Should Countries Worry About Immiserizing Growth?

by

Stephen Tokarick[1]

April 2016

Abstract

In the presence of tariff protection, Johnson (1967) showed that factor accumulation in a two-good, two-factor model could reduce a country's real income if it is biased sufficiently toward production of the tariff-protected good. This paper presents the conditions that must hold for immiserization to occur regardless of the number of goods or factors. In general, adding more goods beyond two seems to reduce the likelihood of immiserization. In the context of the specific factors' model, the chances of immiserization are greater the larger the difference between the tariff rate in the expanding sector and the other tariff rates. This result provides some additional rationale for adopting a more uniform tariff structure.

JEL Codes: F13, C68

Keywords: immiserizing growth, protection, factor accumulation, welfare

[1] Senior economist, International Monetary Fund, Research Department, 700 19th Street N.W., Room 9-511, Washington D.C., 20431. E-mail address: stokarick@imf.org. Phone: 202-623-7590. FAX: 202-623-8291. The views expressed in this paper are those of the author and should not be attributed to the International Monetary Fund, its Executive Board, or its Management.

I. Introduction

International trade theory has pointed out at least two situations under which factor accumulation or technical progress could reduce a country's real income. The first, attributed to Bhagwati (1958), occurs when factor accumulation is biased toward a country's export sector. This will deteriorate the country's terms of trade; if this effect is sufficiently large, then factor accumulation could reduce welfare. The second situation, attributed to Johnson (1967), occurs when factor accumulation takes place in the presence of tariff protection at unchanged terms of trade. Johnson showed that if the factor accumulation is biased sufficiently toward the tariff-protected sector, it could indeed reduce real income.

This paper examines the conditions that must be satisfied in order for Johnson-type immiserization to occur in models with more than two goods and factors. The few papers in the literature that examined the topic of Johnson-type immiserization, such as Bertrand and Flatters (1971), Martin (1977), and Miyagiwa (1993), relied on specific cases and model structures. For example, in the context of the standard two-good, two-factor model of international trade in which all factors of production are intersectorally mobile, Bertrand and Flatters (1971) and Martin (1977) derived the conditions for immiserization if the import good is capital intensive, however, their analysis did not extend beyond two goods. In the context of the specific factors' model, Miyagiwa (1993) analyzed the condition for immiserization with two goods and three factors and concluded that if the tariff rate exceeds the capital-ratio in the import sector, the economy *may* suffer immiserization. The results derived in this paper show that it is possible to be more precise about the conditions necessary for immiserization.

This paper presents exact conditions that must be satisfied in order for factor accumulation to immiserize a country in the presence of protection at unchanged terms of trade, regardless of the number of goods, factors, or tariff-protected goods. The results show that in the "even" model—a model with an equal number of goods and factors—immiserization might not be possible with more than two goods, while immiserization is always possible in the specific factors' model. The final section of the paper reports how increases the supplies of factors of production would affect real income for twenty countries, using an applied general equilibrium model for each country. The simulations suggest that only one of the countries—Tunisia—would be adversely affected by an increase in the supply of a factor specific to one of the import industries.

This paper also tackles the issue of how a country's tariff structure affects the likelihood that it might suffer immiserizing growth, that is, can a country design its tariff structure in a way that would make immiserization impossible? It turns out that in the context of the specific factors' model, immiserization is more likely the larger the difference between the tariff rate applied to imports in the expanding sector and the tariff rate in other sectors. Thus, in the context of this model, moving to a more uniform tariff structure would reduce the likelihood that a country would suffer immiserizing growth in the sense of Johnson, but it would not eliminate the chances of immiserization entirely. There is a rather large literature that has argued that there are benefits from adopting a uniform tariff structure on political

economy grounds (see for example Balassa (1989 and Harberger (1990))[2], so the results from this paper provide additional support for why it may be beneficial for countries to move toward a more uniform tariff structure.

Immiserizing growth is not just a theoretical possibility, but it has real-world applicability. For example, many developing countries expend a great deal of effort trying to attract additional foreign investment. Some of these countries offer tax incentives—such as exemptions from certain import duties and income taxes—in an attempt to induce firms to locate operations in their country. While it is difficult to gauge exactly the magnitude of these incentives, some evidence suggests that they are large and growing. For example, Chai and Goyal (2008) estimate that tax incentives offered by countries that comprise the Eastern Caribbean Currency Union amount to between 9½ and 16 percent of GDP in forgone tax revenue per year. Keen and Mansour (2009) point out that tax incentives offered by countries in sub-Saharan Africa have expanded dramatically between 1980 and 2005. A practical policy question becomes whether the scarce resources of developing countries should be devoted to the attraction of foreign direct investment if the inflow of factors of production (labor and capital inflows) and technological progress could result in a loss in real income. For example, Brecher and Diaz-Alejandro (1977) showed that for a small economy with a tariff in place on its capital intensive import good, an inflow of capital from abroad *must* harm the recipient country if the foreign capital receives the full, untaxed value of its marginal product.

[2] These arguments are refuted to some degree by Panagariya and Rodrik (1993).

II. The Model

This section presents the conditions under which factor accumulation could immiserize a country in the presence of protection. Consider a model with *M* goods, including one export good (denoted by E) taken to be the (untaxed) numeraire and *M -1* imported goods, each subject to an ad-valorem tariff (t_j). Suppose that there are also *N* factors of production that are perfectly inelastically supplied. The budget constraint for the economy is:

$$G(P_E, P_{M1}, P_{M2}, ...P_{M-1}, V_1, V_2, ...V_N) + \sum_{j=M1}^{M-1} t_j P_j^* (E_j - G_j) = E(P_E, P_{M1}, P_{M2}, ...P_{M-1}, U) \qquad (1)$$

where $G(\cdot)$ is the economy's GDP function, $E(\cdot)$ is the expenditure function, P_j and P_j^* are the domestic and world prices of good j (j=E, M1, M2, …M -1) respectively, V_k is the endowment of the kth factor, and U is the consumer's utility level. A subscript next to the expenditure or GDP function represents partial differentiation with respect to that variable. The demand for the jth good is given by the derivative of the expenditure function with respect to the jth price (E_j) and the supply of the jth good by the derivative of the GDP function with respect to the jth price (G_j). Therefore, $(E_j - G_j)$ denotes imports of the jth good and $t_j P_j^* (E_j - G_j)$ gives tariff revenue on the jth imported good. World prices are assumed to be given—the small country assumption.

Suppose that one factor endowment, k, increases. The welfare effect is given by totally differentiating (1), holding prices constant:

$$dU\left[E_U - \sum_{j=M1}^{M-1} t_j P_j^* E_{jU}\right] = \left[G_{V_k} - \sum_{j=M1}^{M-1} t_j P_j^* G_{jV_k}\right] dV_k \qquad (2)$$

where E_U is the marginal utility of income and E_{jU} is the marginal utility of good j, since E_j is the hicksian demand for good j. The term G_{jV_k} measures how output of good j (G_j) changes as a result of a change in the supply of factor k, at constant prices. In equation (2), adopt the "Hatta normality condition," which assumes that the term $\left[E_U - \sum_{j=M1}^{M-1} t_j P_j^* E_{jU}\right] > 0$, see Hatta (1977) and Anderson and Neary (2005) for a discussion.

Now, using equation (2), an increase in the endowment of factor *k* will lead to immiserization if:

$$\left[G_{V_k} - \sum_{j=M1}^{M-1} t_j P_j^* G_{jV_k}\right] < 0 \text{, for } dV_k > 0 \qquad (3).$$

Using some basic duality results (see Dixit and Norman (1980) and Woodland (1982)), equation (3) can be written:

$$w_k < \sum_{j=M1}^{M-1} t_j P_j^* \frac{\partial X_j}{\partial V_k} \tag{4}$$

where w_k is the return to factor k and X_j is output of good j. Putting equation (4) into elasticity form gives:

$$1 < \sum_{j=M1}^{M-1} \omega_j \eta_{jk} \frac{\alpha_j}{\beta_k}, \text{ for } (dV_k > 0) \tag{5}$$

where $\omega_j = \frac{t_j}{1+t_j}$, η_{jk} are the elasticities of output j with respect to a change in the endowment in factor k (the standard Rybczynski elasticities), α_j is the share of sector j's output in national income, and β_k is the share of factor k's income in national income.

An alternative condition that must be satisfied in order for immiserization to occur can be derived by exploiting some well-known duality results. Using the reciprocity relationships (Samuelson (1953)), i.e. $\frac{\partial X_j}{\partial V_k} = \frac{\partial w_k}{\partial P_j}$, equation (4) can be expressed as:

$$1 < \sum_{j=M1}^{M-1} \omega_j \varepsilon_{kj}, \quad \text{for } (dV_k > 0) \tag{6}$$

where ε_{kj} is the elasticity of the price of factor *k* with respect to a change in the price of output *j*—the Stolper-Samuelson elasticity. For an increase in the supply of factor k, all other endowments constant, immiserization will occur when the weighted sum of the Stolper-Samuelson elasticities across all (M - 1) imported goods exceeds one. Equations (5) and (6) represent equivalent conditions that must be satisfied in order for immiserization to occur, regardless of the number of goods and factors—conditions that were not previously available in the literature.

III. Some Results

This section lays out some results that follow from the equations (5) and (6) and these results depend on model structure, i.e. number of goods and factors, so a number of cases need to be examined. Throughout the remainder of the paper, the case of more goods than factors will not be analyzed, given the tendency to specialize under these circumstances.

A. The "Even" Case

Suppose the endowment of some factor *k* increases, while all other endowments remain unchanged, and the number of goods equal the number of factors (M=N). The critical point to emphasize in this case is that immiserization may not be possible. Focussing on equation (6), the weighted sum of the Stolper-Samuelson elasticities with respect to a change in the prices of all imported goods must exceed one for immiserization to occur. Jones and Scheinkman (1977) demonstrated that in the "even" model, every factor has at least one "natural enemy" (a commodity whose price increase lowers the real return to that factor), but

not necessarily a "natural friend". This means that for factor k, there is at least one $\varepsilon_{kj} < 0$, but not necessarily a $\varepsilon_{kj} > 1$. With many goods and factors it is difficult to know the signs of each ε_{kj} without further information, so it is not possible to say very much about the likelihood of immiserization in this case. However, if factor k does not have a "natural friend", then immiserization may not be possible, or at least, it becomes more difficult. If, for example, factor k possesses only one "natural friend" and it happens to be the export good, then immiserization would be difficult according to equation (6), since the weighted-sum of the stolper-samuelson elasticities across the *M-1* import goods would contain at least one negative element and no element greater than one.

Two other general conclusions are evident from equations (5) and (6). First, for goods for which either η_{jk} or ε_{kj} is positive, the chances of immiserization will be greater: (i) the larger the share of sector j in national income (the higher is α_j); and (ii) the higher the tariff rate on good j. Second, immiserization will be more likely the lower the share of factor k (β_k) in national income—the more "unimportant" factor k is in the terminology of Jones and Scheinkman (1977).

In the case of only two goods (an export (E) and an import good (M)) and two factors (labor (L) and capital (K)) it is possible to make some rather definitive statements about the conditions under which immiserization could occur. Applying equations (5) and (6) to this case, the conditions for immiserization become:

$$1 < \omega_M \eta_{Mk} \frac{\alpha_M}{\beta_k}, \qquad \text{for } (dV_k > 0) \tag{7}$$

and

$$1 < \omega_M \varepsilon_{kM}, \qquad \text{for } (dV_k > 0) \tag{8}$$

where the subscript M refers to the single import good.

In the (2x2) case, immiserization requires that the import good be a "natural friend" of factor k, but unlike the (nxn) case, factor k is guaranteed of having a natural friend—this is the Stolper-Samuelson (1941) theorem. Consider the standard case of two goods (exports (E) and imports (M)) and two factors of production (labor (L) and capital (K)) and suppose that the supply of capital increases. The only issue is whether the import good or the export good is a "friend" of capital (K). If the import good is capital intensive, then $\varepsilon_{KM} > 1$ and immiserization will be possible, provided the tariff rate (ω_M) is sufficiently high.[3] Provided $\varepsilon_{KM} > 1$, then the magnitude of the tariff rate needed to generate immiserization is:

[3] In the case of two goods (exports (E) and imports (M)) and two factors (K and L), imports are capital intensive if $\left(\theta_{KM}\theta_{LE} - \theta_{KE}\theta_{LM}\right) > 0$, where θ_{ij} is the cost share of factor i in good j.

$$t_M > \frac{1}{\varepsilon_{KM} - 1}, \text{ for an increase in the supply of factor k (capital)} \quad (9).$$

It can be easily shown that this condition is equivalent to the one expressed in Martin (1977). Assuming that imports are capital intensive and using the algebra contained in Jones (1965), it is well-known that the expression for ε_{KM} is given by:

$$\varepsilon_{KM} = \frac{-\theta_{LE}}{(\theta_{LM}\theta_{KE} - \theta_{LE}\theta_{KM})} > 0, \quad (10)$$

where θ_{kj} is the cost share of factor k (labor (L) or capital (K)) in a unit of good j (imports (M) or exports (E)). The elasticity ε_{KM} is positive since imports are capital intensive and $(\theta_{LM}\theta_{KE} - \theta_{LE}\theta_{KM}) < 0$. Substituting equation (10) into equation (9) gives an alternative condition for immiserization:

$$t_M > \frac{\theta_{LE}}{\theta_{LM}} - 1 \qquad \text{or} \qquad (1 + t_M) > \frac{\theta_{LE}}{\theta_{LM}} \quad (11).$$

This is the same condition as derived by Martin (1977). Thus, the results contained in Martin (1977) are really for a special case—the case of two goods, two factors, and the assumption that imports are intensive in the use of the factor whose supply has risen.

B. The "Uneven" Case: The Specific Factors Model

What can be said about the likelihood of immiserizing growth when the number of factors exceeds the number of goods? In the specific-factors model, it is possible to take advantage of some clear-cut results regarding the relationship between endowment and output changes on the one hand and factor and commodity price changes on the other. Three general results follow from this model structure.

1. The General Case

Immiserization as a result of an increase in the supply of a specific factor to an import sector is always possible because each specific factor has a "natural friend"—it is well-known that an increase in the price of a good must raise the return to the specific factor in that industry by more than the price increase.

An increase in the supply of the specific factor used in the export sector cannot lead to immiserization, provided the export sector is not subject to a distortion such as an export subsidy, because an increase in each import price will reduce the return to the specific factor in the export sector—every Stolper-Samuelson elasticity in equation (6) would be negative.[4]

Finally, an increase in the supply of the mobile factor could lead to immiserization only if the following inequality holds, using equation (6):

[4] See Srinivasan (1983) for further discussion of this result.

$$1 < \omega_{M1}\varepsilon_{LM1} + \omega_{M2}\varepsilon_{LM2} + ... + \omega_{M-1}\varepsilon_{LM-1} \quad (12)$$

where the mobile factor is assumed to be labor (L), so ε_{Lj} denotes the elasticity of the wage rate with respect to the price of each imported good j. Each ω_j and ε_{Lj} lies between zero and one. For ω_j, this is true by definition and it is a well-known property of the specific factors' model that the mobile factor does not have a "natural friend", so $0 < \varepsilon_{Lj} < 1$ for all j.

Furthermore, it is known that $\sum_{j=E}^{M} \varepsilon_{Lj} = 1$, as a given percentage increase in all prices (including the price of the export good) must lead to the same percentage change in the factor prices, given homogeneity. Given this, the sum of each ε_{Lj} over the smaller set of goods—only imported goods—must be less than one since $0 < \varepsilon_{Lj} < 1$: $\sum_{j=M1}^{M-1} \varepsilon_{Lj} < 1$. Since each $\omega_j < 1$, it must be the case that the right-hand side of equation (12) can never exceed one. Therefore, an increase in the supply of the mobile factor cannot immiserize. It is interesting to note that in the context of the specific factors' model, an increase in the supply of the mobile factor (perhaps labor as a result of immigration) cannot leave the receiving country worse off, but an increase in the supply of sector-specific (capital) can.

2. The Two-Good, Three-Factor Case

The case of two sectors (one import and one export good) and three factors (a specific factor in each sector plus a mobile factor) gives clear-cut results. By using equation (9) for

example, the condition for growth in the *specific factor k* used in the import sector M to immiserize is:

$$t_M > \frac{1}{\varepsilon_{kM} - 1} \tag{13}$$

where t_M is the tariff rate on the imported good and ε_{kM} is the elasticity of the return to the specific factor used in the import sector from an increase in the price of the imported good. In the specific factor's model, it is well-known that $\varepsilon_{kM} > 1$. Thus, in this simple structure, immiserization is always possible from an increase in the supply of a specific factor in the tariff-protected sector.

Using some well-known results from the specific-factors' model, it is possible to solve for the *exact* condition for immiserization. Using equation (13), and the expression for the elasticity of the return to the specific factor in the import sector from an change in the price of imports (see Woodland 1982), this condition is:

$$t_M > \frac{\theta_{KM}}{\theta_{LM}} + \frac{\sigma_M \lambda_{LM} \theta_{KE}}{\sigma_E \lambda_{LE} \theta_{LM}}, \text{ or } \quad (1 + t_M) > \frac{1}{\theta_{LM}} + \frac{\sigma_M \lambda_{LM} \theta_{KE}}{\sigma_E \lambda_{LE} \theta_{LM}} \tag{14}.$$

Miyagiwa (1993) correctly stated that if the tariff rate exceeded $\frac{\theta_{KM}}{\theta_{LM}}$, then capital accumulation "may" reduce welfare. Equation (14), however, gives the exact condition that

must hold for immiserization. It reveals that growth in the factor specific to the import sector (say capital) will be more likely to lead to immiserization: (i) the lower the value of θ_{KM} relative to θ_{LM}; (ii) the smaller the magnitude of σ_M and the larger the value of σ_E; and (iii) the smaller is λ_{LM} relative to λ_{LE}.[5]

Comparing equations (11) and (14), the magnitude of the tariff rate needed to generate immiserization in the case of two goods is in general, higher in the specific factor's model compared to the all factor's mobile model. In a sense, all else equal, it is more difficult to generate immiserization in the specific factor's model. Note from equation (14), the tariff rate needed to produce immiserization in the specific factor's model depends on the elasticities of substitution between labor and capital in the two sectors, while in the all factors mobile model, it does not. This is because in the specific factor's model, a change in factor supplies will alter factor prices.

IV. Tariff Structure and Immiserizing Growth

This section examines how a country's tariff structure affects the likelihood that it might suffer immiserizing growth. As shown, it is difficult to reach definitive conclusions in the (nxn) model, because it is not possible to pin down exactly how outputs respond to

---

[5] In the specific factors' model, $\theta_{KM} = \frac{\beta_{KM}}{\alpha_M}$. Equation (5) showed that the possibility of immiserizing growth would be greater the smaller is β_k and the larger is α_j. Both of these situations are consistent with a smaller value for θ_{KM}.

changes in factor supplies. In the context of the specific factors' model, however, it is possible to reach definitive conclusions, so the analysis of this section will be restricted to that model. It turns out that there is a sense in which adopting a uniform tariff structure would reduce the chances that a country could suffer immiserization.

Equation (6) implicitly defines a structure for tariff rates that would give rise to immiserization, for given values of ε_{kj}:

$$1 < \sum_{j=M1}^{M-1} \omega_j \varepsilon_{kj}, \text{ for an increase in the supply of some factor } k \tag{15}$$

or equivalently:

$$1 < \sum_{\substack{j=M1 \\ j \neq k}}^{M-1} \omega_j \varepsilon_{kj} + \omega_k \varepsilon_{kk} \tag{16}.$$

Solving for ω_k, and hence the magnitude of the tariff rate in sector k (= j), t_k, that would be needed to generate immiserization from an increase in the supply of specific factor k:

$$t_k > \frac{1 - \sum_{\substack{j=M1 \\ j \neq k}}^{M-1} \omega_j \varepsilon_{kj}}{\varepsilon_{kk} + \sum_{\substack{j=M1 \\ j \neq k}}^{M-1} \omega_j \varepsilon_{kj} - 1}, \quad \text{provided} \left[\varepsilon_{kk} + \sum_{\substack{j=M1 \\ j \neq k}}^{M-1} \omega_j \varepsilon_{kj} - 1 \right] > 0 \tag{17}.$$

The numerator of equation (17) is positive because each $\varepsilon_{kj} < 0$ for $k \neq j$. So increases in ω_j, ($k \neq j$), require a higher ω_k, and hence a higher t_k, in order for immiserization to occur. Note that if all $t_j = 0$, for all $j \neq k$, then equation (17) collapses to equation (13).

Equation (16) also demonstrates the result that in the context of the specific factors' model, the chances that an increase in the supply of some specific factor will lead to immiserization is greater the *larger* the difference between the tariff rate in the sector that experiences the increase in the supply of the specific factor and the tariff rate on all other goods. Using equation (16), suppose that the supply of specific factor k rises and all other factor supplies remain constant. Then, from the properties of the specific factors' model, $\varepsilon_{kk} > 1$ and $\sum_{\substack{j=M1 \\ j \neq k}}^{M-1} \omega_j \varepsilon_{kj} < 0$, since each $\varepsilon_{kj} < 0$ for all $k \neq j$. Thus, the likelihood of immiserization from an increase in the supply of specific factor k will be greater the larger is ω_k and the smaller is each ω_j, for all $k \neq j$. That is, the further apart the tariff rate is in the expanding sector from the all the other tariff rates, the greater the chance of immiserization. Note this result does not say anything about the relationship that must exist between tariff rates in the contracting sectors. These results suggest that if it is unknown which sector is likely to experience an increase in the supply of its specific factor, then a uniform tariff

structure would lessen the chances that the country would be worse off.[6] This issue does not arise in the case of an increase in the supply of the mobile factor, as immiserization is not possible in that case.

As an example, consider the case of two imported goods, denoted by M1 and M2. Suppose the supply of the specific factor used only in sector M1 rises. For immiserization to occur, the tariff rate in the first import sector (M1) must satisfy the following condition:

$$t_{M1} > \frac{t_{M2}(1-\varepsilon_{K1M2})+1}{t_{M2}(\varepsilon_{K1M1}+\varepsilon_{K1M2}-1)+\varepsilon_{K1M1}-1} \tag{18}$$

provided $(\varepsilon_{K1M1}+\varepsilon_{K1M2}-1)>0$. If $t_{M2}=0$, equation (18) collapses to equation (13).

Although reducing the difference between the tariff rate in the sector experiencing the factor growth and the tariff rates in the other sectors will reduce the likelihood of immiserizing growth, it cannot eliminate the possibility completely. Thus, in the specific factors' model, immiserization is possible even with a completely uniform tariff structure. To see this, recall that the condition for immiserization is:

[6] Anderson and Neary (2007) have shown in a different context that welfare is a decreasing function of the *generalized* variance of a country's tariff structure.

$$1 < \sum_{j=M1}^{M-1} \omega_j \varepsilon_{kj}, \quad \text{for} \quad dV_k > 0 \tag{19}$$

but uniform tariffs mean that $\omega_j = \omega$ for all j, so equation (19) can be written as

$1 < \omega \sum_{j=M1}^{M-1} \varepsilon_{kj}$, for an increase in some specific factor k. The term $\sum_{j=M1}^{M-1} \varepsilon_{kj} > 1$ if the supply of one of the specific factors increases, so immiserization is possible if[7]:

$$\omega > \frac{1}{\sum_{j=M1}^{M-1} \varepsilon_{kj}} \quad \text{or if} \quad t > \frac{1}{\sum_{j=M1}^{M-1} \varepsilon_{kj} - 1} \quad \text{for an increase in the supply of a specific factor.}$$

IV. Country Examples

As the previous sections showed, whether a country would suffer immiserization as a result of an increase in a factor supply is ultimately an empirical question. This section reports the results of simulations using an applied general equilibrium model to assess empirically how different types of factor accumulation would affect welfare for a group of twenty developing countries.

---

[7] The sum of the Stolper-Samuelson elasticities across all goods M (which includes the export good) must equal one: $\sum_{j=M1}^{M} \varepsilon_{kj} = 1$, for any factor k. Thus, the term $\sum_{j=M1}^{M-1} \varepsilon_{kj} > 1$, because it excludes the export good in the summation and in the specific factors' model, it is well known that the elasticity of the price of the factor specific to the export sector with respect to a change in the price of any imported good must be negative.

The methodology uses an applied general equilibrium model for each of the twenty countries. The model structure for each country is the same, but the parameters and benchmark data vary to capture the particular circumstances of each country. Each country model contains five sectors: two exportable goods, two importable sectors, and a nontraded good. The two export and import sectors can be thought of as primary products (agriculture and raw materials) and manufactured goods. Each of the five goods is produced by using a sector-specific factor (i.e. capital), a factor that is mobile across all five sectors (i.e. labor), and domestic and imported intermediate inputs. The terms of trade are taken as given, but the price of the nontraded good is determined endogenously. In each country, a representative consumer is assumed to possess a cobb-douglass utility function over all five goods. Equilibrium is determined when a set of factor prices and price for the nontraded good is found that is consistent with market clearing. The individual country models are benchmarked to data contained in the GTAP database, version 6, for production, trade flows, and protection, which corresponds to the year 2001.[8]

Each country model is used to determine the welfare effect of six types of factor accumulation: an increase in the amount of capital that is specific to all five sectors, plus an increase in the supply of the mobile factor, labor. The change in welfare is measured by the equivalent variation. For simplicity, the experiments simulate the welfare impact of one

[8] GTAP is the Global Trade Analysis Project and it includes a global economic model and database. Documentation of the database can be found in Dimarmaran and McDougal (2006).

percent increases in each of these six factor of production. The results are reported in Table 1.[9]

Of the twenty countries examined, only one, Tunisia, would experience a decline in welfare as a result of factor accumulation, and this occurs as a result of an increase in capital specific to the first import sector—imports of primary products such as agriculture, raw materials, and minerals. This result is due to several factors, including the large dispersion in Tunisia's tariff structure: the average tariff rate on primary products is 41.2 percent, while the average tariff on manufactured goods is 11.8 percent. As well, capital specific to the first import sector accounts for the smallest share of national income of any factor—only 3 percent—and as noted in the first section of the paper, immiserization is more likely the smaller the share of the expanding factor in national income, i.e. the smaller β_k in equation (5). While all other countries gain as a result of capital accumulation specific to both import sectors, the magnitude of these gains is generally lower than the gains from other types of factor accumulation—export-biased or labor biased. Every country gains as a result of an increase in the supply of the mobile factor, labor, as expected.

[9] The choice of a one-percent increase is arbitrary. As is well known, if the magnitude of the increase in factor supply is large enough, the country must gain even with a distortion, provided specialization does not occur. As well, if the magnitude of the increase is small enough, the country must be worse off. See Johnson (1967).

Table 1. Welfare Effects of a One Percent Increase in Factor Endowments
(Welfare effects are in millions of 2001 U.S. Dollars; percent of GDP in parenthesis)

	Capital in First Export Sector	Capital in Second Export Sector	Capital in First Import Sector	Capital in Second Import Sector	Capital in Nontraded Sector	Labor Endowment
Albania	1.4	11.7	1.5	2.2	2.9	14.7
	(0.0)	(0.3)	(0.0)	(0.1)	(0.1)	(0.3)
Argentina	11.8	11.4	0.5	46.1	27.8	122.6
	(0.1)	(0.1)	(0.0)	(0.2)	(0.1)	(0.6)
Bangladesh	1.7	3.8	5.4	2.0	8.5	24.2
	(0.0)	(0.1)	(0.1)	(0.0)	(0.2)	(0.5)
Botswana	0.4	11.4	0.5	46.1	27.8	122.6
	(0.1)	(0.1)	(0.0)	(0.2)	(0.1)	(0.6)
Brazil	21.7	22.1	5.6	61.4	78.0	2506.2
	(0.1)	(0.1)	(0.0)	(0.1)	(0.2)	(0.6)
China	10.2	18.9	1.0	6.6	9.6	53.7
	(0.1)	(0.2)	(0.0)	(0.1)	(0.1)	(0.6)
Colombia	5.7	8.5	1.6	5.4	10.1	46.2
	(0.1)	(0.1)	(0.0)	(0.1)	(0.1)	(0.6)
Egypt	0.5	0.1	0.0	0.5	0.3	0.8
	(0.2)	(0.1)	(0.0)	(0.2)	(0.1)	(0.3)
India	66.6	88.3	6.4	16.3	71.6	204.0
	(0.2)	(0.2)	(0.0)	(0.0)	(0.2)	(0.5)
Madagascar	9.2	0.9	1.4	4.2	4.6	25.0
	(0.2)	(0.0)	(0.0)	(0.1)	(0.1)	(0.5)
Malawi	1.8	2.5	1.3	1.3	0.6	9.1
	(0.1)	(0.2)	(0.1)	(0.1)	(0.0)	(0.6)
Morocco	29.2	65.1	3.1	8.7	39.8	180.9
	(0.1)	(0.2)	(0.0)	(0.0)	(0.1)	(0.5)
Mozambique	2.1	3.5	1.3	5.8	5.8	18.1
	(0.1)	(0.1)	(0.0)	(0.2)	(0.2)	(0.5)
Peru	6.9	7.3	3.1	9.4	7.2	16.6
	(0.1)	(0.1)	(0.1)	(0.2)	(0.1)	(0.3)
Philippines	8.9	6.5	4.3	11.6	9.6	19.9
	(0.1)	(0.1)	(0.1)	(0.2)	(0.1)	(0.3)
Romania	3.4	5.9	3.7	8.4	3.8	13.4
	(0.1)	(0.1)	(0.1)	(0.2)	(0.1)	(0.3)
Tanzania	19.3	4.8	1.0	12.2	8.2	43.4
	(0.2)	(0.1)	(0.0)	(0.1)	(0.1)	(0.5)
Tunisia	12.6	62.0	-1.4	13.0	9.9	84.8
	(0.1)	(0.3)	(0.0)	(0.1)	(0.1)	(0.4)
Vietnam	5.9	8.4	1.9	5.5	10.3	11.7
	(0.1)	(0.2)	(0.0)	(0.1)	(0.2)	(0.2)
Zambia	3.0	2.2	1.0	4.4	7.0	16.0
	(0.1)	(0.1)	(0.0)	(0.1)	(0.2)	(0.5)

Source: Author's calculations.

Since Tunisia was the only country for which factor accumulation would lead to immiserization, a further experiment was conducted. Starting from the initial set of tariff rates (41.2 and 11.8 percent), the model was used to simulate the impact of an increase in the tariff rate on the second import good, keeping the tariff rate on the first import good constant, so that both tariff rates were 41.2 percent. Then, starting from this new benchmark, the effects of an increase in the supply of capital specific to the first import sector were simulated. Relative to this new benchmark in which both tariff rates were equal, an infusion of capital specific to the first import sector still resulted in a reduction in overall welfare, however, the magnitude of the reduction was smaller than the reduction in welfare that occurred when the tariff rates were unequal. This results demonstrates that the dispersion in tariff rates contributed as least partly to the welfare loss that resulted from factor accumulation. It should be emphasized that even if tariff rates are equalized, immiserization is still possible, as shown by equations (18) and (19).

Tunisia is worse off as a consequence of growth in the primary sector because tariff rates are high, relative to the rest of the economy, and because of some special features. Growth in the specific factor used in the fishing sub sector of 1 percent lowers real income because the tariff applied to this sector is 37 percent and the ratio of the output share of the sector (α_j) to the share of national income of the specific factor in the fishing sector (β_k) is very high: nearly 18 as shown in the table below. As shown in equation (5), the larger the ratio of (α_j) to (β_k), the greater the chances that growth specific to sector j will lead to immiserization.

Table 1. Tunisia: Characteristics of the Fishing sector
(in percent)

Sector	(α_j)	(β_i)	Tariff Rate	(ω_j)	Rybczynski Elasticity 1/	Stolper-Samuelson Elasticity 2/
Fish products	0.009	0.0005	0.37	0.27	0.93129	17.298099

1/ Percent change in output of fish products from a one percent increase in sector-specific capital.
2/ Percent change in the return to capital used in the fish products sector from a one percent increase in the domestic price of fish products.

Alternatively, as shown in equation (6), the weighted sum of the Stolper-Samuelson elasticities must exceed one for immiserizing growth to occur. This elasticity is very large for the fishing subsector, mainly because the cost share of the specific factor used in the sector is extremely small—it is very "unimportant" in the terminology of Jones. It is easily shown, using the Jones algebra, that the return to a specific factor varies *inversely* with its cost share. For example, with two goods, the elasticity of the return to capital in sector 1 is:

$$\frac{\hat{r}_1}{\hat{p}_1} = \frac{\sigma_1\lambda_{L1}\theta_{K2} + \sigma_2\lambda_{L2}}{\sigma_1\lambda_{L1}\theta_{K2} + \sigma_2\lambda_{L2}\theta_{K1}}.$$

Therefore the return to capital is sector 1 is inversely related to θ_{K1}.

IV. Conclusions

The possibility of immiserization as a consequence of an increase in the supply of a factor of production is not just a theoretical curiosity, but rather raises some important policy issues. For example, many low-income countries expend resources and offer tax incentives to attract additional foreign direct investment. The question becomes whether this is a good use of scarce resources if the additional factor inflows that result from greater foreign direct investment could leave the country worse off.

This paper has contributed to the literature on immiserizing growth by presenting general conditions that need to be satisfied for immiserization to occur, regardless of the number of goods and factors. Prior literature had only identified the conditions for immiserization in special cases. In "even" models, there is a sense in which the introduction of more than two goods reduces the chances of immiserization. This is because in (nxn) models, every factor may not have a "natural friend". In the specific factors' model, every specific factor has a "natural friend", but the mobile factor does not. So, growth in the supply of a specific factor may lead to immiserization, but an increase in the supply of the mobile factor cannot, regardless of the magnitude of tariff rates. This result is due to the fact that an increase in the supply of the mobile factor must raise outputs of all goods, unlike in the two-good, two-factor model. If the mobile factor is taken to be labor, then an increase in the supply of labor available to the economy, perhaps through immigration, *cannot* make the economy worse off in the short run, provided there is no change in the terms of trade. This conclusion is not valid in the long run when all factors can be thought of as mobile. In a model with all factors mobile, an increase in the labor supply could indeed lead to

immiserization. This could explain differences in attitudes toward immigration in the short and long run.

The paper also investigated the role played a country's tariff structure in influencing whether a country could suffer immiserizing growth. In the specific factor's model, the chances of immiserization are greater the larger the difference between the tariff rate in the expanding sector, relative to the tariff rates on the contracting sectors. Thus, from a policy point of view, if it is unknown which sector will experience an increase in the supply of its specific factor, then adopting a more uniform tariff structure would reduce the chances of immiserization, although this would not eliminate the possibility completely.

Ultimately, with more complicated model structures, whether factor accumulation will immiserize a country in the presence of tariff protection is an empirical question. Simulations for twenty countries with higher than average tariff dispersion revealed that only one would likely experience immiserizing growth. Overall, immiserizing growth of the "Johnson type" does not seem to be very likely, mainly because most country's tariff structures do not contain a degree of dispersion necessary to produce this outcome.

References

Anderson, James, and J. Peter Neary, 2005, *Measuring the Restrictiveness of International Trade Policy*, Cambridge: MIT Press.

_____, 2007, "Welfare Versus Market Access: The Implications of Tariff Structure For Tariff Reform," *Journal of International Economics*, vol. 71, issue 1, pp. 187-205.

Balassa, Bela, 1989, "Tariff Policy and Taxation in Developing Countries," World Bank: Washington D.C.

Bertrand, Trent, and Frank Flatters, 1971, "Tariffs, Capital Accumulation, and Immiserizing Growth," *Journal of International Economics*, vol. 1, pp. 453-460.

Bhagwati, Jagdish, 1958, "Immiserizing Growth: A Geometric Note," *Review of Economic Studies*, vol. xxv, pp. 201-5.

Brecher, Richard, and Carlos Diaz-Alejandro, 1977, "Tariffs, Foreign Capital, and Immiserizing Growth," *Journal of International Economics*, volume 7, pp. 317-322.

Chai, Jingqing and Rishi Goyal, 2008, "Tax Concessions and Foreign Direct Investment in the Eastern Caribbean Currency Union," Washington D.C: International Monetary Fund, Working Paper 08/257.

Dimaranan, Betina V. and Robert A. McDougall, editors, 2006, *Global Trade, Assistance, and Production: The GTAP 6 Data Base*, Center for Global Trade Analysis, Purdue University.

Dixit, Avinash, and Victor Norman, 1980, *Theory of International Trade: A Dual General Equilibrium Approach*, Cambridge: Cambridge University Press.

Harberger, Arnold, 1990, "Principles of Taxation Applied to Developing Countries: What Have We Learned?", in M. Boskin and C. McLure, editors, in *World Tax Reform: Case Studies of Developed and Developing Countries*, San Francisco: ICS Press.

Hatta, Tatsuo, 1977, "A Theory of Piecemeal Policy Recommendations," *Review of Economic Studies*, volume 44, pp. 1-21.

Johnson, Harry, 1967, "The Possibility of Income Losses From Increased Efficiency or Factor Accumulation in the Presence of Tariffs," *Economic Journal*, vol. 77, pp. 151-54.

Jones, Ronald, 1965, "The Structure of Simple general Equilibrium Models," *Journal of Political Economy*, vol. 73, (December) pp. 557-572.

Jones, Ronald, and Jose Scheinkman, 1977, "The Relevance of the Two-Sector Production Model in Trade Theory," *Journal of Political Economy*, vol. 85, pp. 909-935.

Keen. Michael and Mario Mansour, 2009, "Revenue Mobilization in Sub-Saharan Africa: Challenges From Globalization," Washington D.C: International Monetary Fund, Working Paper 09/157.

Martin, Ricardo, 1977, "Immiserizing Growth For A Tariff-Distorted, Small Economy: Further Analysis," *Journal of International Economics*, vol. 7, pp. 323-328.

Miyagiwa, Kaz, 1993, "On the Impossibility of Immiserizing Growth," *International Economic Journal*, vol. 7, no. 2, pp. 1-13.

Panagariya, Arvind, and Dani Rodrik, 1993, "Political-Economy Arguments For a Uniform Tariff," *International Economic Review*, vol. 34, no. 3, (August), pp. 685-703.

Samuelson, Paul, 1953-1954, "The Prices of Factors and Goods in General Equilibrium," *Review of Economic Studies*, vol. 21, no. 1, pp. 1-20.

Srinivasan, T.N., 1983, "International Factor Movements, Commodity Trade, and Commercial Policy in a Specific Factor Model," *Journal of International Economics*, vol. 14, pp. 289-312.

Stolper, Wolfgang, and Paul Samuelson, 1941, "Protection and Real Wages," *Review of Economic Studies*, volume 9, number 1, pp. 58-73.

Woodland, Alan, 1982, *International Trade and Resource Allocation*, North Holland.