export quality to minimize cost when higher quality requires relatively intensive use of capital. If, however, they could substitute capital by skilled labour *for*

the same and each level of quality, quality need not be downgraded following devaluation, or even if so, such downgrading could be much smaller.[12]

In other words, the shock of devaluation through a rise in capital costs need not necessarily have to be absorbed through a downgrading of quality now, but at least part of this shock can be absorbed through a change in the technique of producing a particular quality level. Thus, flexible coefficients in Z sector appear to be more relevant and worthwhile to explore. Also note that such substitution of capital by skilled labour in the Z sector will be another channel to raise employment of unskilled labour by releasing capital to the (T, N) nugget - this is pure factor substitution effect originating in Z sector for employment expansion in the rest of the economy.

4.4. Many Commodity Extension

Instead of only one quality differentiated export good Z, suppose the country exports n number of quality differentiated goods Z_j, $j = 1, 2, \cdots, n$. If these goods are produced by the same skilled labour and capital, then, at free trade equilibrium, the economy will produce only one of these n goods, the one that yields the highest return to skilled labour. This is a standard result in trade theory[13]: at free trade equilibrium, number of goods *produced* and traded cannot exceed the number of factors of production available.

One way to accommodate production of all these n number of quality differentiated exports is to consider the case where each of the n quality differentiated sectors uses *different types* of sector specific skilled labour along with the common mobile capital[14]. Suppose there are $i = 1, \cdots, m$ types of skill and $n = m$.[15] Suppose the n number of Z goods and m types of skill are indexed such that Z_1 uses S_1 type of skilled labour, Z_2 uses S_2 skill type and so on. The zero profit conditions of the n export productions and marginal condition for quality choice can be rewritten as follows:

$$eP_j^W(Q_j) = a_{KZ}^j(Q_j)r + a_{SZ}^{ij}(Q_j)w_S^i, \; j = 1, \cdots, n; \; i = 1, \cdots, m. \tag{30}$$

$$eP_j^{W\prime}(\tilde{Q}_j) = a_{KZ}^{j\,\prime}(\tilde{Q}_j)r + a_{SZ}^{ij\,\prime}(\tilde{Q}_j)w_S^i. \tag{31}$$

[12] Assuming $a_{KZ} = a_{KZ}(Q, \frac{w_S}{r})$, $a_{SZ} = a_{SZ}(Q, \frac{w_S}{r})$, one can derive the change in export quality as $\hat{Q} = -\frac{\theta_{LT}(\gamma_{KZ}\theta_{KZ} + \gamma_{SZ}\theta_{SZ})(\theta_{KZ} + \mu_S)}{\theta_{KT}\theta_{SZ}\varphi}\hat{e}$, where $\mu_S \equiv \frac{\rho_S}{a'_{SZ}}\frac{\partial a'_{SZ}}{\partial \rho_S}$ elasticity of per unit requirement of skilled labour with respect to the wage-rental ratio. Thus, quality is upgraded if $\mu_S > 0$, or if $|\mu_S| < \theta_{KZ}$ when $\mu_S < 0$.

[13] See Samuelson (1953).

[14] This structure resembles Grossman and Helpman (1994) where each of the *n* sectors are produced using a specific factor and some mobile factor.

[15] For $n > m$, only m number of quality differentiated goods will be produced as $(n - m)$ goods will not have their matching skilled labour. If there is domestic demand for these $(n - m)$ goods, then these goods will be imported.

Full employment conditions for $m\,(=n)$ types of skilled labour and capital are as follows:

$$\bar{S}_i = a_{SZ}^{j}(Q_j)Z_j, \tag{32}$$

$$\bar{K} - \sum_{j=1}^{n} a_{KZ}^{j}(Q_j)Z_j = a_{KT}X_T + a_{KN}X_N, \tag{33}$$

where $a_{SZ}^{j}(Q_j)$ is the amount of $i^{th}(=j^{th})$ skill used per unit of production of good Z_j with initial quality Q_j.

Note that now we have n number of zero profit conditions to solve for the $m\,(=n)$ number of skilled wages, n number of marginal conditions to solve for qualities of the n number of Z goods, and m number of full employment conditions of skilled labour to solve for outputs of $n\,(=m)$ number of Z goods thus making the system determinate.

Once devaluation changes the factor prices in a way as explained earlier, producers decide to upgrade or lower quality for each of the n goods depending on whether that particular good requires more skilled labour relative to capital for quality upgrading ($\gamma_{SZ}^{j} > \gamma_{KZ}^{j}$) or less ($\gamma_{SZ}^{j} < \gamma_{KZ}^{j}$). So as these Z goods vary from each other in terms of their skill requirements for quality upgrading, devaluation will asymmetrically affect their choice of quality:

$$\hat{Q}_j = \frac{\alpha_j}{\delta_j}(\gamma_{KZ}^{j} - \gamma_{SZ}^{j})\hat{e}. \tag{34}$$

Coming to the effect on aggregate employment, it is sufficient to note that by Lemma 1, irrespective of whether quality is upgraded or lowered for each of the n quality differentiated exports, capital is released from all these Z sectors *as a whole* which is now available to raise output levels in the other sectors of the economy:

$$\hat{K}_Z = \sum_{j=1}^{m} \hat{K}_Z(Q_j) = \sum_{j=1}^{n}(\gamma_{KZ}^{j} - \gamma_{SZ}^{ij})\hat{Q}_j < 0. \tag{35}$$

Such a rise in production in the (T, N) nugget will be realized by drawing unskilled labour from the pool of unemployed thus raising their level of aggregate employment.

5. CONCLUSION

With worldwide increasing sensitiveness towards non-price dimensions of imported goods, there has been a shift in focus of export promoting strategies from realizing gains in the intensive margin through a rise in volume of exports, towards quality upgrading to realize welfare gains at the extensive margin and augment export led growth. Given this backdrop, this paper explored whether a currency devaluation upgrades quality of

exports of a small dependent economy; whether quality upgrading comes at a cost of unemployment of the unskilled workers implicating thereby a policy conflict as is generally apprehended; and what implications changes in export quality have on the welfare or the real income. In this regard, by taking into account quality valuation by the importing countries, as well as quality provision by the exporting countries contingent upon changes in domestic factor costs and hence in the cost of quality upgrading, we have found that the effect of devaluation of domestic currency on the choice of export quality is contingent upon the technology for quality upgrading. Under fixed coefficients and homothetic tastes, devaluation increases (decreases) export quality as relative skill intensity of the export good rises (falls) with quality upgrading. On the other hand, the aggregate employment of unskilled workers is found to rise unambiguously. Change in the aggregate real income is, however, conditional, but independent of quality changes. Most of the results satisfy the robustness check with respect to domestic consumption of good Z and flexible coefficient technology. Production of more than one quality differentiated export good, each using different types of sector specific skilled labour along with capital, does not change the results either. For non-homothetic tastes of domestic consumers, and domestic demand for the quality differentiated good, the effect of devaluation on export quality remain the same qualitatively, but employment change is no longer unambiguous. Devaluation now may be contractionary thus calling for a more cautious approach for such policy interventions.

The paper lends itself readily for policy prescriptions since currency devaluation is not found to be effective in boosting export-promotion prospects for all types of quality-differentiated export goods at once. So, adoption of a policy concurrent to devaluation that can mitigate its adverse quality effects when relative skill intensity of the export good falls with quality upgrading would be desirable. However, given our result that the employment and real income changes are independent of the direction in which the export quality changes, the policy makers can focus on upgrading export quality through an appropriate concurrent policy without worrying about the effect on the aggregate level of employment of the unskilled workers. One such policy can be an input-subsidy on capital cost specific to the capital available only for Z production. A sufficiently large input subsidy that will lower the effective rate of return to capital below the initial rise due to devaluation, will lower the marginal capital cost of quality upgrading. At the same time, as this subsidy encourages producers to expand the scale of production, it raises the demand for skilled workers and hence raises the marginal cost of quality upgrading on this account. Overall, however, the marginal cost declines when higher qualities of Z are relatively more capital intensive. Thus, a capital input subsidy will mitigate the adverse effect of currency devaluation in specific situations when higher quality varieties of good Z are relatively more intensive in capital than skill. Essentially, a currency devaluation (or interventionist policies to prevent the domestic currency from appreciating under a managed float) combined with a capital-input subsidy acts as a pure export subsidy. Thus, marginal revenue from quality upgrading is raised without raising the marginal cost.

APPENDIX

A1.1. Slope of the π_z curve

The marginal condition for quality choice is given as:

$$eP_Z^{W\prime}(Q) = a'_{KZ}(Q)r + a'_{SZ}(Q)w_S.$$

Total differentiating the above gives:

$$eP_Z^{W\prime}(Q)d(Q) = w_S a''_{SZ}(Q)dQ + a'_{SZ}(Q)dw_S + ra''_{KZ}(Q)dQ + a'_{KZ}(Q)dr$$
$$\Rightarrow \delta dQ = a'_{KZ}(Q)dr + a'_{SZ}(Q)dw_S, \quad \text{(A1)}$$

where $\delta = \left[eP_Z^{W\prime\prime}(Q) - w_S a''_{SZ}(Q) - ra''_{KZ}(Q)\right] < 0$.

Total differentiating the zero profit condition of Z at initial e and Q gives:

$$0 = a_{KZ}(Q)dr + a_{SZ}(Q)dw_S \Rightarrow dw_S = -\frac{a_{KZ}(Q)}{a_{SZ}(Q)}dr. \quad \text{(A2)}$$

Substituting (A2) in (A1) yields:

$$\delta dQ = \left[a'_{KZ}(Q) - a'_{SZ}(Q)\frac{a_{KZ}(Q)}{a_{SZ}(Q)}\right]dr \Rightarrow \left.\frac{dr}{dQ}\right|_{\pi_Z} = \frac{\delta Q}{(\gamma_{KZ}-\gamma_{SZ})a_{KZ}(Q)}.$$

A1.2. Independence of Skilled Wage

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

$$P_Z^W de + eP_Z^{W\prime}(Q)dQ = ra'_{KZ}(Q)dQ + a_{KZ}(Q)dr + a_{SZ}(Q)dw_S.$$

Using the marginal condition (6) in the text reproduced below,

$$eP_Z^{W\prime}(Q) = a'_{KZ}(Q)r, \quad \text{(A3)}$$

the above expression boils down to:

$$\hat{e} = \theta_{KZ}\hat{r} + \theta_{SZ}\hat{w}_S. \quad \text{(A4)}$$

Substitution the value for $\hat{r}$ in (A1) yields the change in skilled wage as in (16) in the text:

$$\widehat{w}_S = \left[\frac{\theta_{KT}-\theta_{KZ}}{\theta_{SZ}\theta_{KT}}\right]\hat{e}. \tag{A5}$$

A1.3. Change in Real Exchange rate

From the zero profit conditions in sectors T and N we can obtain,

$$\hat{P}_T = \hat{e} = \theta_{KT}\hat{r},\ \hat{P}_N = \theta_{KN}\hat{r}. \tag{A6}$$

Such that, $\hat{P}_T - \hat{P}_N = [\theta_{KT} - \theta_{KN}]\hat{r} = \frac{[\theta_{KT}-\theta_{KN}]}{\theta_{KT}}\hat{e}$ as in the text.

A2.1. Change in Marginal Cost of Quality

First of all, recall from the text the marginal condition for quality choice:

$$eP_Z^{W\prime}(Q) = a'_{SZ}(Q)w_S + a'_{KZ}(Q)r. \tag{A7}$$

Proceeding as before we can obtain,

$$\gamma_Z = \theta_{SZ}\gamma_{SZ} + \theta_{KZ}\gamma_{KZ}, \tag{A8}$$

where $\gamma_Z \equiv \frac{QP_Z^{W\prime}(Q)}{P_Z^W}$ is the quality elasticity of the foreign currency price of good Z.

Now, consider the marginal cost for quality, which is the right hand side in (A.7):

$$MC = a'_{SZ}(Q)w_S + a'_{KZ}(Q)r.$$

Total differentiation, holding the quality level, yields,

$$\frac{dMC|_Q}{MC} = \frac{1}{MC}[w_S a'_{SZ}(Q)\widehat{w}_S + r a'_{KZ}(Q)\hat{r}]$$

$$\Rightarrow \widehat{MC}\big|_Q = \frac{eP_Z^W}{QMC_Q}\frac{[(\theta_{KT}-\theta_{KN})\gamma_{SZ}+\theta_{KZ}\gamma_{KZ}]}{\theta_{KT}}\hat{e} = \frac{1}{\theta_{KT}\gamma_Z}[(\theta_{KT}-\theta_{KN})\gamma_{SZ} + \theta_{KZ}\gamma_{KZ}]\hat{e}$$

$$= \frac{\theta_{KT}\gamma_{SZ}+\theta_{KZ}(\gamma_{KZ}-\gamma_{SZ})}{\theta_{KT}[\theta_{SZ}\gamma_{SZ}+\theta_{KZ}\gamma_{KZ}]}\hat{e}.$$

Now, $\widehat{MC}\big|_Q - \hat{e} = \frac{\theta_{KT}\gamma_{SZ}+\theta_{KZ}(\gamma_{KZ}-\gamma_{SZ})-\theta_{KT}[\theta_{SZ}\gamma_{SZ}+\theta_{KZ}\gamma_{KZ}]}{\theta_{KT}[\theta_{SZ}\gamma_{SZ}+\theta_{KZ}\gamma_{KZ}]}\hat{e} = \frac{\theta_{KZ}\theta_{LT}(\gamma_{KZ}-\gamma_{SZ})}{\theta_{KT}[\theta_{SZ}\gamma_{SZ}+\theta_{KZ}\gamma_{KZ}]}\hat{e}.$

Hence, devaluation raises the marginal cost of quality (at the initial quality level) more than proportionately if $\gamma_{KZ} > \gamma_{SZ}$, and less than proportionately otherwise

A2.2. Change in Quality

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

$$eP_Z^{W\prime\prime}(Q)dQ + P_Z^{W\prime}de = w_S a_{SZ}''(Q)dQ + a_{SZ}'(Q)dw_S + r a_{KZ}''(Q)dQ + a_{KZ}'(Q)dr$$

$$\Rightarrow \frac{Q^2}{eP_Z^W}\delta\hat{Q} + \frac{QP_Z^{W\prime}}{P_Z^W}\hat{e} = \frac{a_{SZ}(Q)w_S}{eP_Z^W}\left[\frac{Qa_{SZ}'(Q)}{a_{SZ}(Q)}\right]\hat{w}_S + \frac{a_{KZ}(Q)r}{eP_Z^W}\left[\frac{Qa_{KZ}'(Q)}{a_{KZ}(Q)}\right]\hat{r}$$

$$\Rightarrow \frac{Q^2}{eP_Z^W}\delta\hat{Q} + \lambda_Z\hat{e} = \theta_{SZ}\gamma_{SZ}\hat{w}_S + \theta_{KZ}\gamma_{KZ}\hat{r},$$

where $\delta \equiv \left[eP_Z^{W\prime\prime}(Q) - w_S a_{SZ}''(Q)dQ - r a_{KZ}''(Q)dQ\right] < 0$ by the second order condition for profit maximization. Substitution of (A8) and the value of $\hat{r}$ and $\hat{w}_S$ yields:

$$\frac{Q^2}{eP_Z^W}\delta\hat{Q} + (\gamma_{KZ}\theta_{KZ} + \gamma_{SZ}\theta_{SZ})\hat{e} = \theta_{SZ}\gamma_{SZ}\frac{(\theta_{KT}-\theta_{KZ})}{\theta_{KT}\theta_{SZ}}\hat{e} + \theta_{KZ}\gamma_{KZ}\frac{\hat{e}}{\theta_{KT}}$$

$$\Rightarrow \hat{Q} = \frac{eP_Z^W}{Q^2\delta}\left[\frac{(\gamma_{KZ}-\gamma_{SZ})\theta_{KZ}\theta_{LT}}{\theta_{KT}}\right]\hat{e} \Rightarrow \hat{Q} = \frac{\alpha}{\delta}(\gamma_{KZ} - \gamma_{SZ})\hat{e}, \qquad \text{(A9)}$$

where $\alpha = \frac{eP_Z^W\theta_{KZ}\theta_{LT}}{Q^2\theta_{KT}}$.

A2.3. Change in Capital Availability with Change in Quality Choice

Capital used in Z sector can be written as $K_Z(Q) = a_{KZ}(Q)\frac{\bar{S}}{a_{SZ}(Q)}$.

Total differentiation gives:

$$K_Z'(Q)dQ = a_{KZ}'(Q)dQ(0 - a_{SZ}'(Q)dQ)$$

$$\Rightarrow \hat{K}_Z(Q) = \left[a_{KZ}'(Q)\frac{Q}{a_{KZ}(Q)} - a_{SZ}'(Q)\frac{Q}{a_{SZ}(Q)}\right]\hat{Q}$$

$$\Rightarrow \hat{K}_Z(Q) = [\gamma_{KZ} - \gamma_{SZ}]\hat{Q}. \qquad \text{(A10)}$$

Substituting expression for quality change from (A9) in the above give:

$$\hat{K}_Z(Q) = \frac{\alpha}{\delta}(\gamma_{KZ} - \gamma_{SZ})^2\hat{e} < 0. \tag{A11}$$

A2.4. Change in Aggregate Employment of Unskilled Labour

Total differentiation of (13) in the text gives us:

$$\hat{L}_e = \lambda_{LT}\hat{X}_T + \lambda_{LN}\hat{X}_N. \tag{A12}$$

Note that capital available to the (T, N) nugget now changes on account of both a change in per unit capital requirement for higher quality as well as the output of the Z good itself.

Percentage change from of the capital constraint now becomes:

$$-\frac{a'_{KZ}(Q)Q}{a'_{KZ}(Q)}\hat{Q}\frac{a_{KZ}X_Z}{\bar{K}} - \frac{a_{KZ}(Q)X_Z}{\bar{K}}\hat{X}_Z = \frac{a_{KT}X_T}{\bar{K}}\hat{X}_T + \frac{a_{KN}X_N}{\bar{K}}\hat{X}_N.$$

Now from the market clearing condition in the non traded sector under homothetic tastes we obtain $-\varepsilon_N(\hat{P}_N - \hat{e}) = \hat{X}_N - \hat{X}_T$.

Using (A6), we can rewrite this as

$$\hat{X}_N - \hat{X}_T = \frac{-\varepsilon_N(\theta_{KN} - \theta_{KT})}{\theta_{KT}}\hat{e} = \frac{-\varepsilon_N|\theta|}{\theta_{KT}}\hat{e}. \tag{A13}$$

Rise in export quality reduces the total output of the quality differentiated good.

Total differentiation of the full employment condition for skilled labour in the text gives us the change in X_Z as:

$$\hat{S} = 0 = \frac{a'_{SZ}(Q)Q}{a_{SZ}(Q)}\frac{a_{SZ}(Q)X_Z}{\bar{S}}\hat{Q} + \frac{a_{SZ}(Q)X_Z}{\bar{S}}\hat{X}_Z.$$

$$\Rightarrow \hat{X}_Z = -\gamma_{SZ}\hat{Q} < 0. \tag{A14}$$

Substituting $\hat{X}_Z$ from (A14) we get

$$\lambda_{KN}\hat{X}_N + \lambda_{KT}\hat{X}_T = \frac{-\lambda_{KZ}\alpha}{\delta}(\gamma_{KZ} - \gamma_{SZ})^2\hat{e}, \tag{A15}$$

where $\lambda_{Kj} \equiv \frac{a_{Kj}X_j}{\bar{K}(Q)}$, $j = T, N$, denote the share of sector T in net availability of capital for the (T, N) nugget. Representing (A15) and (A13) in matrix notation:

$$\begin{bmatrix}\lambda_{KT} & \lambda_{KN}\\ -1 & 1\end{bmatrix}\begin{bmatrix}\hat{X}_T\\ \hat{X}_N\end{bmatrix}=\begin{bmatrix}-\lambda_{KZ}\frac{\alpha(\gamma_{KZ}-\gamma_{SZ})^2\hat{e}}{\delta}\\ \frac{-\varepsilon_N|\theta|}{\theta_{KT}}\hat{e}\end{bmatrix}.$$

And solving for the values of $\hat{X}_T$ and $\hat{X}_N$ by applying Cramer's rule yields:

$$\hat{X}_T=\left[\left\{-\lambda_{KZ}\frac{\alpha(\lambda_{KZ}-\gamma_{SZ})^2}{\delta}\right\}+\lambda_{KN}\frac{\varepsilon_N|\theta|}{\theta_{KT}}\right]\hat{e}, \tag{A16}$$

$$\hat{X}_N=\left[\left\{-\lambda_{KZ}\frac{\alpha(\lambda_{KZ}-\gamma_{SZ})^2}{\delta}\right\}-\lambda_{KT}\frac{\varepsilon_N|\theta|}{\theta_{KT}}\right]\hat{e}. \tag{A17}$$

Plugging the values of $\hat{X}_T$ and $\hat{X}_N$ from (A16) and (A17) in the percentage change form of the unskilled labour constraint (A12) give us the overall change in aggregate employment of unskilled labour under the generalized case.

A3. Non-Homothetic Taste

Total differentiation of the market clearing condition for non-traded good under non-homothetic taste yields $-\tilde{\varepsilon}_N(\hat{P}_N-\hat{P}_T)+\eta\hat{y}=\hat{X}$.

Substitution of values of the change in relative price of non-traded good and that of real income yields $\hat{X}_N=\frac{-\tilde{\varepsilon}_N(\theta_{KN}-\theta_{KT})}{\theta_{KT}}\hat{e}+\eta\left[\theta_L\hat{L}_e+\theta_S\hat{w}_S+\theta_K\hat{r}-\hat{e}\right]$.

Using values from (A2), (A8) and the value of $\hat{r}$ the above expression boils down to

$$\hat{X}_N=\frac{-\tilde{\varepsilon}_N|\theta|}{\theta_{KT}}\hat{e}+\eta\left[\theta_L\left(\lambda_{LT}\hat{X}_T+\lambda_{LN}\hat{X}_N\right)+\frac{\theta_S(\theta_{KT}-\theta_{SZ})}{\theta_{KT}\theta_{SZ}}\hat{e}+\frac{\theta_K}{\theta_{KT}}\hat{e}-\hat{e}\right].$$

$$\Rightarrow(1-\eta\theta_L\lambda_{LN})\hat{X}_N-\eta\theta_L\lambda_{LT}\hat{X}_T=\frac{-\tilde{\varepsilon}_N|\theta|}{\theta_{KT}}\hat{e}+\eta\left[\frac{\theta_S(\theta_{KT}-\theta_{SZ})+\theta_K\theta_{SZ}-\theta_{KT}\theta_{SZ}}{\theta_{KT}\theta_{SZ}}\hat{e}\right].$$

Using this and $\lambda_{KT}\hat{X}_T+\lambda_{KN}\hat{X}_N=-\frac{\alpha\lambda_{KZ}}{\delta}(\gamma_{KZ}-\gamma_{SZ})^2\hat{e}$ we get

$$\begin{bmatrix}-\eta\theta_L\lambda_{LT} & 1-\eta\theta_L\lambda_{LN}\\ \lambda_{KT} & \lambda_{KN}\end{bmatrix}\begin{bmatrix}\hat{X}_T\\ \hat{X}_N\end{bmatrix}=\begin{bmatrix}\frac{-\varepsilon_N|\theta|}{\theta_{KT}}\hat{e}+\beta_y\hat{e}\\ -\psi\hat{e}\end{bmatrix}, \tag{A18}$$

where $\beta_y=\eta\left[\frac{\theta_S(\theta_{KT}-\theta_{KZ})+\theta_K\theta_{SZ}-\theta_{KT}\theta_{SZ}}{\theta_{KT}\theta_{SZ}}\hat{e}\right]$ and $\psi=\frac{\alpha\lambda_{KZ}}{\delta}(\lambda_{KZ}-\lambda_{SZ})^2<0$.

Solving for output changes by Cramer's Rule we obtain:

$$\hat{X}_T=\frac{1}{\Delta}\left[\frac{-\lambda_{KN}\tilde{\varepsilon}_N|\theta|}{\theta_{KT}}+\psi(1-\eta\theta_L\lambda_{LN})+\frac{\eta\lambda_{KN}\beta_y}{\theta_{KT}\theta_{SZ}}\right]\hat{e},$$

$$\hat{X}_N = \frac{1}{\Delta}\left[\frac{\lambda_{KT}\check{\varepsilon}_N|\theta|}{\theta_{KT}} + \psi\eta\theta_L\lambda_{LT} - \frac{\eta\lambda_{KT}\beta_y}{\theta_{KT}\theta_{SZ}}\right]\hat{e}.$$

Finally, substituting these values in (A8) yields the change in aggregate employment as in the text.

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