Anti-immigration Policy in Developed Countries: Welfare and Distributional Implications for Developing Economies

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Abstract

This paper develops a 3×4 full-employment small open economy model for examining the consequences of anti-immigration policy adopted in the host country on both national income and wage inequality in a source developing economy that is plagued with multiple distortions. The country exports a primary agricultural commodity while it imports one low-skilled manufacturing commodity and one high-skilled commodity. The low-skilled manufacturing sector faces a unionized labour market. Both the import-competing sectors are protected by import tariffs. All skilled workers of the economy are equally desirous of migrating to a developed country because of high skilled wage differential. However, how many skilled workers would be allowed to migrate is a policy variable of the host country. The analysis finds that the outcomes of a restrictive immigration policy adopted in the host country on the major economic variables in the source economy crucially hinge on both technological factors and the bargaining power of the trade unions in the low-skilled sector. Most interestingly, both national income and wage inequality are very likely to deteriorate when, given other things, the degree of distortion in the unskilled labour market is sufficiently high. Besides, we have also carried out a systematic quantitative analysis of our results using the simulation techniques to show that our results are valid for a wide range of parameter values. Finally, some policy recommendations have been made for improving both economic growth and relative wage distribution.

Keywords: Anti-immigration policy; Source economy; National income; Skilled labour; Unskilled labour; Wage inequality; Trade unionism; General equilibrium model.

JEL Codes: D58, I24, I28, J31, J61.

1. Introduction and motivation

The percentage of immigrants in jobs in developed countries, especially in US increased more than 400 percent over the last six decades.[1] The high earnings differential between developed and developing countries and better work and living conditions are the driving forces behind increasing pace of migration to developed countries. From a study by Lopez and Radford (2015) on the US immigrants it is evident that the skilled workers without US origin, especially with South and East Asian including Indian origin constitute a major proportion of the skilled workforce in US and have contributed significantly to economic growth in the country.

Despite increases in international mobility of labour, especially skilled labour and higher rates of economic growth across countries, studies by Pimentel et al. (2018) and the World Inequality Report (2018), Quereshi (2018) have reported that the income and wealth inequality has increased in all major countries and that in some countries it has increased very sharply. The benefits of higher rates of economic growth have been pocketed only by a very few super rich people while the poorer section of the population has been largely left out. The real wage of the common workers has stagnated. The Oxfam Annual Wealth Checklist report (2019) sheds light on the magnitude of income and wealth inequalities, in both global and some country-specific cases, and states how fast these are increasing over time.

A very important recent incident that is worth mentioning in this context is that the US president, Mr. Donald Trump after taking the office has announced to resorting to stricter immigration policies by lowering the number of H-1B and H-4 Visas issued by the country with a view to reduce the number of high-skill immigrants citing the reason to preserve more white-collar jobs for the native skilled workers. The high-skill workers from India would be the worst sufferers.[2] This anti-immigration policy on the part of US and the Brexit incident in UK severely restricts freer international mobility of labour across countries.

What could be possible impacts of the anti-immigration policy pursued by US and UK on

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[1] See the reports by Docquier (2014), Geiger (2017) etc.

[2] See The Time of India, April 24, 2018. Available at https://timesofindia.indiatimes.com/business/india-business/trump-adminstartion-plans-to-end-work-permits-for-h-1b-visa-spouses/articleshow/63892934.cms

welfare and wage inequality in a source small open country? There exists a conventional theoretical literature, which analyzes the effect of emigration of labour from a small country on the welfare of the non-migrants in that country. Theoretical models, devoted to welfare impact of migration, do not provide an unambiguous answer to the question how international migration affects natives in the host and source countries. Moreover, the presented results are strongly conditional on assumptions.
The customary result in the setting of the Heckscher-Ohlin-Samuelson (HOS) model for an undistorted small open source economy with two homogenous inputs, labour and capital and in the absence of both transfer of capital and remittances, any given amount of emigration reduces the national income because the labour endowment of the source country decreases although the welfare of the non-migrants measured in terms of per capita national income that includes both wage income and rental income definitely rises. Note that workers are the owners of capital and that the same amount of capital income is now distributed among a lesser number of people.[3]

The literature that discusses the welfare impact of emigration on the welfare of the non-migrants in the developing countries starts with the work by Berry and Soligo (1969) who define the welfare gain (loss) as a net increase (decrease) of non-migrants' income and have shown that in almost all cases, emigration harms the non-migrants through the price mechanism. Besides, Rivera-Batiz (1982) has shown that if one of the two commodities is internationally non-tradable, the emigration, if it is from the non-tradable goods sector may lower welfare of the non-migrants. Nevertheless, Quibria (1988) has shown that if international migration of labour is not accompanied by any movement of capital, the per capita availability of capital for the non-migrants labour force also rises. This produces a positive income-effect. If the positive income-effect outweighs the adverse TOT effect, if any, the effect on welfare is exactly opposite to that Rivera-Batiz (1982) has found. However, in his later paper, Quibria (1997) has shown that if the model is extended to include remittances sent by emigrants, the welfare of non-mobile natives does not have to decrease. Djajić (1998) has examined the impact of emigration on the welfare of non-mobile residents of source country in the presence of foreign capital and has noted that the negative effect can be reversed.

[3] This is based on the assumption that an emigrant leaves his capital share behind and does not send any remittances to the source economy.

Three important observations are as follows. First, in all the above papers labour is assumed to be homogeneous. In other words, no distinction has been made between migrants and non-migrants from the viewpoint of skills. Second, this literature does not consider some of the essential characteristics of the developing economies like existence of factor market distortion, dualistic structure including rural-urban migration etc. Finally, the rising trend of income and wage inequality has not been addressed by the works that have been listed above.

If we take up the aspect of wage inequality, we will find that there are two strands of literature. The first strand (e.g. Acemoglu (1998), Feenstra (2004), Zhou and Trefler (2005) and Marjit et al. (2004) etc.) finds that the rising trend of wage inequality can be attributed to trade liberalization and transfer of skill-biased technology. The second strand (e.g. Chaudhuri and Yabuuchi (2007), Pan and Zhou (2013), Pi and Zhou (2012, 2014), Anwar and Sun (2015), Pi and Chen (2016), Chaudhuri et al. (2018), Pi and Zhang (2017) etc.) finds that factors like governmental policies and institutional characteristics of the factor market could be held responsible for worsening of the wage inequality in the Southern countries. In addition to these two, there are some works for example Marjit and Kar (2005), Chaudhuri (2004), Beladi et al. (2008), Chaudhuri (2008) that study the impacts of international mobility of capital and labour on wage inequality and conclude that the results are conditional on the relative distributive shares of the input (capital) that is intersectorally mobile between the low-skilled and high-skilled sectors.

It is evident from the above discussion that there is dearth of work in the theoretical literatures on both international migration of labour and wage inequality that not only studies the impacts of international labour mobility on both national welfare and wage inequality but also highlights the role of different market imperfections in influencing the consequences of this exogenous change.[4] The present work attempts to fill up this vacuum in terms of a three-sector, full-employment general equilibrium model with both labour market and production market distortions. There are two import-competing sectors, a low-skilled manufacturing sector (sector 2) and a high-skilled sector (sector 3) both of which are protected by import tariffs. The exports sector (sector 1) apart from unskilled (low-skilled) labour and capital uses a specific input, land.

[4] Mention should be made of a paper by Fuest and Thum (2000) who have studied the welfare consequence of immigration on natives in the host country in the presence of labour unions and collective bargaining. They have found that welfare of the native population might improve depending on suitable restrictions on the wage elasticity of labour demand in the unionized sector and number of immigrants. However, they have not examined the consequences of labour migration on welfare and relative wage inequality in the source country.

The low-skilled manufacturing sector (sector 2) faces a unionized labour market where the unionized unskilled wage is determined through a Nash bargaining game between the representative firm and the representative trade union in the industry.

The analysis finds that the outcomes of the anti-immigration policy adopted in the host country on both national income and per capita income and the relative wage inequality in the source country hinge crucially on both technological factors and the bargaining power of the trade unions in the low-skilled sector. The paper then goes on to show how a change in the bargaining power of the labour unions could alter the outcomes on both the economic indicators. Most interestingly, both national income and wage inequality are very likely to deteriorate when, given other things, the degree of distortion in the unskilled labour market is sufficiently high. Qualitative results, however, do not depend much on the institutional factor if the bargaining power of the trade unions is low. Besides, we have also carried out a systematic quantitative analysis of our results using the simulation techniques to show that our results are valid for a wide range of parameter values. Finally, policy recommendations have been made for improving both economic growth and relative wage distribution.

2. The Model

Let us consider a full-employment model for a small open developing economy with three-sectors and four factors of production. Sector 1 produces an agricultural commodity (commodity 1) with the help of unskilled labour (L), land (N) and capital (K). Sector 3 produces a high-skilled commodity like computer software (commodity 3) using skilled labour (S) and capital. Finally, sector 2 produces a low-skilled manufacturing good (commodity 2) by means of unskilled labour and capital. Throughout this paper by capital we mean 'working capital'. Land, on the other hand, is natural capital. The four inputs of production are fully employed and the country's endowments of unskilled labour, skilled labour, land and capital are exogenously fixed at $\bar{L}, \bar{S}, \bar{N}$ and $\bar{K}$, respectively. Land and skilled labour are specific to sector 1 and sector 3 and their rates of return are R and W_S, respectively. Capital is perfectly mobile among all the sectors and its economy-wide rate of return is r. The capital-output ratio in sector 1, a_{K1} is technologically given.[5]

[5] Although this is a simplifying assumption it is not completely without any basis. Agriculture requires inputs like fertilizers, pesticides, weedicides etc. which are to be used in recommended doses. Now if

There is imperfection in the market for unskilled labour in sector 2. In sector 2 (formal sector) workers receive the unionized wage, W^* which is determined through collective bargaining between the representative firm and the representative labour union in the industry. The workers in the informal sector receive a low competitive wage, W.

Although the general form of the production function in sector 2 is $X_2 = F^2(L_2, K_2)$, for expositional purpose we consider the following specific algebraic form of the same.

$$X_2 = (L_2)^{\alpha}(K_2)^{(1-\alpha)} \tag{1}$$

Here, X_2, L_2 and K_2 denote that output level, employment of unskilled labour and amount of use of capital in sector 2, respectively. Finally, α denotes the output elasticity of unskilled labour. We here directly borrow the following unionized wage function as derived in Chaudhuri (2016).[6]

$$W^* = W[1 + \frac{U(1-\alpha)}{\alpha}] \tag{2}$$

Here U denotes the bargaining power of the labour union in each competitive firm in sector 2.[7]

From (2) we find that W^* and W are proportionately related and that $E_W = (\frac{\partial W^*}{\partial W}\frac{W}{W^*}) = 1$.

Besides, W^* and U are also positively correlated. It is to be noted that unskilled labour is perfectly mobile between sector 1 and sector 2 despite the presence of imperfection in the labour market in sector 2. The intersectoral wage differential or the degree of imperfection in the unskilled labour market is then given by

capital (working capital) is used to purchase those inputs, the capital-output ratio becomes constant technologically. However, unskilled labour and land are substitutes and the production function displays the property of constant returns to scale in these two inputs. However, even if the capital-output ratio is not given technologically the results of the paper still hold under an additional sufficient condition incorporating the elasticities of the input-output coefficients in sector 1 with respect to input prices.

[6] See Appendix 3 in Chaudhuri (2016).

[7] One of the most important objectives of the labour unions is to bargain with their respective employers to set the unionized wage, W^* to be as high as possible compared to the reservation wage, i.e., the agricultural sector (an informal sector) wage, W. The higher the bargaining power of the representative firm in the formal sector (sector 2) industry, U, the larger would be the intersectoral wage differential. However, U is amenable to policy measures. If the government undertakes different labor market regulatory measures, e.g., partial or complete ban on resorting to strikes by the trade unions, reformation of employment security laws to curb union power, U, takes a lower value.

$$(W^* - W) = W(\frac{1-\alpha}{\alpha})U \qquad (2.1)$$

From (2.1), we find that

$W^* = W$ when $U = 0$.

All other standard assumptions of the Heckscher-Ohlin-Samuelson model including CRS with positive but diminishing marginal productivity to each factor are retained.[8] In this model, all the three commodities are internationally traded. Hence, their prices, P_is are given by the small open economy assumption.

At this junction, we do not speak much about the trade pattern of this small open developing economy except that the country exports commodity 1. Two possible trade patterns are as follows. Apart from commodity 1, the country exports the high-skill good (commodity 3) as well. This could well fit the trade pattern of a country like India that is a large exporter of high-skill commodity like computer software. Alternatively, we can think about a country with a small endowment of skilled labour that is a net importer of this commodity. Initially, we consider a general structure where the country imports both the low-skill manufacturing good (commodity 2) and the high-skill good (commodity 3). Let us also assume that both the sectors are protected by import tariffs, at the ad valorem rates, t_2 and t_3, respectively. Because of the presence of import tariffs, the domestic or tariff-inclusive prices of commodity 2 and commodity 3 are $(1+t_2)P_2$ and $(1+t_3)P_3$, respectively. Finally, commodity 1 is chosen as the numeraire.

Because both skilled and unskilled wages are higher in the developed destination country like US relative to those prevailing in the source country, both types of worker would be interested to emigrate if higher income is considered to be the only motivator behind emigration. In this paper, we fully concentrate on the international migration of skilled labour. In our model, either type of labour is homogeneous. Hence, because of the inter-country wage differential, all of them ($\bar{S}$) will be interested to emigrate provided emigration is costless and are allowed to do so. However, how many high-skill people would be allowed to emigrate, S^* is a policy variable of the destination country. Consequently, $(\bar{S} - S^*)$number of skilled workers cannot emigrate

[8] Note that although the capital-output ratio, a_{K1} is fixed in sector 1, the production function still displays constant returns to scale in the other two inputs, unskilled labour and land.

and are fully employed in the high-skill sector (sector 3) in our source developing country. Therefore, the source country's effective skilled labour endowment is $(\bar{S} - S^*)$.

We assume that the international migration of skilled labour does not deplete the economy's given capital stock and that the workers are the owners of capital. The latter implies that the total population of the economy comprises of only the skilled and unskilled workers. Emigration is not accompanied by capital outflow and no remittances are received by the source country from abroad.

The general equilibrium structure of the model consists of the following set of equations.

$$Wa_{L1} + Ra_{N1} + ra_{K1} = 1 \tag{3}$$

$$W^* a_{L2} + ra_{K2} = (1+t_2)P_2 \tag{4}$$

$$W_S a_{S3} + ra_{K3} = (1+t_3)P_3 \tag{5}$$

$$a_{N1}X_1 = \bar{N} \tag{6}$$

$$a_{S3}X_3 = (\bar{S} - S^*) \tag{7}$$

$$a_{L1}X_1 + a_{L2}X_2 = \bar{L} \tag{8}$$

$$a_{K1}X_1 + a_{K2}X_2 + a_{K3}X_3 = \bar{K} \tag{9}$$

where a_{ji} denotes the per unit requirement of the jth input in the ith sector with $j = L, N, S, K$ and $i = 1, 2, 3$. Besides, we define $\theta_{ji} = (\frac{w_j a_{ji}}{P_i})$ as the distributive share and $\lambda_{ji} = (\frac{a_{ji} X_i}{J_i})$ as the allocative share of the jth input in the ith sector which would be subsequently used in stating the results.

Equations (3) – (5) are the three zero-profit conditions for the agricultural, low-skilled manufacturing and high-skilled sectors, respectively. Equations (6) – (9) are the full-employment conditions for land, skilled labour, unskilled labour and capital correspondingly.

In this small open economy with tariff distortion, national welfare can be proxied by national income measured at domestic prices, which is given by the following.[9, 10]

National income at domestic prices is given by

$$Y = X_1 + (1+t_2)P_2X_2 + (1+t_3)P_3X_3 + t_2P_2M_2 + t_3P_3M_3 \tag{10}$$

where, M_2 and M_3 denote the volume of imports of commodity 2 and the volume of imports of commodity 3, respectively and these two are given by the following, respectively.

$$M_2 = D_2(\underset{(-)}{(1+t_2)P_2}, \underset{(+)}{(1+t_3)P_3}, \underset{(+)}{Y}) - X_2 \tag{11}$$

$$M_3 = D_3(\underset{(+)}{(1+t_2)P_2}, \underset{(-)}{(1+t_3)P_3}, \underset{(+)}{Y}) - X_3 \tag{12}$$

and,

$$D_2 = D_2(\underset{(-)}{(1+t_2)P_2}, \underset{(+)}{(1+t_3)P_3}, \underset{(+)}{Y}) \text{; and,} \tag{13}$$

$$D_3 = D_3(\underset{(+)}{(1+t_2)P_2}, \underset{(-)}{(1+t_3)P_3}, \underset{(+)}{Y}) \tag{14}$$

are the two aggregate demand functions for commodity 2 and commodity 3, respectively. As we can see from equations (13) and (14), the demands have negative own-price and both positive cross-price and income elasticities.

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[9] The optimum social welfare depends on the commodity prices (faced by consumers) and national income. When the commodity prices change, there are two effects on welfare − ***price effect*** and ***income effect***. In such cases, national welfare should ideally be measured in terms of a strictly quasi-concave social welfare function of the form, $\Omega = \Omega(D_1, D_2, D_3)$, since both the price and income effects can be captured by this function. However, in a small open economy which is a price-taker at the international market and where there are no non-traded final commodities and consumer prices of commodities do not change, national income at domestic, Y can be used as a good proxy for social welfare as it captures the ***income effect***. Because of reduction in skilled emigration, the consumer prices of commodities (exogenously given) do not change which in turn implies that there is only ***income effect*** and no ***price effect***. Hence, national income at domestic prices, Y has here been used for measuring social welfare. See also Chaudhuri and Mukhopadhyay (2014), Chapter 2 for further details. However, in this model, welfare is meant and defined in a special sense which is explained in detail in footnote 10.

[10] In the original Heckcher-Ohlin-Samuelson (HOS) model and in its hybrid structures with income inequality, there are limitations in measuring national welfare in terms of social welfare function or national income unless there is a social planner who taxes the rich people and redistributes the tax proceeds among the poor people in a non-distortionary manner so that social equity is ensured. However, if apart from welfare we want to focus on wage inequality too, the Sen's (1974) welfare index might be a better option relative to the social welfare function.

In (10), $t_i P_i M_i$ measures the aggregate tariff revenue of the government earned from imports of commodity i for $i = 2,3$. The aggregate tariff revenue collected by the government is transferred to consumers in a lump-sum manner.[11]

Using (6) and (7), equations (8) and (9) can be, respectively rewritten as follows.

$$(\frac{a_{L1}}{a_{N1}})\bar{N} + a_{L2}X_2 = \bar{L} \tag{8.1}$$

$$(\frac{a_{K1}}{a_{N1}})\bar{N} + a_{K2}X_2 + (\frac{a_{K3}}{a_{S3}})(S - S^*) = \bar{K} \tag{9.1}$$

This general equilibrium system consists of 13 independent equations, (2) – (14) and exactly the same number of endogenous variables, namely $W, R, r, W_S, W^*, X_1, X_2, X_3, Y, M_2, M_3, D_2$ and D_3. The unknown factor prices, $W, W_S R$ and r cannot be solved from the three zero-profit conditions, (3) - 5). Hence, the system is indecomposable. All unknown factor prices depend on both commodity prices and factor endowments. The process of determination of the endogenous variables is as follows. W, R, r and X_2 are simultaneously solved from equations (3), (4), (8.1) and (9.1). Then W_S is found from (5). W^* is obtained from (2). Once factor prices are known, the factor-coefficients, a_{ji} s are also known as these are functions of factor prices. X_1 and X_3 are then found from equations (6) and (7), respectively. Finally, Y, D_2, D_3, M_2 and M_3 are determined from equations (10) – (14).

[11] This is the standard assumption made in the theoretical literature on international trade. See Beladi and Marjit (1992a,b), Marjit and Beladi (1996), Chaudhuri and Mukhopadhyay (2009, 2014) among others.

It may be noted that sector 1 and sector 2 use two common inputs, unskilled labour and capital and together form a sub-system that can be classified in terms of factor intensities. It is sensible to assume that the low-skilled manufacturing sector (sector 2) is more capital-intensive vis-à-vis the agricultural sector (sector1) in value sense, i.e. $(\frac{\theta_{K2}}{\theta_{L2}} > \frac{\theta_{K1}}{\theta_{L1}})$. Because, $W^* > W$, it then follows that sector 2 is more capital-intensive relative to sector 1 in physical sense as well i.e. $(\frac{\lambda_{K2}}{\lambda_{L2}} > \frac{\lambda_{K1}}{\lambda_{L1}}) \Rightarrow (\frac{a_{K2}}{a_{L2}} > \frac{a_{K1}}{a_{L1}})$.[12]

3. Comparative statics

In this theoretical piece we intend to examine the consequences of the anti-immigration policy in the destination country on the source developing from the perspective of both welfare and income inequality. More specifically, we would like to investigate how the policy affects the national income, per capita income and the wage inequality between the two groups of working population. Anti-immigration policy in this model is captured through an exogenous decrease in the number of skilled workers allowed emigration to the destination country.

3.1 Policy effect on national income

As discussed previously, the welfare of this small open developing is measured in terms of national income at domestic which is given by the following.

$$Y = X_1 + (1+t_2)P_2X_2 + (1+t_3)P_3X_3 + t_2P_2M_2 + t_3P_3M_3 \quad (10)$$

The notations used in equation (10) have already been defined.

[12] In the theoretical literature on trade and development, the exports (import-competing) sector in a developing economy is conventionally assumed to be labor-intensive (capital-intensive). A pertinent question is whether this assumption is true at present although the same was reasonable in the distant past. UNCTAD (2015) after analyzing global trade data up to 2013 has reported that the developing countries' exports basket is still skewed towards primary products both in their exports towards the North and the South, while developed countries' export basket mainly comprises intermediate products. Because the capital content in the production of primary products is unquestionably lower than that in manufacturing and/or intermediate goods, the above-mentioned capital intensity condition seems to be valid in general even in recent years.

Differentiating equations (2) – (4), (2.1), (7), (8.1), (9.1) and (10) – (12) we can derive the following expression.[13]

$$(\frac{dY}{dS^*}) = -V\Big[(\underset{(-)}{\frac{X_2 M}{(1+t_2)P_2 S^* \Delta}})\Big[\Big\{\Big(\frac{(1-\alpha)U}{\alpha+(1-\alpha)U}\Big)\theta_{L2} - \frac{t_2}{1+t_2}\Big\}\Big\{\underset{(+)}{B(\theta_{L1}\theta_{K2} - \theta_{K1}\theta_{L2})}$$

$$+\underset{(+)}{\theta_{N1}\theta_{K2}\lambda_{L1}(S^1_{LN} + S^1_{NL})}\Big\} - (\frac{t_2}{1+t_2})\underset{(+)}{\theta_{N1}\lambda_{L2}S^2_{LK}}\Big]$$

$$+ (\frac{W_S}{\theta_{S3}})[\theta_{S3} - (\frac{t_3}{1+t_3})]\Big] \qquad (15)$$

Here, $(M,\ B,\ S^i_{jk}) > 0$; $V > 1$; and, $\Delta < 0$ are a few terms that have been defined in Appendix 1 and Appendix 2. All other terms in (15) have already been defined.

From (15), the following results immediately follow.

$(\frac{dY}{dS^*}) < 0$ if (i) $\theta_{L2} \le (\frac{t_2}{1+t_2})$; and, (ii) $\theta_{S3} \ge (\frac{t_3}{1+t_3})$

(16.1)

$(\frac{dY}{dS^*}) < 0$ if (i) $U \simeq 0$; (ii) $t_2 > 0$; and, (ii) $\theta_{S3} \ge (\frac{t_3}{1+t_3})$

(16.2)

$(\frac{dY}{dS^*}) > 0$ if (i) $U \simeq 1$; (ii) t_2 is small; and, (ii) $\theta_{S3} \le (\frac{t_3}{1+t_3})$

(16.3)

$(\frac{dY}{dS^*}) > 0$ if (i) $t_2 \simeq 0$; and, (ii) $\theta_{S3} \le (\frac{t_3}{1+t_3})$

(16.4)

The results, as presented above, can be verbally stated in terms of the following two propositions.

Proposition 1: The anti-immigration policy adopted in the destination country raises national income at domestic prices if (i) $\theta_{L2} \le (\frac{t_2}{1+t_2})$; and, (ii) $\theta_{S3} \ge (\frac{t_3}{1+t_3})$. The national income also

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[13] This has been derived in Appendix 1 and Appendix 2.

rises due to the policy under the alternative set of sufficient conditions: (i) $U \approx 0$; (ii) $t_2 > 0$; and, (ii) $\theta_{S3} \geq (\frac{t_3}{1+t_3})$.

Proposition 2: The national income, Y falls following a more stringent immigration policy if (i) $U \approx 1$; (ii) t_2 is small; and, (iii) $\theta_{S3} \leq (\frac{t_3}{1+t_3})$. The national income plummets also under the set of sufficient conditions, (i) $t_2 \approx 0$; and, (ii) $\theta_{S3} \leq (\frac{t_3}{1+t_3})$.

We intuitively explain proposition1 proposition 2 as follows. Because the anti-immigration policy in the developed nations, captured through a reduction in the value of S^* raises the effective skilled endowment of the economy, $(\bar{S} - S^*)$, the aggregate skilled wage income rises. This we call the ***Skilled Endowment Effect*** (SEE). This raises Y. On the other hand, sector 3 expands because skilled labour is specific to this sector. The expanding sector 3 draws capital from the Sub-system comprising of sector 1 and sector 2. Hence, a reduction in the availability of capital produces a ***Rybczynski type effect*** in the sub-system. Because sector 2 is more capital-intensive relative to sector 1 with respect to unskilled labour in value sense, X_2 decreases and X_1 increases.

On the other hand, the higher unskilled wage-paying sector (sector 2) contracts while the lower unskilled wage-paying sector (sector 3) expands. Note that $W^* > W$. Consequently, the aggregate unskilled wage income decreases. We call this the *Labour Reallocation Effect* (LRE) that lowers Y. Finally, the tariff revenue that the consumers receive as transfer payments, also changes. In our generalized cases, there are two import-competing sectors, sector 2 and sector 3 and both of them are tariff-protected at the ad valorem rates, t_2 and t_3, respectively. We have seen that sector 3 (sector 2) has expanded (contracted). Hence, the volume of imports of commodity 3 (commodity 2) would fall (increase) and so would the respective tariff revenues. The reduction in tariff revenue from the imports of commodity 3 is called *Tariff Revenue Effect 3* (TRE_3) that

exerts a downward pressure on national income at domestic prices, Y. On the contrary, the *Tariff Revenue Effect 2* (TRE_2) raises Y.

Hence, in all there are four different effects on the national income, Y. While Y increases due to SEE and TRE_2, it falls following LRE and TRE_3. If TRE_2 outweighs LRE and SEE dominates over TRE_3, national income rises. Besides, if the bargaining strength of the labour unions of unskilled in sector 2 is negligibly small, the magnitude of the LRE would almost be zero. In such a case national income increases if SEE outweighs TRE_3 and if there is a small tariff on sector 2. Proposition 1 sums up these sufficient conditions pairwise.

On the contrary, if LRE outweighs TRE_2 and TRE_3 dominates over SEE, national income falls. The alternative sufficient conditions pairwise are provided in proposition 2.

From (15), the following *Corollary* is also imminent.
Corollary 1: **National income can fall following a reduction in skilled migration even in the absence of any protectionist policy.**

In the absence of any protectionist policy, t_2 and t_3 are zero. Hence, TRE_2 and TRE_3 are zero. However, national income falls if the negative *LRE* dominates over the positive *SEE*.

3.2 Simulation exercise

In this section, in terms of a simulation exercise we would like to show that our claims made in Proposition 1 could be correct at least quantifiably. We consider several parameter values according to assumptions in the model and in close approximation to actual data. Our results show that under plausible initial conditions, the conditions presented in (16.1 -16.2) holds.

From (15) it is clear that $(\frac{dY}{dS^*}) < 0$, if the sign of the expression $\{(\frac{(1-\alpha)U}{\alpha+(1-\alpha)U})\theta_{L2} - \frac{t_2}{1+t_2}\} \leq 0,$ and $[\theta_{S3} - (\frac{t_3}{1+t_3})] \geq 0.$ We denote the first expression as

Π and the second expression as ρ . Our basic objective is to show the fact that these sufficient conditions (presented in 16.1 -16.2) hold under meaningful parametric values.

We consider following values of different parameters as presented in Table 1 below and present the sign of expression Π against U .

Table 1:

	α	t_2	θ_{L2}	U (range)
Simu 1	0.3	0.2	0.3	.01 - 1
Simu 2	0.3	0.2	0.4 (↑)	.01 - 1
Simu 3	0.3	0.2	0.5 (↑)	.01 - 1

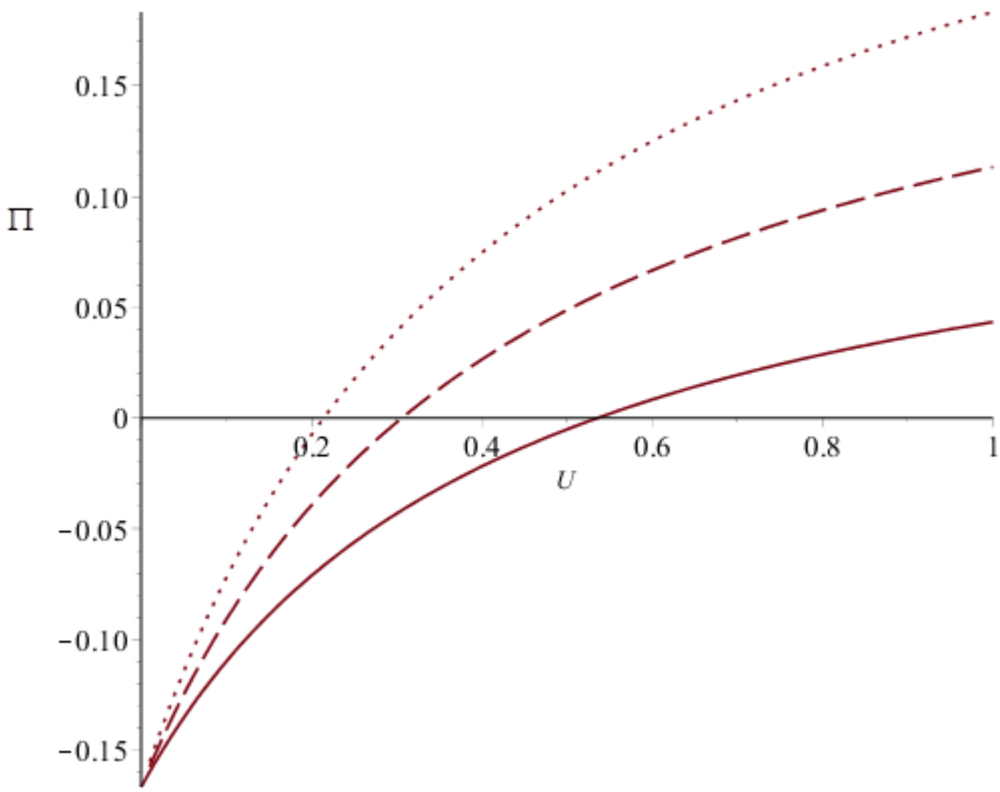

Figure 1: Π against U (under different values of θ_{L2})

It is evident from Figure 1 that when U is close to 0, higher is the probability that $\Pi \leq 0$ and therefore, $(\frac{dY}{dS*}) < 0$. We have raised the value of θ_{L2} to see how the sign of Π gets affected. As θ_{L2} increases from 0.3 to 0.5 the relationship moves from the solid line to dashed line and then to the dotted line indicating the fact that the probability of getting the desired result increases with lower value of θ_{L2} which is consistent with our intuitive explanation. It is easy to check that the relation holds under wide range of values of α and t_2 as well.

Figure 2 portrays the second sufficient condition of (16.1/16.2). It is clear that the sign of ρ is positive under a range of values of θ_{S3} and t_3 which generates the result $(\frac{dY}{dS^*}) < 0$. As t_3 increases from 0.1 to 0.2 to 0.3, the resulting relationship moves from the solid line to dashed line to the dotted line indicating the fact that the probability of ρ being positive decreases with increase in t_3 (given other things constant)

*

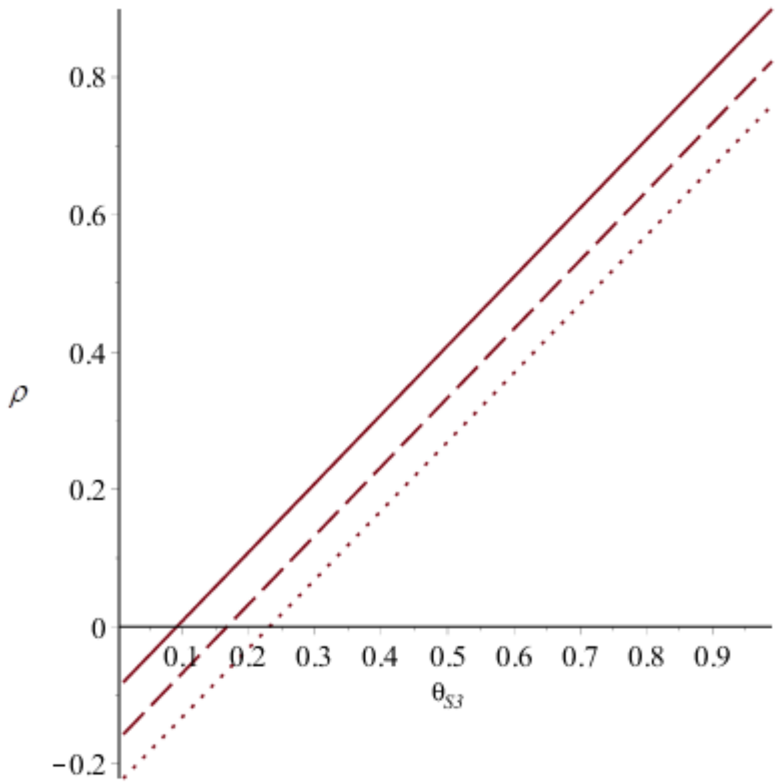

Figure 2: ρ against θ_{S3} (under different values of t_3)

3.3 Policy effect on per capita income

There is a fundamental asymmetry between analyzing the welfare consequence of international movement of capital with that of labour. This is because, in the case of capital the population size over whom welfare is defined remains the both before and after capital movement. On the contrary, the size of population itself changes in the case of international mobility of labour, either skilled or unskilled. Hence, instead of national income, one should be more concerned about the change in per capita national income in the latter case.

The per capita income, denoted y is defined as follows.

$$y = \left(\frac{Y}{\bar{L} + \bar{S} - S^*}\right) \tag{17}$$

Differentiating (17), it is easy to find that

$$\left(\frac{dy}{dS^*}\right) = \left[\frac{1}{\bar{L} + \bar{S} - S^*}\right]\left[\left(\frac{dY}{dS^*}\right) + \mathrm{y}\right] \tag{18}$$

Using (16.1) – (16.4) from (18), it is easy to establish the following proposition.

Proposition 3: The per capita income of the non-migrants decreases if (i) $U \approx 1$; (ii) t_2 is small; and, (ii) $\theta_{S3} \le \left(\frac{t_3}{1+t_3}\right)$. The per capita income also decreases if (i) $t_2 \approx 0$; and, (ii) $\theta_{S3} \le \left(\frac{t_3}{1+t_3}\right)$. In all other possible cases, the effect of the policy on the per capita income cannot be unambiguously stated.

The interpretations of proposition 3 are fairly straightforward. The per capita national income, y rises with an increase in national income, Y and decreases with an increase in the size of population, $(\bar{L} + \bar{S} - S^*)$ and vice versa. The population size rises due to anti-immigration that lowers y given Y. Now if Y falls that happens under the sufficient conditions as stated in proposition 3, y definitely falls. However, if Y rises, there would be two opposite forces on y. Its direction of change cannot be definitely predicted.

3.4 Policy effect on skilled-unskilled wage inequality

In this section of this paper, we would like to investigate the consequence of the anti-immigration policy on high-skill labour in the developed nations, on the relative wage inequality in the developing economy that we are considering.

Unskilled workers in this system earn two different wages – either the unionized wage, W^*, in sector 2 or a lower competitive wage, W, in sector 1. The average wage for unskilled labour is given by

$$W_A \equiv (W\lambda_{L1} + W^*\lambda_{L2}) \tag{19}$$

We have already stated that λ_{L1} and λ_{L2} are allocative shares of unskilled labour in the two sectors, 1 and 2. In other words, λ_{L1} and λ_{L2} are the proportions of unskilled labour employed in sectors 1 and 2, respectively. Hence, we have $(\lambda_{L1} + \lambda_{L2}) = 1$. In this case, the skilled–unskilled wage gap improves (worsens) in absolute terms if the gap between W_S and W_A falls (rises). On the other hand, the wage inequality improves (deteriorates) in relative terms if $(\hat{W}_S - \hat{W}_A) < (>) 0$. Here '^' denotes proportional change e.g. $\hat{T} \cong (\frac{dT}{T})$.

Differentiating (2) – (4), (8.1), (9.1) and (19), the following mathematical term can be derived.[14]

$$\left(\frac{\hat{W}_S - \hat{W}_A}{\hat{S}^*}\right) = -\left(\frac{\theta_{N1}\lambda_{L2}M}{\theta_{S3}\Delta}\right)\Big[\underset{(-)}{(\theta_{K3} - \theta_{K2})} - \Big[\frac{(1-\alpha)U}{\alpha + (1-\alpha)\lambda_{L2}U}\Big]\Big[\underset{(+)}{B\left(\frac{\theta_{L1}\theta_{K2} - \theta_{K1}\theta_{L2}}{\theta_{N1}}\right)} + \underset{(+)}{\theta_{K2}\lambda_{L1}(S^1_{LN} + S^1_{NL})}\Big]\Big] \tag{20}$$

From (20) the following results are imminent.

$$\left(\frac{\hat{W}_S - \hat{W}_A}{\hat{S}^*}\right) > 0 \text{ if (i) } \theta_{K3} > \theta_{K2}\text{; and, (ii) } U \text{ is sufficiently small;} \tag{21.1}$$

$$\left(\frac{\hat{W}_S - \hat{W}_A}{\hat{S}^*}\right) < 0 \text{ if (i) } \theta_{K3} \le \theta_{K2}\text{; and, (ii) } U > 0; \tag{21.2}$$

$$\left(\frac{\hat{W}_S - \hat{W}_A}{\hat{S}^*}\right) < 0 \text{ if (i) } (\theta_{K3} - \theta_{K2}) \text{ is sufficiently small; and, (ii) } U \text{ is sufficiently high.} \tag{21.3}$$

[14] For detailed derivations, see Appendix 1 and Appendix 3.

Note that $[\frac{(1-\alpha)U}{\alpha+(1-\alpha)\lambda_{L2}U}]$ is increasing in U.

The results as presented in (21.1) – (21.3) can be summarized in the form of the following proposition.

Proposition 4: A curb on the emigration of skilled labour from the developing country, leads to an improvement in the skilled-unskilled wage inequality if the capital content of the production technology in the high-skill sector is greater than that in the low-skill manufacturing sector and if the bargaining power of the labour unions in the latter sector is very low. On the contrary, the wage inequality worsens due to the policy if the low-skill manufacturing sector not at least less capital-intensive relative to the high-skill sector and if the labour unions have some bargaining power. The inequality also deteriorates if the difference between the capital contents of the two sectors is very small and if the bargaining strength of the labour unions in the low-skill manufacturing sector is very high.

We verbally explain proposition 4 in the following fashion. A reduction in emigration of skilled labour raises the effective skilled endowment of the economy, $(\bar{S}-S^*)$ and leads to a decrease in the skilled wage rate, W_S. To satisfy the zero profit condition in sector 2, the return to capital, r, rises. The high-skill sector (sector 3), however, expands and draws capital from the sub-system. Because sector 2 is more capital-intensive relative to sector 1 with respect to unskilled labour, sector 2 contracts while sector 1 expands following a Rybczynski-type-effect. As r rises given the relative domestic price of commodity 2, the unionized unskilled wage, W^*, must fall to satisfy the zero profit condition in sector 2. Nevertheless, W^* can fall only if the competitive unskilled wage, W, falls. The return to land, R, falls as a consequence. Producers in sector 1 adopt more (less) land (unskilled labour) intensive technology of production than before which in turn implies a contraction of sector 1 both in terms of output and employment of unskilled labour, as land is specific to this sector. The released workers from sector 1 are now absorbed in sector 3. Sector 3 expands both in terms of output and employment. Thus, we find that the average unskilled wage increases due to (i) an increase in W; (ii) an increase in W^*; and, due to (iii) an increase (a decrease) in the proportion of unskilled labour employed in the higher (lower) wage-paying sector i.e. λ_{L3} (λ_{L1}). Therefore, the average unskilled wage, W_A unambiguously rises.

What happens to the skilled-unskilled wage inequality depends on the rates of increase in W_S and W_A. If $(\theta_{K3}/\theta_{L3}) > (=)(\theta_{K2}/\theta_{S2})$, the saving on capital cost in the low-skill manufacturing sector is more than (equal to) that in the high-skill sector, which in turn, implies that the rate of increase of the unionized unskilled wage, W^*, is greater than (equal to) that of the skilled wage, W_S. But, as we have mentioned above, that there are other two factors working positively on the average unskilled wage. Thus, the wage inequality improves under the sufficient condition as mentioned in proposition 1.

The role of the degree of imperfection in the unskilled labour market, captured through the value of the bargaining power of the trade unions, U in influencing the results on wage inequality can be easily understood from equations (2), (2.1) and (4). It has already been explained why a reduction in magnitude of skilled emigration, S^* raises the return to capital, r thereby lowering all the three wages, W_S, W^* and W. The higher the value of U, the higher would be the fall in W^*. Consequently, the larger the value of U, the higher would be the fall in the average unskilled wage, W_A under the situation. Hence, the possibility that the wage inequality worsens, following the anti-immigration policy, ceteris paribus, increases with an increase in the bargaining power of the trade union, U in the formal unskilled labour market. From (20), it is easily seen that when there is no imperfection in the unskilled labour market i.e. when $U = 0$, the relative wage inequality deteriorates if and only if $\theta_{K3} > \theta_{K2}$.

3.5 Simulation exercise

To understand whether the results presented in (21.1)- (21.3) holds under meaningful parametric values we attempted a similar simulation exercise as in section 3.2. From (20) it is clear that if $\theta_{K3} \leq \theta_{K2}$, wage inequality increases owing to a reduction in S^* that is $(\frac{\hat{W}_S - \hat{W}_A}{\hat{S}^*}) < 0$. However, the direction of change is ambiguous if $\theta_{K3} > \theta_{K2}$ and from (20) is clear that the sign of the term $(\frac{\hat{W}_S - \hat{W}_A}{\hat{S}^*})$ is determined by the sign of the expression $\left[(\theta_{K3} - \theta_{K2}) - [\frac{(1-\alpha)U}{\alpha + (1-\alpha)\lambda_{L2}U}][B(\frac{\theta_{L1}\theta_{K2} - \theta_{K1}\theta_{L2}}{\theta_{N1}}) + \theta_{K2}\lambda_{L1}(S^1_{LN} + S^1_{NL})]\right]$. We denote the expression as Γ and simulate its value for different values of the contained parameters. It is clear that the value of the expression $[B(\frac{\theta_{L1}\theta_{K2}-\theta_{K1}\theta_{L2}}{\theta_{N1}})+\theta_{K2}\lambda_{L1}(S_{LN}^{1}+S_{NL}^{1})]$ lies in 0-1 range and we denote it as ψ. It is evident that $(\frac{\hat{W}_S-\hat{W}_A}{\hat{S}*})>0$, if and only if $\Gamma>0$. We consider following values of different parameters as presented in Table 2 below and present the sign of expression Γ against U.

Table 2:

	α	θ_{K3}	θ_{K2}	λ_{L2}	ψ	U (range)
Simu 1	0.3	0.6	0.3	0.3	0.5	.01 - 1
Simu 2	0.3	0.7 (↑)	0.3	0.3	0.5	.01 - 1
Simu 3	0.3	0.8 (↑)	0.3	0.3	0.5	.01 - 1

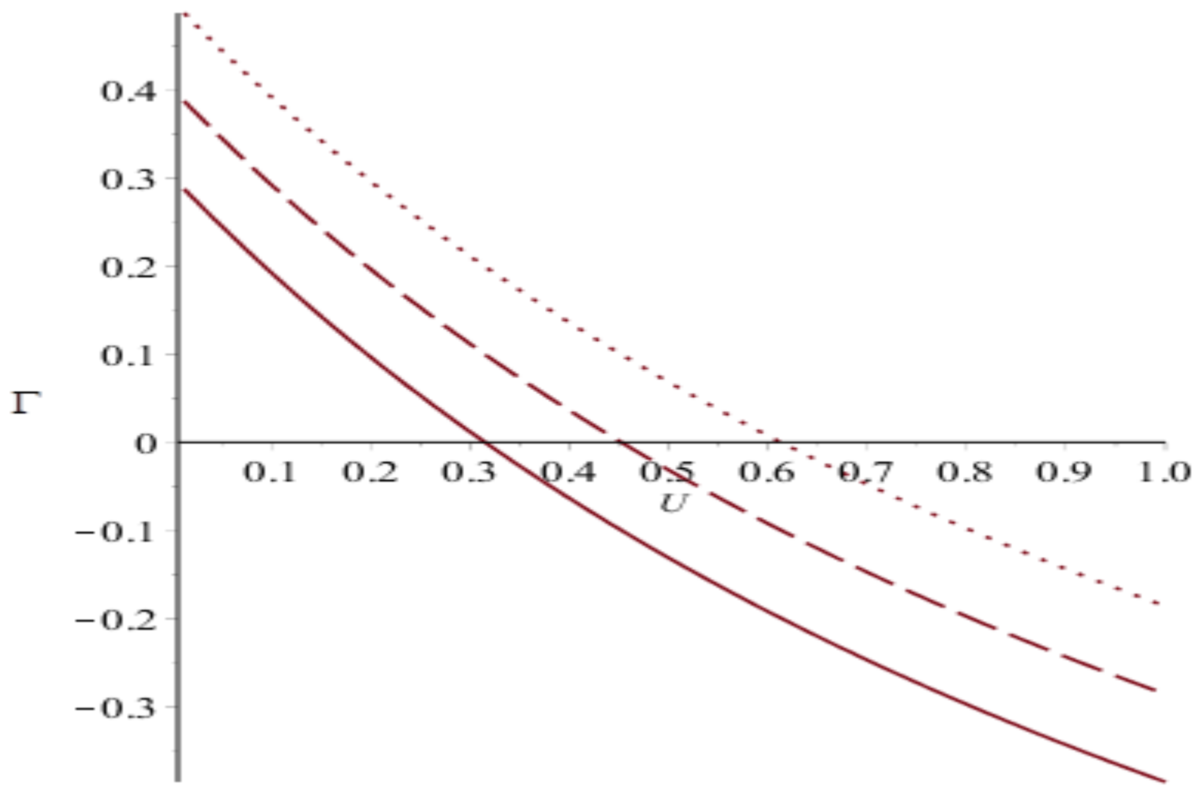

Figure 3: Γ against U (under different values of θ_{K3})

It is evident from Figure 3 that smaller the value of U, higher is the probability that $\Gamma > 0$ and therefore $(\frac{\hat{W}_S - \hat{W}_A}{\hat{S}^*}) > 0$. We have considered higher values of θ_{K3} to see how the sign of Γ gets affected. As θ_{K3} increases from 0.6 to 0.8 the relationship moves from the solid line to dashed line and then to the dotted line indicating the fact that the probability of getting the desired result increases with higher value of θ_{K3} corresponding to an even higher value of U. This is consistent with our intuitive explanation. It is easy to check that the relation holds under wide range of values of α, θ_{K3}, θ_{K2}, λ_{L2} and ψ as well.

4. Concluding Remarks and Policy Implications of Results

The ongoing process of globalization has not been an unmixed blessing for all people across the globe. Although the rates of economic growth have increased across countries, the income and wealth inequality has considerably increased. The benefits of higher growth have not reached the bottom-rung of the societies because only a few super rich people have appropriated most of the gains. The discontent of the rising inequality and the consequent social conflict and feeling of insecurity of the mass people have possibly resulted in the Brexit incident and the unexpected win for Mr. Donald Trump in the post of US president. The process of globalization has suddenly experienced a heavy jitter when US has begun to undertake a couple of anti-globalization policies like imposition of heavy import duties on many commodities that are exported by China and some other developing economies and issuance of less H-1B and H-4 visas so as to curb the level of skilled immigration with a view to preserve sufficient number of high quality white color jobs for the native workers.

The existing theoretical literature on international migration has not adequately discussed the consequences of such an anti-immigration policy undertaken in the host country on the economic growth and wage inequality in a source developing economy that is plagued with multiple distortions. These issues have been addressed in this paper using a three-sector full-employment general equilibrium model with both labour market and commodity market imperfections. The economy exports a low-skilled agricultural commodity and imports two commodities – one low-skilled manufacturing and one high-skilled commodities. Both the import-competing sectors are protected by import tariffs. Finally, there is imperfection in the unskilled manufacturing labour market. Unskilled workers in this sector receive a high unionized wage which is determined through collecting bargaining between the representative firm and the representative trade union. The higher the bargaining power of the trade unions, the larger would be intersectoral unskilled wage differential. Skilled labour is specific to the high-skilled sector. Because of international skilled wage differential skilled workers are willing to emigrate abroad. However, how many skilled workers will be allowed to immigrate from the source developing country to the developed host country is a policy variable of the latter. Anti-immigration policy is captured through a reduction in the number of skilled immigration.

In this setting, it is found that a restrictive immigration policy on the part of the developed country might adversely affect not only national income and per capita income of the non-immigrants but also the relative wage inequality under a wide range values of parameters like ad valorem tariff rates and degree of imperfection prevailing in the unskilled labour market. The stronger the trade unions, the higher would be the possibility of having unfavorable consequences on both the economic indicators. Additionally, a higher degree of protectionism also affects economic growth negatively. These results lead to a couple of important policy implications. In the face of anti-globalization policies adopted by developed economies, the developing countries should not retaliate by resorting to the same restrictive economic policies that distract them from the path of economic liberalism. They should rather open up their economies further by resorting to trade and labour market reforms because only these policies can protect themselves from the potential unfavorable outcomes of the protective policies that the developed countries are presently pursuing. If the developing world sticks to the path of economic liberalism, opens up their economics further and could form custom unions, their aggregate bargaining strength in the world commodity markets will increase. Consequently, the developed countries will think twice before adopting to restrictive economic policies because of the fear that the policies might backfire and hurt them more in the long run relative to their developing counterparts.

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Appendix 1: Derivations of a couple of useful expressions

Differentiating equations (2) – (4), (8.1) and (9.1) and arranging in a matrix notation, we write the following.

$$\begin{bmatrix} \theta_{L1} & \theta_{N1} & \theta_{K1} & 0 \\ \theta_{L2} & 0 & \theta_{K2} & 0 \\ -A & B & C & \lambda_{L2} \\ -D & G & -H & \lambda_{K2} \end{bmatrix} \begin{bmatrix} \hat{W} \\ \hat{R} \\ \hat{r} \\ \hat{X}_2 \end{bmatrix} = \begin{bmatrix} 0 \\ 0 \\ 0 \\ M\hat{S}* \end{bmatrix}$$

(A.1)

where: $A = [\lambda_{L1}(S_{LN}^1 + S_{NL}^1) + \lambda_{L2} S_{LK}^2] > 0$; $B = [\lambda_{L1}(S_{LN}^1 + S_{NL}^1)] > 0$;

$C = (\lambda_{L2} S_{LK}^2) > 0$; $D = [\lambda_{K1} S_{NL}^1 - \lambda_{K2} S_{KL}^2] = ?$; $G = (\lambda_{K1} S_{NL}^1) > 0$;

(A.2)

$H = (\lambda_{K2} S_{KL}^2) > 0$; $M = (\dfrac{\lambda_{K3} S*}{\bar{S} - S*}) > 0$

Here, S_{jk}^i is the elasticity of the input-output coefficient of factor j in sector i i.e. a_{ji} with respect to the price of the kth input for $j,k = L,N,K$ and $i = 1,2$. For example, in sector 1, $S_{LL}^1 = (\partial a_{L1} / \partial W)(W / a_{L1})$, $S_{LN}^1 = (\partial a_{L1} / \partial R)(R / a_{L1})$. $S_{jk}^i > 0$ for $j \neq k$ and $S_{jj}^i < 0$. It should be noted that as the production functions are homogeneous of degree one, the factor coefficients, a_{ji}s are homogeneous of degree zero in the factor prices. Hence the sum of elasticities of any factor coefficient (a_{ji}) in any sector with respect to factor prices must be equal to zero. For example, in sector 1, with respect to labour coefficient, we have $(S_{LL}^1 + S_{LN}^1) = 0$ while with respect to land coefficient, $(S_{NL}^1 + S_{NN}^1) = 0$. Similarly, in sector 2, $(S_{LL}^2 + S_{LK}^2) = 0$ and $(S_{KL}^2 + S_{KK}^2) = 0$.

Solving (A.1), using (A.2) and simplifying we obtain the following expressions.

$$(\frac{\hat{X}_2}{\hat{S}*}) = -(\underset{(-)}{\frac{M}{\Delta}})[\underset{(+)}{B}(\underset{(+)}{\theta_{L1}\theta_{K2} - \theta_{K1}\theta_{L2}}) + \underset{(+)}{\theta_{N1}(\theta_{L2}C + \theta_{K2}A)}] > 0$$

(A.3)

$$(\frac{\hat{W}}{\hat{S}*}) = -(\underset{(-)}{\frac{\theta_{N1}\theta_{K2}\lambda_{L2}M}{\Delta}}) > 0$$

(A.4)

$$(\frac{\hat{R}}{\hat{S}*}) = [(\frac{\lambda_{L2}M}{\Delta})(\theta_{L1}\theta_{K2} - \theta_{K1}\theta_{L2}) \ > \ 0$$

(−) (+)

(A.5)

$$(\frac{\hat{r}}{\hat{S}*}) = (\frac{\theta_{N1}\theta_{L2}\lambda_{L2}M}{\Delta}) \ < \ 0$$

(−)

(A.6)

$$(\frac{\hat{W}_S}{\hat{S}*}) = -\ (\frac{\theta_{K3}\theta_{N1}\theta_{L2}\lambda_{L2}M}{\theta_{S3}\Delta}) \ > \ 0$$

(−)

`(A.7)

where

$$\Delta = -\big[(\theta_{K2}\theta_{L1} - \theta_{L2}\theta_{K1})[\lambda_{L1}\lambda_{K2}S^1_{LN} + (\lambda_{L1}\lambda_{K2} - \lambda_{L2}\lambda_{K1})S^1_{NL}] + \theta_{N1}\theta_{L2}(C\lambda_{K2} + H\lambda_{L2})$$

(+) (+) (+) (+)

$$+\theta_{N1}\theta_{K2}[(\lambda_{L1}\lambda_{K2} - \lambda_{L2}\lambda_{K1})S^1_{NL} + \lambda_{K2}\lambda_{L1}S^1_{LN} + \lambda_{L2}\lambda_{K2}(S^2_{KL} + S^2_{LK})]\big] \ < \ 0$$

(+) (+)

(A.8)

We note that

$$L_2 = a_{L2}X_2$$

(A.9)

Differentiating equation (A.9) we get

$$(\frac{\hat{L}_2}{\hat{S}*}) = -\big[S^2_{LK}[(\frac{\hat{W}}{\hat{S}*}) - (\frac{\hat{r}}{\hat{S}*})] - (\frac{\hat{X}_2}{\hat{S}*})\big]$$

(A.10)

Using (A.2) – (A.7) and simplifying from (A.10) we finally arrive at the following expression.

$$(\frac{\hat{L}_2}{\hat{S}*}) = -(\frac{M}{\Delta})\big[B(\theta_{K2}\theta_{L1} - \theta_{L2}\theta_{K1}) + \theta_{K2}\theta_{N1}\lambda_{L1}(S^1_{LN} + S^1_{NL})\big] \ > \ 0$$

(−) (+) (+)

(A.11)

Besides, from equation (7) we can write the following.

$$X_3 = (\frac{\overline{S} - S*}{a_{S3}})$$

(A.12)

Differentiating (A.12), we obtain the following.

$$(\frac{dX_3}{dS*}) = -\ (\frac{1}{a_{S3}}) \ < \ 0$$

(A.13)

Appendix 2: Change in National Income

Differentiating equation (10) one gets

$$dY = [dX_1 + (1+t_2)P_2 dX_2 + (1+t_3)P_3 dX_3 + t_2 P_2 dM_2 + t_3 P_3 dM_3]$$

(A.14)

Differentiation of (11) and (12) and substituting in (A.14) we find

$$dY = \left[dX_1 + (1+t_2)P_2 dX_2 + (1+t_3)P_3 dX_3 + t_2 P_2 (\frac{\partial D_2}{\partial Y} dY - dX_2) + t_3 P_3 (\frac{\partial D_3}{\partial Y} dY - dX_3)\right]$$

(A.15)

Here note that $X_1 = F^1(L_1, N_1)$and $X_2 = F^2(L_2, K_2)$are the two production functions and that production technologies in sector 3 are of fixed-coefficient type. Besides, the capital-output ratio in sector 1, $a_{K1}$is also fixed. The full-employment conditions for the four inputs are:

$$L_1 + L_2 = \bar{L}\ ;\ N_1 = \bar{N};\ S_3 = (\bar{S} - S^*) \text{ and } K_1 + K_2 + K_3 = \bar{K}.$$

(A.16)

where, $Z_i$denotes the amount of the Zth input employed in the ith sector for $Z = L, N, K, S$; and, $i = 1, 2, 3$.

After differentiating the production functions equation, equation (A.15) may be expressed as follows.

$$dY = \Big[[F_L^1 dL_1 + F_N^1 dN_1] + rdK_1 + P_2^*[F_L^2 dL_2 + F_K^2 dK_2] + [W_S dS_3 + rdK_3]$$

$$+ [t_2 P_2 (\frac{\partial D_2}{\partial Y} dY - dX_2) + t_3 P_3 (\frac{\partial D_3}{\partial Y} dY - dX_3)]\Big]$$

or,

$$dY = \Big[[WdL_1 + RdN_1] + rdK_1 + [W^* dL_2 + rdK_2] + [W_S dS_3 + rdK_3]$$

$$+ [t_2 P_2 (\frac{\partial D_2}{\partial Y} dY - dX_2) + t_3 P_3 (\frac{\partial D_3}{\partial Y} dY - dX_3)]\Big]$$

(A.17)

Differentiating the full-employment conditions as given in (A.16) and noting that $d\bar{L}, d\bar{N}, d\bar{S}, d\bar{K} = 0$ we get

$$dL_1 = -dL_2;\ dN_1 = 0;\ dS_3 = -dS^*;\ (dK_1 + dK_2 + dK_3) = 0$$

(A.18)

$$dY = \left[(W^* - W)dL_2 - W_S dS^* + t_2 P_2[(\frac{\partial D_2}{\partial Y})dY - dX_2] + t_3 P_3[(\frac{\partial D_3}{\partial Y})dY - dX_3]\right]$$

After simplification we get

$$dY\left[1-(\frac{t_2m_2}{1+t_2})-(\frac{t_3m_3}{1+t_3})\right]=\left[(W^*-W)dL_2-W_SdS^*-t_2P_2dX_2-t_3P_3dX_3\right]$$

(A.19)

where $m_2=[(1+t_2)P_2(\frac{\partial D_2}{\partial Y})]$ and $m_3=[(1+t_3)P_3(\frac{\partial D_3}{\partial Y})]$ are the marginal propensities to consume commodity 2 and commodity 3, respectively with $(1>m_2>0);(1>m_3>0)$; and, $(m_2+m_3)<1$.

Further simplification leads to the following.

$$dY=V\left[(W^*-W)dL_2-W_SdS^*-t_2P_2dX_2-t_3P_3dX_3\right]$$

(A.20)

where, $V=[\frac{1}{[1-(\frac{t_2m_2}{1+t_2})-(\frac{t_3m_3}{1+t_3})]}]$ is the standard multiplier term. Note that $V>1$ when $1>t_2,t_3>0$; and, $V=1$ when $t_2,t_3=0$.

Hence, $(\frac{dY}{dS^*})=V\left[(W^*-W)(\frac{dL_2}{dS^*})-W_S-t_2P_2(\frac{dX_2}{dS^*})-t_3P_3(\frac{dX_3}{dS^*})\right]$

(A.21)

Using (A.2), (A.3), (A.11) and (A.13) and simplifying from (A.21) we can arrive at the following expression.

$$(\frac{dY}{dS^*})=-V\Big[(\frac{X_2M}{S^*\Delta})\big[\underset{(-)}{\{(W^*-W)a_{L2}-t_2P_2\}}\{B\underset{(+)}{(\theta_{L1}\theta_{K2}-\theta_{K1}\theta_{L2})}+\theta_{N1}\theta_{K2}\lambda_{L1}\underset{(+)}{(S^1_{LN}+S^1_{NL})}\}$$
$$-t_2P_2\theta_{N1}\lambda_{L2}S^2_{LK}\big]+W_S-(\frac{t_3P_3}{a_{S3}})\Big]$$

(A.22)

Further simplification leads to

$$(\frac{dY}{dS^*}) = -V\Big[(\frac{X_2 M}{(1+t_2)P_2 S^* \Delta})\Big[\Big\{(\theta_{L2} - \frac{t_2}{1+t_2}) - \frac{Wa_{L2}}{(1+t_2)P_2}\Big\}\Big\{B(\theta_{L1}\theta_{K2} - \theta_{K1}\theta_{L2})$$

(−) (+)

$$+\theta_{N1}\theta_{K2}\lambda_{L1}(S^1_{LN} + S^1_{NL})\Big\} - (\frac{t_2}{1+t_2})\theta_{N1}\lambda_{L2}S^2_{LK}\Big]$$

(+) (+)

$$+ (\frac{W_S}{\theta_{S3}})[\theta_{S3} - (\frac{t_3}{1+t_3})]\Big]$$

(15)

Appendix 3: Effect on Wage Inequality

We rewrite equation (19) as follows.

$$W_A = (\lambda_{L1}W + \lambda_{L2}W^*) = [W + (W^* - W)(\frac{L_2}{\overline{L}})]$$

(A.23)

where $L_2 \ (= a_{L2}X_2)$ is the employment level of unskilled labour in sector 2.
Differentiating (A.23) we get

$$\hat{W}_A = [\hat{W} + (W^* - W)(\frac{\lambda_{L2}}{W_A})\hat{L}_2]$$

(A.24)

Using (A.4) and (A.11) and simplifying from equation (A.25) we can arrive at the following expression.

$$(\frac{\hat{W}_A}{\hat{S}^*}) = -(\frac{\lambda_{L2}M}{\Delta})\Big[\theta_{N1}\theta_{K2} + \frac{(W^* - W)}{W_A}[B(\theta_{L1}\theta_{K2} - \theta_{K1}\theta_{L2}) + \theta_{N1}\theta_{K2}\lambda_{L2}(S^1_{LN} + S^1_{NL})]\Big]$$

(A.25)

Subtracting (A.25) from (A.7) we obtain the following expression.

$$(\frac{\hat{W}_S - \hat{W}_A}{\hat{S}^*}) = -(\frac{\theta_{N1}\lambda_{L2}M}{\theta_{S3}\Delta})\Big[(\theta_{K3}\theta_{L2} - \theta_{K2}\theta_{S3})$$

(−)

$$-(\frac{W^* - W}{W_A})[B(\frac{\theta_{L1}\theta_{K2} - \theta_{K1}\theta_{L2}}{\theta_{N1}}) + \theta_{K2}\lambda_{L1}(S^1_{LN} + S^1_{NL})\Big]$$

(+) (+)

(A.26)

Using (2.1) and (19) and simplifying from equation (A.26) the following expression can be easiy derived.

$$(\frac{\hat{W}_S - \hat{W}_A}{\hat{S}*}) = -(\frac{\theta_{N1}\lambda_{L2}M}{\theta_{S3}\Delta})\Big[\underset{(-)}{(\theta_{K3} - \theta_{K2})}$$

$$-[\frac{(1-\alpha)U}{\alpha + (1-\alpha)\lambda_{L2}U}][B\underset{(+)}{(\frac{\theta_{L1}\theta_{K2} - \theta_{K1}\theta_{L2}}{\theta_{N1}})} + \underset{(+)}{\theta_{K2}\lambda_{L1}(S^1_{LN} + S^1_{NL})}]\Big] \tag{20}$$

Note that $(\theta_{K2} + \theta_{L2} = 1 = \theta_{K3} + \theta_{S3})$