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Globalisation and factor returns in competitive markets

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Abstract

The standard competitive trade model, extended to include many goods and factors, is used to analyze the effect of goods and factor market integration on average international disparities in the real returns of internationally immobile factors. It is shown that goods market integration decreases international real return differentials for all factors. We derive sufficient conditions for this result to hold for the subgroup of internationally immobile factors as well. While there is a presumption for similar results to hold with international factor market integration, we show that this is true for international migration but in general not for international investment.

Keywords: Factor mobility; Factor real returns; Nontraded goods

JEL: F11; F16

1. Introduction

The ongoing debate over the causes of the shifts in relative returns to skilled and unskilled labour in developed countries has drawn attention to the impact of "globalisation" on national factor markets. National and international markets have become increasingly linked through the movement of goods, factors of production and

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individuals (acting as both workers and consumers) among countries. These movements are usually prompted by differences in prices and returns, which they will tend to remove. As yet this process is not all encompassing, however, and some factors and goods remain nontraded (internationally immobile). Questions then arise concerning the implications of (expanding) international goods and factor mobility for international disparities in the real returns of immobile factors. How does globalisation in its various forms affect the relative international position of the non-participating factors? Here we investigate this issue using the standard multi-sector competitive model of international trade.

We restrict attention to cases where countries differ only in their factor endowments (i.e. technologies and preferences are identical internationally), so that countries are "defined" by their endowments of internationally immobile factors. Our aim is to investigate the implications of three aspects of globalisation for international disparities in the real returns to internationally immobile factors. These are (a) the presence of nontraded goods; (b) the presence of international factor mobility (investment or migration); and (c) the presence of consumer mobility (which equalises the cost of living across countries).

The link between trade in goods and international differences in factor returns has always been of interest to trade economists. In the context of the competitive model employed here, the focus has often been on establishing conditions for free trade in goods to lead to full international factor price equalisation (see, for example, Dixit and Norman, 1980; Woodland, 1982; Blackorby et al., 1993; Deardorff, 1994). Where countries have identical technologies and preferences, this outcome depends on the relative numbers of internationally traded goods and internationally immobile factors or, equivalently, on the number of international markets (for both goods and factors) relative to the number of factors (Ethier and Svensson, 1986). If the number of traded goods equals the number of immobile factors, then factor price equalisation can be a characteristic of the non-specialised trading equilibrium. If the number of traded goods exceeds the number of immobile factors, there is a problem of indeterminacy in the international location of production, and trade can lead to factor price divergence (Deardorff, 1986). Where the number of internationally immobile factors exceeds the number of traded goods, the production outcome is determinate, and factor returns will not be equalised by goods trade in general. This is the structure we employ here. It is to be interpreted as a scenario where the number of international markets for goods and factors is small enough to prevent factor price equalization from occurring.

The arguably most important contribution to this strand of the literature is Neary (1985). He shows in a framework similar to ours that international factor mobility tends to reduce international disparities in the returns of the immobile factors. Neary (1985) focuses on nominal returns, assuming that all goods are traded. Our main contribution with the present paper is to focus on factor real returns in the presence of nontraded goods rather than assuming that all goods are freely traded and focus on nominal factor returns. To put it differently, while Neary (1985) derives results for a world with fully integrated goods markets and then goes on to assess the difference that factor market integration makes, we derive results for the case with less than perfectly integrated goods and factor markets. A first step in this direction has been undertaken by Falvey (1999) who compares a free trade regime with restricted trade but considers neither different degrees of goods market integration nor international factor mobility.

As has been pointed by Dixit and Norman (1980, p. 102) for the case of nominal returns, it is not possible for the general production structure employed here to derive results for arbitrarily large endowment differences. The same argument applies to the case of real returns we are interested in. Therefore, we follow Neary (1985) and concentrate on small differences in the relative factor endowments between countries.

In outline, the remainder of this paper is as follows. The next section sets up the model in the most familiar case where all goods are traded, allowing for international mobility of some of the factors. Section 3 then considers the case where some of the goods are nontraded, but all factors are internationally immobile. Section 4 combines the previous cases, allowing for factor mobility in the presence of nontraded goods. The existence of nontraded goods requires us to distinguish international migration, where the factor owner moves with the factor, from factor investment, where the factor owner does not move. Factor migration responds to international differences in mobile factor real returns, while factor investment responds to international differences in the nominal (numeraire) returns of the mobile factors. Section 5 analyzes consumer mobility, where international expenditure flows arbitrage away international differences in the cost of living (but not international differences in individual nontraded goods prices). Section 6 concludes.

2. Factor returns under free trade

Consider a two country world, where a small (home) and a large (foreign) trading economy produce and consume Q+1 goods using R factors under CRS production technologies.[1] We begin by assuming that all factors are internationally immobile, and that all goods are tradable. In the small economy, domestic demand is represented using that economy's expenditure function $E(p,u)$, where u denotes the welfare of a "representative individual" and p is a Q+1 column vector of domestic prices (p_j, j=0,. . .,Q) with good 0 acting as numeraire ($p_0\equiv 1$).[2] The derivatives of E with respect to product prices yield the compensated demand vector $E_p(p,u)$. Domestic supply can similarly be represented using the economy's Gross National Product function $G(p,v)$, where v is the R column vector of factor endowments.[3] The derivatives of this function with respect to product prices and factor endowments yield, respectively, the economy's supply vector $G_p(p,v)$ and its vector of factor returns w=$G_v(p,v)$.

[1] The small/large country combination simplifies the presentation of the results that follow. All results remain valid in the case of two large trading economies with identical preferences and proportional endowments, as discussed in Conclusion and illustrated in Dixit and Woodland (1982), Svensson (1984) and Svensson and Markusen (1985). Assuming the economy's production possibility set is convex and exhibits CRS allows for joint production, intermediate goods and any pattern of factor mobility among sectors within the economy.

[2] The expenditure function is concave and linearly homogeneous in prices, and increasing in utility. It is also assumed to be twice continuously differentiable.

[3] The GNP function is convex and linearly homogeneous in product prices and concave and linearly homogeneous in factor endowments. Where the GNP function is also assumed to be twice continuously differentiable we require that the number of factors exceeds the number of final goods, or, if there is joint production, the number of productive activities.

The large (foreign) country has the same structure, and its variables are denoted with an asterisk. Initially both countries are identical, except for scale. In addition, consumers in both countries have identical homothetic preferences. Then p=p*, w=w*, v is proportional to, but much smaller than, v*, and there is no incentive for international trade. For notational convenience, we normalise units so that p*, and hence p initially, is a unit vector.

Suppose that, starting from the initial equilibrium described above, there is a small change (dv) in the home endowment vector. Since the home country is small world prices are unaffected, but now the difference in relative endowments provides a basis for trade. For given product prices, the corresponding difference in factor (real and numeraire) returns, are given by[4]

$$\mathrm{d}w = G_{vv}\mathrm{d}v \tag{1}$$

In general, little can be said about the international differences in individual factor returns. But the matrix G_{vv} is negative semidefinite, and hence, given that dv is not proportional to v,[5] there is a negative correlation between the differences in relative endowments between the large and the small country and differences in factor returns—i.e.

$$\mathrm{d}v'\mathrm{d}w = \mathrm{d}v'G_{vv}\mathrm{d}v<0.^{6} \tag{2}$$

Since product prices are unchanged, there must be (cost-offsetting) increases in some factor returns and decreases in others. Otherwise, price would depart from average cost. Therefore, allowing for a difference in relative factor endowments will tend to reduce some factors' returns and increase others'. Eq. (2) indicates that in comparison with the rest of the world the home country has "on average" a lower return to those factors with which it is relatively well endowed. As shown in Dixit and Norman (1980), the correlation result (Eq. (2)) holds as well for large endowment differences between countries. We follow Dixit and Norman (1980, p. 102) in interpreting the magnitude of this correlation as the appropriate indicator of general international differences in factor returns when there are many goods and factors.

Now assume, as in Neary (1985), that all goods continue to be traded but in addition there is international mobility of some of the factors of production. Under free trade, international migration and international investment have identical effects on factor prices, and therefore are not distinguished. The vector v is separated into the two disjoint components l (internationally immobile) and k (internationally mobile), i.e. $v'=(l',k')$. With

[4] If the number of goods (or productive activities) (Q+1) equals the number of factors (R), and the change in v does not move the home country out of its 'cone of diversification' at these world prices, then FPE holds and G_{vv} is a zero matrix. In this case, the difference in relative endowments alone would generate no international disparities in factor returns.

[5] If dv is proportional to v, all outputs adjust in the same proportion and there is no change in factor returns at the given product prices.

[6] As Deardorff (1980) has pointed out, a sufficient condition for inequalities like Eq. (2) to have the same sign as a true correlation is for one of the vectors involved to have a zero mean. We assume this to be the case for dv throughout. This involves no loss of generality because proportional differences in endowments have no effect on factor prices.

factor mobility, international differences in factor prices for l depend on international differences in employment (rather than endowment) of l and k, where the differences in the employment of k are endogenous and denoted by $\mathrm{d}\tilde{k}$.

In analogy to Eq. (1), the international differences in factor prices are

$$\mathrm{d}\tilde{w}_l = G_{ll}\mathrm{d}l + G_{lk}\mathrm{d}\tilde{k}$$

$$\mathrm{d}\tilde{w}_k = G_{kl}\mathrm{d}l + G_{kk}\mathrm{d}\tilde{k} = 0 \tag{3}$$

where ~ over a variable denotes values when factors are mobile, and G_{ij} are the appropriate submatrices of G_{vv}.[7] Solving the second equation for $\mathrm{d}\tilde{k}$ and inserting into the first one, premultiplied by $\mathrm{d}l'$, gives

$$\mathrm{d}l'\mathrm{d}\tilde{w}_l = \mathrm{d}l'\tilde{G}_{ll}\mathrm{d}l \leq 0 \tag{4}$$

with $\tilde{G}_{ll} \equiv G_{ll} - G_{lk}G_{kk}^{-1}G_{kl}$ being negative semidefinite. Hence, as shown by Neary (1985), the negative correlation between endowment differences of immobile factors and differences in their returns is preserved in the presence of factor mobility.

Comparing the correlations with and without factor mobility is less straightforward. Using Eqs. (2) and (4), we get

$$\mathrm{d}l'(\mathrm{d}w_l - \mathrm{d}\tilde{w}_l) = \mathrm{d}l'G_{lk}\mathrm{d}k + \mathrm{d}l'G_{lk}G_{kk}^{-1}G_{kl}\mathrm{d}l \tag{5}$$

which cannot be signed in general. Only if one is willing to assume that either $\mathrm{d}k$ or $G_{lk}\mathrm{d}k$ equals zero, can one conclude that introducing international factor mobility decreases on average international factor price differentials of the immobile factors. On the other hand, we can compare correlations for the full set of factors, i.e. including the internationally mobile ones. This gives

$$\mathrm{d}v'(\mathrm{d}w - \mathrm{d}\tilde{w}) = \mathrm{d}v'\begin{pmatrix} G_{lk}G_{kk}^{-1}G_{kl} & G_{lk} \\ G_{kl} & G_{kk} \end{pmatrix}\mathrm{d}v \leq 0, \tag{6}$$

and hence the correlation is algebraically larger, i.e. smaller in absolute value, if there is factor mobility. This is an application of the Le Châtelier principle, as pointed out by Neary (1985).[8,9]

The key to understanding why the comparison of the two correlations in Eq. (6) gives a clearcut result while the comparison in Eq. (5) does not is the following. With international factor mobility, endowment differences $\mathrm{d}k$ are irrelevant for factor price differentials, and hence the negative correlation between $\mathrm{d}v$ and $\mathrm{d}\tilde{w}$ implies a negative correlation between

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[7] We assume that there is enough substitutability in G_{vv} for its submatrices G_{kk} and G_{ll} to be negative definite.

[8] Neary (1985) considers only the case where $\mathrm{d}k$=0. So his statement that "as more and more factor price rigidities are imposed on an economy, it comes 'closer' to factor price equalization" has in general to be interpreted in terms of all factors, including the internationally mobile ones.

[9] This result is subject to the well-known qualification, which equally applies to all analogous results derived below, that the matrices involved be evaluated at the same point. Hence, as mentioned in Introduction, all our results involving the comparison of correlations are of a local nature.

$\mathrm{d}l$ and $\mathrm{d}\tilde{w}_l$. In contrast, without international factor mobility endowment differences $\mathrm{d}k$ generally influence all factor prices. Therefore, the negative correlation between endowment differentials and factor return differentials for the full set of factors need not lead to an analogous correlation for a subset of factors such as l. Only if endowment differences in k do not influence w_l (i.e. $G_{lk}\mathrm{d}k$=0) can we be sure that the correlation holds for the subset l. So it is the absence of a clearcut correlation in the case of no factor mobility that prevents a clearcut general result for the comparison of the two scenarios.

3. Nontraded goods

We now suppose that some goods are not tradable, and divide the set of Q+1 goods into N nontraded and T traded goods (including the numeraire). In this section, we focus on the case where all factors are internationally immobile, introducing factor mobility in the next section. Let p_n denote the vector of nontraded goods prices, and p^* the vector of traded goods prices. The equilibrium is summarized by

$$E(p_n, p^*, u) = G(p_n, p^*, v) \tag{7}$$

$$E_n(p_n, p^*, u) = G_n(p_n, p^*, v) \tag{8}$$

where Eq. (7) is the economy's budget constraint and Eq. (8) gives market clearing conditions for the nontraded goods. In order to simplify notation, subscript n is used throughout to denote derivatives with respect to the nontraded goods' prices.

In the presence of nontraded goods, international differentials of factor real and numeraire returns no longer coincide. The vector of factor real returns is given by W=w/P where $P = \sum_{j=0}^{Q} p_j e_j$ is a price index and e_j denotes the average expenditure share for good j. By the assumption of homothetic tastes, average expenditure shares equal marginal expenditure shares, and hence the same variable is used for both. Since all prices have been normalized to unity initially, P=1 initially also. Therefore, the difference in factor real returns is given by

$$\mathrm{d}W = \mathrm{d}w - w\mathrm{d}P \tag{9}$$

where $\mathrm{d}P$=$e_n'\mathrm{d}p_n$ since tradables prices are constant. We proceed by deriving expressions for the endogenous variables $\mathrm{d}p_n$ as well as $\mathrm{d}w$ in terms of the exogenous endowment difference $\mathrm{d}v$. By solving out the effects of endowment differences on nontraded goods prices in this way, and using our assumption of homothetic preferences, we obtain a reduced form relationship between endowment differences and factor real return differences similar in structure to that in the absence of nontraded goods.

Differentiating totally Eqs. (7) and (8) allows us to derive the following expression for international differences in nontraded goods prices:

$$\mathrm{d}p_n = M_n^{-1}(G_{nv} - e_n G_v')\mathrm{d}v \tag{10}$$

In deriving Eq. (10), use has been made of E_{nu}=$e_n E_u$, with the column vector e_n having as its kth element e_k the marginal propensity to spend on nontraded good k. M_n≡E_{nn}−G_{nn}

is the substitution matrix among nontraded goods.[10] The matrix $(G_{nv}-e_nG'_v)$ gives the effect of the endowment change on excess supplies of the nontraded goods at initial prices, with these excess supplies being translated into price changes by M_n^{-1}.

Now consider the effects of the endowment change on factor numeraire returns. Including the effects of nontraded-goods price changes, Eq. (1) becomes

$$\mathrm{d}w = G_{vn}\mathrm{d}p_n + G_{vv}\mathrm{d}v \tag{11}$$

Combining Eqs. (9)–(11) gives

$$\mathrm{d}W(\Gamma_{vv} + G_{vv})\mathrm{d}v \tag{12}$$

with $\Gamma_{vv} \equiv (G_{vn}-G_ve'_n)M_n^{-1}(G_{nv}-e_nG'_v)$ being a negative semidefinite matrix.[11] As marginal expenditure shares equal average expenditure shares due to homothetic preferences, one can state amended reciprocity relations which are responsible for Γ_{vv} being a negative semidefinite matrix: If

(i) an increase in the endowment of factor i leads to an excess supply (demand) of nontraded good k, then
(ii) the induced decrease (increase) in the price of good k leads to a decrease in the real return to factor i.

While in (i) it is the marginal expenditure shares that are relevant, in (ii) it is the average expenditure shares.[12]

For non-proportional endowment differences, we then have

$$\mathrm{d}v'\mathrm{d}W = \mathrm{d}v'(\Gamma_{vv}+G_{vv})\mathrm{d}v<0, \tag{13}$$

showing that there is a negative correlation between relative factor endowments and disparities in factor real returns, just as is the case with relative factor endowments and disparities in numeraire returns in the model without nontraded goods. This is an application of the general result (Woodland, 1982, ch. 8) that the reduced form functions obtained by substituting out the prices of nontradables in this way have the same properties as the corresponding functions without nontraded goods.

Comparing Eq. (13) to Eq. (2), we furthermore see that

$$\mathrm{d}v'(\mathrm{d}W - \mathrm{d}w) = \mathrm{d}v'\Gamma_{vv}\mathrm{d}v \leq 0 \tag{14}$$

where the strict inequality holds if the endowment difference implies different nontraded goods prices in the two countries. We conclude that the international disparity in factor real returns is larger on average in the presence of some nontraded goods than under free trade.

[10] We assume that there is some substitutability between traded and nontraded goods, in which case M_n is negative definite (Dixit and Norman, 1980, p. 130).

[11] In the borderline case, $(G_{niv}-e_{ni}G'_v)\mathrm{d}v=0\forall i$, i.e., the endowment change is such that there arises no excess supply or demand for any of the nontraded goods at the initial prices.

[12] The assumption of identical and homothetic tastes rules out certain paradoxical outcomes. For example, Neary (1989) illustrates circumstances under which an inflow of migrants can raise an economy's real wage when some goods are nontraded and tastes are not identical and homothetic.

The similarity to Eq. (6) suggests that Eq. (14) is another application of the Le Châtelier principle. Here, international factor price differentials are smaller in the situation exhibiting less restrictions on international mobility of goods. One has to be careful though, because in contrast to Eq. (6) the result (Eq. (14)) does not hold for arbitrary preferences, even if they are identical internationally, and hence it does not follow directly from the Le Châtelier principle. However, the assumption of identical homothetic preferences neutralizes the demand side effects of the endowment differences, leaving the supply side effects to drive the result.[13] In this sense, we can say that Eq. (14) is a Le Châtelier result.

Falvey (1999) has shown that in the present framework protective tariffs on some or all of the tradables increase international disparities in factor real returns. The result stated in Eq. (14) can be seen as a special case where tariffs on some goods are prohibitive while being zero for all other goods. Given that free trade in the absence of any nontraded goods should be seen as a reference scenario rather than a realistic possibility, it is interesting to compare two situations with different strictly positive numbers of nontraded goods. To this end, the set of nontraded goods n is divided into the disjoint sets n_1 and n_2, and we compare a situation where all goods n are nontraded with a situation where only the smaller number n_1 is nontraded. In the latter case, the international disparity in factor real returns is given by

$$\mathrm{d}v'\mathrm{d}W^1 = \mathrm{d}v'\left(\Gamma^1_{vv} + G_{vv}\right)\mathrm{d}v \tag{15}$$

where

$$\Gamma^1_{vv} \equiv \left(G_{vn_1} - G_v e'_{n_1}\right) M_{11}^{-1} \left(G_{n_1 v} - e_{n_1} G'_v\right)$$

$$M_n \equiv \begin{pmatrix} M_{11} & M_{12} \\ M_{21} & M_{22} \end{pmatrix}$$

Using Lemma 2 from Diewert (1981, p. 78), and remembering that M_n is negative definite, we have

$$\mathrm{d}v'\mathrm{d}W - \mathrm{d}v'\mathrm{d}W^1 = \mathrm{d}v'\left(\Gamma_{vv} - \Gamma^1_{vv}\right)\mathrm{d}v \leq 0 \tag{16}$$

and hence decreasing the number of nontradables decreases the international disparities in factor real returns.

[13] To see this, assume for the moment that the endowment difference dv in Eq. (14) has no impact on domestic demand, e.g. because these factors are owned by the foreign country, and focus—as is appropriate with dv being foreign owned—on the difference in numeraire rather than real returns. In this case, the right-hand side of Eq. (14) becomes $G_{vn} M_n^{-1} G_{nv}$, the additional change in numeraire factor prices due to the presence of nontraded goods. This is an example of the Le Châtelier principle, relying solely on supply-side effects. Comparing this to the original version of Eq. (14), we see that adding the demand side and focusing on differences in factor real returns leaves the sign of the right-hand side unchanged if preferences in the two countries are identical and homothetic. In this sense, we can say that the result is "driven by" a supply-side Le Châtelier effect.

4. International factor mobility

In this section, we allow for international mobility of some factors of production, but retain the assumption that some of the goods are nontraded. With nontraded goods, one must make a distinction between *factor investment* and *factor migration*.[14] Under the latter, the countries of residence and employment coincide for the migrating factors, hence the migrants are concerned with real returns. International investors, on the other hand, respond to differences in numeraire returns as the country of residence (where their spending takes place) differs from the country where their factors are employed. Here, we alternatively consider migration or investment of k.

4.1. Migration

Factor migration equalizes the real returns of the mobile factors; in analogy with Eq. (3), we have

$$\mathrm{d}\tilde{W}_l = G_{ll}\mathrm{d}l + G_{lk}\mathrm{d}\tilde{k} + A_l'\mathrm{d}p_n \tag{17}$$

$$\mathrm{d}\tilde{W}_k = G_{kl}\mathrm{d}l + G_{kk}\mathrm{d}\tilde{k} + A_k'\mathrm{d}p_n = 0 \tag{18}$$

where $A_z \equiv (G_{nz} - e_n G_z')$, $z = k,l$. The international difference in the prices of nontraded goods is given, in analogy to Eq. (10), by

$$\mathrm{d}p_n = M_n^{-1}\left(A_l\mathrm{d}l + A_k\mathrm{d}\tilde{k}\right). \tag{19}$$

Now, one has to substitute from Eqs. (18) and (19) for the two endogenous variables in Eq. (17), namely $\mathrm{d}p_n$ and $\mathrm{d}\tilde{k}$. There are two equivalent ways of doing this. First, one can show that

$$\mathrm{d}\tilde{W}_l = \left(\tilde{G}_{ll} + \tilde{A}_l'\tilde{M}_n^{-1}\tilde{A}_l\right)\mathrm{d}l \tag{20}$$

where $\tilde{A}_l \equiv A_l - A_k G_{kk}^{-1} G_{kl}$ and $\tilde{M}_n \equiv M_n + A_k G_{kk}^{-1} A_k'$ differ from A_l and M_n, respectively, by the effects of the induced change in domestic employment of the mobile factors. One can see that this employment change has both a supply side and a demand side effect. This is because owners of the mobile factors are assumed to move together with the factors they supply. $\tilde{M}_n$ is negative definite, and hence $\tilde{A}_l'\tilde{M}_n^{-1}\tilde{A}_l$ is either negative semidefinite (with $L>N$) or negative definite (otherwise).[15] Alternatively, we have

$$\mathrm{d}\tilde{W}_l = \left(G_{ll} + \Gamma_{ll} - \tilde{G}_{lk}\tilde{G}_{kk}^{-1}\tilde{G}_{kl}\right)\mathrm{d}l \tag{20$'$}$$

[14] See Dixit and Norman (1980). Bond (1993) uses a structure similar to ours to discuss the standard trade theorems in the presence of migration in a regional context.

[15] With $L>N$, it is possible that $\tilde{A}_l\mathrm{d}l = 0$, i.e., a change in the endowment of immobile factors preserves equilibrium in all nontraded goods markets at the initial prices.

with $\tilde{G}_{kl} \equiv G_{kl} + \Gamma_{kl}$ and $\tilde{G}_{kk} \equiv G_{kk} + \Gamma_{kk}$.[16] Premultiplying Eq. (20) by dl' gives

$$\mathrm{d}l'\mathrm{d}\tilde{W}_l = \mathrm{d}l'\left(\tilde{G}_{ll} + \tilde{A}_l'\tilde{M}_n^{-1}\tilde{A}_l\right)\mathrm{d}l \leq 0, \tag{21}$$

showing that the negative correlation between immobile factor real returns and differences in their endowments is preserved in the presence of international migration.

Furthermore, using Eqs. (20) and (20′), respectively, and comparing these to Eqs. (4) and (13), we find

$$\mathrm{d}l'\left(\mathrm{d}W_l - \mathrm{d}\tilde{W}_l\right) = \mathrm{d}l'\left(G_{lk} + \Gamma_{lk}\right)\mathrm{d}k + \mathrm{d}l'\left(\tilde{G}_{lk}\tilde{G}_{kk}^{-1}\tilde{G}_{kl}\right)\mathrm{d}l \tag{22}$$

$$\mathrm{d}l'\left(\mathrm{d}\tilde{W}_l - \mathrm{d}\tilde{w}_l\right) = \mathrm{d}l'\left(\tilde{A}_l'\tilde{M}_n^{-1}\tilde{A}_l\right)\mathrm{d}l \leq 0 \tag{23}$$

Hence, Eq. (23) shows that in the presence of international migration an increase in the number of traded goods decreases the international disparity in immobile factor real returns. On the other hand, from Eq. (22) allowing for international migration decreases the factor price differentials for immobile factors if endowment differences in k in the absence of migration have a sufficiently small effect on w_l. The reasoning is the same as in the absence of nontraded goods dealt with above. Again, without further qualification we can say that introducing international migration on average decreases the factor real return differential for all factors because

$$\mathrm{d}v'\left(\mathrm{d}W - \mathrm{d}\tilde{W}\right) = \mathrm{d}v'\begin{pmatrix} \tilde{G}_{lk}\tilde{G}_{kk}^{-1}\tilde{G}_{kl} & G_{lk} + \Gamma_{lk} \\ G_{kl} + \Gamma_{kl} & G_{kk} + \Gamma_{kk} \end{pmatrix}\mathrm{d}v \leq 0. \tag{24}$$

Inequalities (Eqs. (23) and (24)) are Le Châtelier results: Increasing the number of internationally mobile goods or factors decreases differences in factor real returns internationally.

4.2. Investment

As noted above, the distinguishing feature of factor investment lies in the fact that the owners of the factors do not move to the country of their investment. This implies that factor investment leads to the equalisation of nominal rather than real returns for the moving factors. In addition, changes in the domestic employment of the mobile factors have only a supply side effect while they influence domestic supply and demand if the owner moves together with the factor, i.e., in the factor migration case. As factor owners do not move in the investment case, it is the endowment change dk, rather than d$\tilde{k}$, that has an effect on domestic demand. This can be seen if we compare Eq. (19) with the analogous equation in the present context, which is

$$\mathrm{d}p_n = M_n^{-1}\left(A_l\mathrm{d}l + G_{nk}\mathrm{d}\tilde{k} - e_nG_k'\mathrm{d}k\right) \tag{25}$$

[16] Eq. (20) follows from solving Eq. (18) for d$\tilde{k}$ and substituting into Eqs. (19) and (17), then solving Eq. (19) for dp_n and substituting into Eq. (17). Eq. (20′) follows from using Eq. (19) to substitute for dp_n in Eqs. (17) and (18), then solving Eq. (18) for d$\tilde{k}$ and substituting into Eq. (17).

The international factor price differentials for mobile and immobile factors are given by

$$\mathrm{d}\breve{W}_l = A_l'\mathrm{d}p_n + G_{ll}\mathrm{d}l + G_{lk}\mathrm{d}\tilde{k} \tag{26}$$

$$\mathrm{d}\breve{w}_k = G_{kn}\mathrm{d}p_n + G_{kl}\mathrm{d}l + G_{kk}\mathrm{d}\tilde{k} = 0 \tag{27}$$

Using Eqs. (25)–(27) results analogous to the factor migration case can be derived by proceeding in exactly the same way as in the previous section. In particular, we get

$$\mathrm{d}v'\mathrm{d}\breve{W} = \mathrm{d}v'\begin{pmatrix} \tilde{G}_{ll} + \breve{A}_l'\breve{M}_n^{-1}\breve{A}_l & -\breve{A}_l'\breve{M}_n^{-1}e_n G_k' \\ -G_k e_n'\breve{M}_n^{-1}\breve{A}_l & G_k e_n'\breve{M}_n^{-1}e_n G_k' \end{pmatrix}\mathrm{d}v \leq 0. \tag{28}$$

with $\breve{A}_l \equiv A_l - G_{nk}G_{kk}^{-1}G_{kl}$ and $\breve{M}_n \equiv M_n + G_{nk}G_{kk}^{-1}G_{kn}$. We see that the negative correlation result including all factors is preserved in the presence of international investment. If dk=0, this holds for the subset of immobile factors as well, as can be seen in Eq. (28). This is a weaker result than in the case of migration, where it has been shown that the correlation holds for the immobile factors without further qualification. Comparing Eq. (28) to Eq. (4), we find

$$\mathrm{d}v'\left(\mathrm{d}\breve{W} - \mathrm{d}\tilde{w}\right) = \mathrm{d}v'\begin{pmatrix} \breve{A}_l'\breve{M}_n^{-1}\breve{A}_l & -\breve{A}_l'\breve{M}_n^{-1}e_n G_k' \\ -G_k e_n'\breve{M}_n^{-1}\breve{A}_l & G_k e_n'\breve{M}_n^{-1}e_n G_k' \end{pmatrix}\mathrm{d}v \leq 0, \tag{29}$$

and hence as more goods become tradable the differentials of factor real returns between countries becomes smaller on average. This is another Le Châtelier result. One can easily verify that this result carries over to the subset of immobile factors if dk=0. Again, no such qualification was necessary in the migration case.

It turns out that even for the full set of factors one cannot say in general that international investment decreases international differences in factor real returns, i.e. dv'(dW−d$\breve{W}$) cannot be signed. Intuitively, this is due to the fact that with international investment supply-side effects depend on employment differences d$\tilde{k}$ whereas demand-side effects depend on endowment differences dk. This asymmetry stands in contrast to a situation without international factor mobility, where both demand- and supply-side effects depend on endowment differences dk. For dk=0, this becomes irrelevant, and further Le Châtelier results follow: Allowing for international investment decreases on average

Table 1
Impact of globalisation on real factor prices

	Migration		Investment	
	Correlation for all factors	Correlation for immobile factors	Correlation for all factors	Correlation for immobile factors
Factor mobility	–	?	?	?
Goods mobility	–	–	–	?

A "–" means that the respective correlation becomes smaller in absolute value if more factors (more goods) become internationally mobile. Columns 2 and 3 (4 and 5) describe the scenario where all factor mobility takes the form of migration (investment).

international factor real return differentials for all factors as well as for internationally immobile factors.[17]

The results for both the migration and the investment case are summarized in Table 1, referring to the general case where we allow for $\mathrm{d}k \neq 0$. With $\mathrm{d}k=0$, all entries in Table 1 would be "–", i.e. the difference between the qualitative impact of migration and investment as well as between goods and factor mobility on international return differentials would vanish in this special case.

5. International consumer mobility

If nontraded goods prices differ across countries, then the cost of living is likely to differ across countries also. This generates consumption arbitrage opportunities for individuals whose income earning activities do not tie their consumption to a particular location.[18] If this group has sufficient expenditure, such arbitrage may effectively remove international differences in the cost of living. We assume this to be the case. Note that we are restricting individuals to consuming their entire basket in a single location, rather than making individual purchases where prices are cheapest.[19] While this makes the nontraded goods prices identical across countries "on average", individual nontraded goods prices are not equalised—i.e. the goods remain "nontraded".

Because of consumer migration, domestic income does not equal domestic expenditure, i.e. the budget constraint (Eq. (7)) does not bind. It is replaced by the condition that in equilibrium both countries must have the same price index, which implies

$$\mathrm{d}P = e_n' \mathrm{d}p_n = 0. \tag{30}$$

Totally differentiating the market clearing conditions for nontraded goods, Eq. (8) gives

$$\mathrm{d}p_n = M_n^{-1}(G_{nv}\mathrm{d}v - e_n E_u \mathrm{d}u). \tag{31}$$

Now, Eqs. (30) and (31) can be combined to yield an expression of international differences in the vector of nontraded goods prices as a function of endowment differences:

$$\mathrm{d}p_n = \left(M_n^{-1} - B\right) G_{nv}\mathrm{d}v \tag{32}$$

where $B \equiv M_n^{-1} e_n (e_n' M_n^{-1} e_n)^{-1} e_n' M_n^{-1}$. As usual, in Eq. (32) the endowment difference $\mathrm{d}v$ has both a supply side and a demand side effect on the price differential $\mathrm{d}p_n$. The demand effect is captured by BG_{nv} and is spelt out as follows. G_{nv} gives the supply change for nontraded goods, which is translated by $e_n' M_n^{-1}$ into a change in P. Then, $(e_n' M_n^{-1} e_n)^{-1}$ gives the change in expenditure induced by consumer mobility, and $M_n^{-1} e_n$ translates the expenditure change into a change in the price vector for nontraded goods.

[17] See Appendix A for a formal derivation of the results in this paragraph.

[18] Examples may include those retired from working, capital-owners and absentee landlords.

[19] This can be compared with "tourist purchases" which can be made on a more selective basis. For an examination of tourism in this type of model, see Copeland (1991).

This is supplemented by the standard supply side effect of dv. As the matrix B is a quadratic form in the negative scalar $(e_n' M_n^{-1} e_n)^{-1}$, it is negative semidefinite. It is shown in Appendix B that $M_n^{-1} - B$, translating a change in excess supply at constant prices into a price change, is negative semidefinite as well.[20]

With no differences in international price indices, international differences in factor real returns are given by Eq. (11). Denoting the vector of factor return differentials by $\mathrm{d}\bar{W}$ and using Eq. (32), we get

$$\mathrm{d}v'\mathrm{d}\bar{W} = \mathrm{d}v'\left(G_{vv} + G_{vn}\left(M_n^{-1} - B\right)G_{nv}\right)\mathrm{d}v \leq 0. \tag{33}$$

Thus, the negative correlation between factor real returns and endowment differences continues to hold with consumer migration. Comparing this case with the situation where all goods are traded (and hence there is no incentive for consumer migration), we have

$$\mathrm{d}v'\left(\mathrm{d}\bar{W} - \mathrm{d}w\right) = \mathrm{d}v'G_{vn}\left(M_n^{-1} - B\right)G_{nv}\mathrm{d}v \leq 0, \tag{34}$$

and hence free goods trade (which equalizes all goods prices) leads to international factor price differentials that are smaller on average than in the presence of nontraded goods and consumer migration (which equalizes price indices only). This result indicates that consumer migration is, in general, an imperfect substitute for goods market integration, and the incentive disappears when goods markets are fully integrated. In contrast to this, there is an incentive for factors to move internationally for any degree of goods market integration. In that sense, factor movements are an independent aspect of globalisation while consumer migration, responding to incomplete goods market integration, is not.

We turn now briefly to the question of the impact of consumer migration itself on international factor return disparities. Comparing Eqs. (13) and (33), we find that their difference $\mathrm{d}v'(\mathrm{d}W - \mathrm{d}\bar{W})$ cannot be signed in general. Hence, we cannot be sure that consumer migration leads to a decrease in international factor real return differentials on average. This is reminiscent of the factor investment case where allowing for international mobility of factors does not necessarily decrease factor price differentials in real terms. More broadly, it is noticeable that there are fewer general convergence results on real factor returns in the cases of investment and consumer mobility as compared to a situation with migration. This asymmetry is related to the fact that with factor migration w/P (for the moving factors) is equalized internationally, whereas in the other cases it is either w or P.

[20] Note that for N=1 it follows that $B=M_n^{-1}$ and therefore dp_n=0 in Eq. (32) for any endowment difference dv. Clearly, with a single nontraded good consumer mobility, by equalising price indices, equalises the price of the nontraded good. With more than one nontraded good, consumer mobility equalises price vectors p_n internationally if output differences at the initial prices are proportional to expenditure shares, i.e., if $G_{nv}\mathrm{d}v=e_n\gamma$ where γ is some scalar. Then the change in domestic expenditure induced by consumer migration clears simultaneously all nontraded goods markets at the initial prices. The result can be verified by substituting $e_n\gamma$ into Eq. (32).

6. Conclusion

We have shown in a general competitive model with many goods and factors that globalisation, defined as increasing freedom in the international mobility of goods and factors, has a tendency to decrease on average international differentials of factor real returns for the non-participating factors. It has also become apparent, as can be clearly seen in Table 1, that ceteris paribus the convergence results are stronger for the case of "goods market globalisation" than for the case of "factor market globalisation", and they are stronger for the migration case than for the investment case. Only if we focus on the case where international endowment differences of the mobile factors have no influence on factor return differentials do these differences vanish. This illustrates the importance of looking at both goods and factor market integration at the same time. It is this feature in particular which distinguishes the present paper from Falvey (1999) who did not analyze international factor mobility and Neary (1985) who analyzed only situations with fully integrated goods markets.

One key assumption for our analysis is for the endowment differences between the two countries to be small. This assumption, combined with that of identical, homothetic preferences, allowed us to take the matrices used in comparing the different scenarios as being evaluated at the same point. We have argued that in those cases where we can unambiguously sign the difference in correlations, this is due to supply-side Le Châtelier effects with demand side effects neutralized by assuming homothetic preferences. Roberts (1999) shows that a global version of the Le Châtelier principle cannot always hold in any nondegenerate problem. Therefore, we cannot expect our results to hold for arbitrarily large endowment differences without imposing additional restrictions.

For notational convenience, we assumed a large and a small country, but given small differences in relative endowments the results are extended readily to a situation with two large countries. In this case, the added complication lies in the induced changes in traded goods prices. However, if the differences in relative endowments between the two countries are small, as assumed here, changes in traded goods prices have identical effects on factor returns in both countries. Therefore, all results derived in this paper hold in this case as well.

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Appendix A. Investment

In analogy to Eq. (20′) in the case of migration, we can derive

$$\mathrm{d}\breve{W}=\begin{pmatrix} G_{ll}+\Gamma_{ll}-\breve{G}_{lk}\breve{G}_{kk}^{-1}\breve{G}_{kl} & -\left(A_l'-\breve{G}_{lk}\breve{G}_{kk}^{-1}G_{kn}\right)\breve{M}_n^{-1}e_nG_k' \\ -G_ke_n'M_n^{-1}\left(A_l-G_{nk}\breve{G}_{kk}^{-1}\breve{G}_{kl}\right) & G_ke_n'M_n^{-1}e_nG_k' \end{pmatrix}\mathrm{d}v,$$

which together with Eq. (12) gives

$$\mathrm{d}v'\left(\mathrm{d}W-\mathrm{d}\breve{W}\right)=\mathrm{d}v'\begin{pmatrix} A & B \\ B' & C \end{pmatrix}\mathrm{d}v \tag{35}$$

where

$$A\equiv\breve{G}_{lk}\breve{G}_{kk}^{-1}\breve{G}_{kl}$$

$$B\equiv G_{lk}+\Gamma_{lk}+\left(A_l'-\breve{G}_{lk}\breve{G}_{kk}^{-1}G_{kn}\right)\breve{M}_n^{-1}e_nG_k'$$

$$C\equiv G_{kk}+\Gamma_{kk}-G_ke_n'M_n^{-1}e_nG_k'$$

with $\breve{G}_{kl}\equiv G_{kl}+G_{kn}M_n^{-1}A_l$, and $\breve{G}_{kk}\equiv G_{kk}+G_{kn}M_n^{-1}G_{nk}$ being a negative semidefinite matrix. The quadratic form (Eq. (35)) cannot be signed because C is indefinite. If dk=0, Eq. (35) reduces to $\mathrm{d}l'A\mathrm{d}l\leq 0$.

Appendix B. Migration

Since M_n^{-1} is symmetric, by the spectral theorem there exists an orthogonal matrix R such that $R^{-1}M_n^{-1}R=D$ where D is a diagonal matrix whose elements $(d_1,\ldots,d_N)$ are the eigenvalues of M_n^{-1}. As R is orthogonal, $R'=R^{-1}$, and we can write $M_n^{-1}=RDR'$. We then have

$$M_n^{-1}-B=RFR'$$

with $F\equiv D-Dz(z'Dz)^{-1}z'D$ and $z\equiv R'e_n$. We go on to show that F is negative semidefinite which implies that $M_n^{-1}-B$ is negative semidefinite because every quadratic form $x'(M_n^{-1}-B)x$ can be written as $y'Fy$, where $y\equiv R'x$. Routine calculations show that F is symmetric with elements

$$f_{ii}=d_i\left(1-\frac{d_iz_i^2}{\sum_{j=1}^{N}d_jz_j^2}\right)\quad\text{and}\quad f_{ik}=-\frac{d_id_kz_iz_k}{\sum_{j=1}^{N}d_jz_j^2}$$

Let F_K denote a principal minor of order K of F, and $k \in K$ the numbers of the rows and columns included in K. Then one can show that

$$F_K = \left(1 - \frac{\sum_{k \in K} d_k z_k^2}{\sum_{j=1}^{N} d_j z_j^2} \right) \prod_{k \in K} d_k$$

With all eigenvalues of M_n^{-1} being negative, we have $(-1)^i F_i > 0 \forall i \neq N$, and $F_N = 0$. This establishes that F is negative semidefinite.

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