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RESEARCH ARTICLE

International Saving, Investment and Trade

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Abstract Feldstein and Horioka (Econ J 90:314–329, 1980) observed that saving and investment move closely together in the major OECD countries. This finding is a puzzle if national economies are characterized by one sector neoclassical production functions—with diminishing returns to capital, a high level of savings in a country should create an incentive to export capital. In this paper, we show that this incentive disappears in the presence of multiple sectors with differing capital intensities. In a high saving country, national capital can be absorbed domestically without a decline in its marginal product through a shift in the sectoral composition of national production towards capital intensive sectors. This is nothing but the well-known Rybczynski effect. We present a modified version of the standard Heckscher–Ohlin (HO) Model to show that very small barriers to capital mobility are enough to force national savings to stay within the country of origin. We also argue that, while the assumptions of this model may appear special, they are not unrealistic for the developed countries in the Feldstein Horioka study. Some historical economic trends are also consistent with the picture presented in this paper. Finally, the paper shows that the conventional insights from the one sector neoclassical model can be completely overturned in a multi-sector setting when technological differences are introduced.

Keywords Investment · Savings · OECD · Capital · Heckscher-Ohlin · International capital mobility

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1 Introduction

In their seminal paper Feldstein and Horioka (1980) (FH) made the observation that domestic saving and investment are strongly correlated for the major OECD-countries during the period 1960–1974. Virtually all of what is saved in a country is also invested in that country. FH interpreted this high correlation between saving and investment as evidence of segmented capital markets and/or low capital mobility in spite of ongoing liberalizations in capital markets. The FH finding is a puzzle in a world with global capital markets when the national economies are thought to be well characterized by one sector neoclassical production functions of the form $F(K, L)$. This paper shows that the FH observation is far less troubling in a trading world with multiple sectors that have varying capital intensities.The FH observation has led to an extended literature.[1] Obstfeld and Rogoff (2000) consider the FH puzzle one of the six main puzzles in international macroeconomics.[2] The original FH observation focuses on the long-run averages of saving and investment rates in a cross-country regression among OECD countries.[3] The extended literature has studied the saving–investment correlation over time using annual data and for larger sets of countries, including developing countries. Different time periods have been considered, including more recent years and even the pre-WWI era of the settler economies. Regional savings–investment correlations have also been investigated, instead of taking countries as the unit of analysis. While those numerous studies constitute an impressive body of work, they have, sometimes, diverted the attention from the original observation that was reported for the rich OECD countries, for which the FH observation still applies. As Blanchard and Giavazzi (2002) note, while Obstfeld and Rogoff (1996) find that the saving–investment correlation decreased in the years after 1980, the correlation has remained at the same level in the period following the Obstfeld and Rogoff (1996) paper, with a coefficient on saving of around 0.6. In this paper, we focus on this cross-country correlation for the rich OECD countries. We explain the FH observation with an argument taken from trade theory that has been largely absent from the literature, except for two footnotes that mention the possible nexus between the FH observation and the factor-proportions theory.

[1] Well-known surveys of the literature are Tesar (1993), Mussa and Goldstein (1993) and Obstfeld (1986,1994). A more recent, good survey is Hericourt and Maurel (2005).

[2] This paper addresses the FH puzzle only, and does not focus on the separate puzzles of 'consumption correlation' or 'portfolio home bias' that Obstfeld and Rogoff (2000) consider. The lack of portfolio diversification and consumption correlation are puzzles because they conflict with the desire to diversify risk. The FH observation is primarily a puzzle because it conflicts with the diminishing returns to capital associated with a neoclassical production function.

[3] At the heart of Feldstein and Horioka's analysis is a simple cross-country regression of the following form:

$$(I/Y)_i = \alpha + \beta(S/Y)_i + \varepsilon_i,$$

where S/Y is the gross domestic savings rate, and I/Y the gross domestic investment rate. The slope coefficient was estimated 0.887 (S.E. 0.07).

When national economies are characterized by one sector neoclassical production functions of the form $F(K,L)$, a high rate of investment and capital accumulation results in a decline of the marginal product of capital. This should create an incentive to export capital in a country with a high saving rate. However, in a world with multiple sectors that have sufficiently different factor intensities, a country with a high saving-rate can employ its national capital stock domestically without a decline in its marginal product. Indeed, it can shift the composition of its national production towards capital intensive sectors. This is nothing but the well-known Rybczynski effect from the Heckscher–Ohlin Theory (HO). Instead of exporting capital directly, a country can produce more of capital intensive goods and export these products. With the mechanism suggested here, as soon as returns to capital tend to fall in a heavily saving and investing country, there is a shift in the pattern of production in that country towards tradable and capital intensive sectors. If the increase in output of those sectors exceeds the changes in domestic absorption, the excess can be exported in exchange for less capital intensive products. This shift in production ensures that the additions to the stock of capital are absorbed without a decline in the rental rate of capital.

Is such a shift empirically plausible? The real world obviously has many sectors with different capital intensities. The critical empirical question is whether those capital intensity differences are large enough to enable excess capital of a country to be absorbed through sectoral shifts (or to enable a shortage of capital to be made up for through such shifts). The answer is affirmative; as Debaere and Demiroglu (2003) shows, the differences in capital intensities of sectors are sufficiently large to accommodate the capital abundance differences between developed OECD countries.[4]

The sectoral shift in production can completely remove the incentive for capital movements, which can also be seen in the well-known Factor Price Equalization (FPE) Theorem. That theorem states that trade equalizes factor returns across countries under certain conditions. As such, with equal returns, the incentive for capital to move abroad disappears, and the saving–investment correlation becomes self-evident. The major requirements for FPE are identical technologies and free trade (so that goods prices are identical in all the countries), and some degree of similarity of the factor proportions of countries. An intuitive way to understand FPE is to realize that the labor and capital contained in a country's exports and imports affect the factor returns in the same way that in-or outflows of labor (through migration) or capital (through capital movements) do. In other words, trade in goods and factor flows are substitutes.

While the Rybczynski and FPE Theorems give some indication of why it is possible to have no capital flows in equilibrium, they do not exactly describe the economic mechanism that equalizes saving and investment in a country. In fact, if

[4] The explanation provided here does not address the question posed by Lucas (1990) why capital was not flowing from rich to poor countries. As a matter of fact, as Debaere and Demiroglu (2003) shows, the sectoral variation in factor intensities is not large enough to absorb the huge differences in factor endowments between developed and developing countries. Therefore, see also Sections 2 and 3, developed and developing countries cannot produce the same set of goods (there is complete specialization of production) and we are back to the analysis of one-sector production functions mentioned above and hence back to Lucas' original question: Why is it that with much more labor per unit of capital that developing countries do not attract more capital flows?

the returns to capital are equalized in all the countries, capital could either move abroad, or stay within the country of origin. This implies that the international allocation of capital would be indeterminate.

However, the indeterminacy of capital allocations is fragile, disappearing even with the slightest cost for international capital movements. In the model of Section 2, we postulate that a flow of capital across country borders requires a (possibly very small) premium Δ, which is easily justified given the risks and costs associated with foreign investment such as the exchange rate risk and information costs. Unless the foreign return r^* exceeds the home country return r by the amount Δ (i.e., unless $r^* \geq r+\Delta$), capital chooses to stay within the home country. That premium means that, if the returns to capital are identical in the home country and elsewhere, the preferred alternative is to invest at home. As shown in Section 2, such a required premium eliminates the multiplicity of equilibria and "no capital flows" emerges as the unique outcome as long as the country endowments are similar. For analytical convenience, and also because we want to emphasize the substitution between trade and factor flows, we take the premium Δ to be small and positive. Needless to say, variations in Δ over time can occur, i.e. Δ could turn negative for a while.[5] As a matter of fact such changes in Δ could be invoked as possible explanations for why the correlation between saving and investment that is observed in empirical studies is high, but not one.

The mechanism that equates saving and investment can then be summarized as follows. Consider a country with a high saving rate. The supply of capital grows faster in that country than in countries with lower saving rates, unless there is a capital outflow. However, capital does not flow abroad immediately, as there is the required premium Δ. The increase in the capital stock consequently puts downward pressure on the rental price of capital, and creates an incentive for entry in the capital intensive sector. While more firms enter that sector, the excess of capital eventually gets fully employed, and the pressure on the rental rate of capital disappears. (In the process, both labor and capital are drawn from the labor intensive sector, which gets smaller in the country.) Hence, a new equilibrium is reached with no international movement of capital.[6]

The Heckscher–Ohlin Theory and FPE have been around for a very long time, and international trade is known to be a substitute for capital movements (Mundell 1957). Hence, our explanation should hardly sound novel to an international trade economist. It is remarkable, however, that the influence of trade on factor returns has

[5] For example, a possible explanation for a changing D could be a change in the perceived exchange rate risk, or even a changing balance between trade restrictions and those on factor movements.

[6] As we know from the Stolper–Samuelson Theorem, factor prices are determined by goods prices. If the country under consideration is large, the shift in the country's production towards capital intensive sectors may change the world relative prices of goods. Consequently, the factor prices may change worldwide as a result of the capital accumulation in that single country. However, the changes in goods prices will prevail *across* the world because of trade. As a result, the factor prices implied by these goods prices will be the same in all the countries also. In the two-by-two model, if, for instance, there is a decline in the price of the capital intensive good, the rental rate of capital declines everywhere in the world. The FPE Theorem assures that the returns to capital will still be identical across countries and there will be no incentive for capital flows as before.

never been seriously considered a viable alternative to justify the saving–investment correlation.[7] One can only guess at the reason for this neglect.

One reason is the widespread use of the neoclassical one-sector models. While learning and teaching such models, we (economists) perhaps develop a tendency to think mainly in terms of a one-sector world. In Section 4, an example with multiple sectors is presented where the high saving country turns out to be the more attractive direction for international capital flows. In other words, the implications of the one-sector and multi-sector models are very different when the issue is saving–investment correlations. Another reason for the neglect of FPE as an explanation for the FH result may be the separation, as noted by Krugman (1993), between the fields of international finance and international trade.

Finally, perhaps the more important factor may be the general distrust of the applicability of the HO Theory to empirical questions, given the failure of the HO Theory in empirical predictions and the specific, unrealistic assumptions of the textbook model (such as the 2×2×2 world, identical technologies, etc.). Those may have generated some reluctance to think of empirical questions in HO terms, limiting the mention of its possible link to the saving–investment correlation to the footnotes of the literature. In Sections 3 and 4 of the paper, we address some of these concerns. We argue that the HO assumptions are fairly realistic for the developed countries that are considered by Feldstein–Horioka.

In Section 2, we illustrate our point in a modified version of the basic HO model that includes saving and investment explicitly. More specifically, we have a multi-period model in which each period is nothing but the standard 2×2×2 HO model except that capital is mobile internationally. In Section 3, we discuss the assumptions of the HO model and the FPE Theorem, and how the proposed explanation of the FH puzzle accords with general observations. In section 4, we show how returns to capital are equalized by trade even under more general conditions, allowing for different technologies in the countries and without requiring the equalization of *all* factor prices. This section also shows that with multiple sectors that have different capital intensities, outcomes can differ markedly from the conventional insight from the one sector neoclassical model. Section 5 concludes.

2 Trade removes the need for capital movements

Consider a 2×2×2 standard Heckscher–Ohlin framework. Capital, K, and labor, L, are mobile across sectors within a country. Good 1 and 2 (G1 and G2) are produced with identical neoclassical constant returns to scale production functions. Their prices are p_1 (numeraire) and p_2. The country endowments are inside the diversification cone formed by the cost-minimizing capital-labor ratios of the two

[7] In a footnote Obstfeld (1986) refers to Kotlikoff (1984) who briefly mentions a conversation in which the possible relevance of the FPE result to the FH puzzle is brought up. The explanation is not pursued by either of the authors, possibly because it is thought of as an intellectual curiosity, rather than an issue that may have actual pertinence to reality. Ventura (1997) who develops a dynamic Heckscher–Ohlin model also mentions FPE as a possible explanation for the FH puzzle in a footnote.

industries at prevailing world prices. Both countries produce both goods, and there are no factor intensity reversals.

We *modify* this setting and incorporate saving, investment and changes in the capital stock. We provide a setup in which each period accords with the standard HO model, so that the standard FPE and Rybczynski Theorems can be used separately for each period.[8] Deviating from the standard HO model, we assume that capital is internationally mobile (whereas labor is not). The consumers save a fraction of their income and invest it in one of the two countries based on the return to capital in the next period. The countries are assumed to be similar in terms of their endowments, and stay in the diversification cone in *every* period, although the location of the cone may itself change.

$$\begin{aligned} &Y = Y_1 + p_2 Y_2, \qquad Y^* = Y_1^* + p_2 Y_2^*, \quad (\text{ note that } p_1 = 1) \\ &S = sY, \qquad\qquad S^* = s^* Y^*, \\ &S + S^* = I + I^*, \\ &K_+ - K = I, \qquad K_+^* - K^* = I^*, \end{aligned}$$

where Y_1 and Y_2 are the quantities of output in the two sectors, and Y is national income measured in good-1 prices. The national saving rate is denoted by s, which can be thought of the result of a life-time utilization problem. (For the purposes of this paper, it does not matter how s is determined and whether it is time-varying or constant.) S is national saving, I is investment, and K and K_+ are current and next period's real capital stock. Note that Y, S, I and K are all measured in units of the first good. Variables with asterisks (*) denote the foreign country variables; the plus-subscripts ($_+$) denote the 'next-period' quantities. Good 1 is assumed to be labor intensive and is used only for consumption, while Good 2 is used also for investment. This assumption is made so as to avoid having to introduce a third good, and to be able to stay within the standard 2×2×2 framework. This helps keep the model simple, with no loss of insight. Consequently, the final demand for the second good will be C_2+I in the home country and $C_2^* + I^*$ abroad.[9]

It may be useful to elaborate on the saving rates. The households in both countries save different portions of their incomes, i.e., s and s* may be different. As mentioned earlier, it is not important where s comes from, although the readers with fondness of representative agent models may prefer to think it as the solution of a dynamic utility maximization problem. Furthermore, it can be constant or varying over time. Finally, individuals may be heterogeneous or identical in their saving rates, i.e., the saving rate may be the result of not an optimal control problem for a representative agent, but the income weighted average of individual saving rates each of which maximizes a separate utility function. Thus, simply put, s and s* are *average* saving rates for the two countries that prevail in the period under consideration, and they may not stay constant in the following periods.

[8] In case the endowments are so different that they do not lie inside the diversification cone, the two countries cannot produce the same set of goods and FPE will not materialize.

[9] Alternatively, good 1 could also be chosen as the investment good, and that would not make any difference in the model.

The tools needed to obtain the saving–investment equality in our model are the FPE, Rybczynski, and Stolper–Samuelson Theorems. These theorems are valid and the saving–investment equality is obtained regardless of who saves how much or consumes which good and in what quantity. The crucial assumptions here are identical technologies, country endowment similarity, and that goods prices are the same in both countries.

There is no depreciation, and therefore I equals $K_+ - K$, the amount of capital accumulated between the two subsequent periods. We abstract from the complications that may arise due to population growth by fixing L and L^*. The equation $S + S^* = I + I^*$ states that world investment is financed by world saving. No restrictions have been imposed so far on how world saving is allocated between I and I^*. To close the model, we need to specify the investment behavior in each country. Let S^{d} denote the portion of the home country's savings S that does not leave the country and that is invested domestically, and let S^{a} be the part of S that flows abroad. Defining similar variables for the foreign country, we have:

$$S = S^d + S^a \quad S^* = S^{d*} + S^{a*} \tag{1}$$

The amount of savings that moves abroad is determined by the difference in returns. The savers consider the *next* period return to capital when deciding where to invest, as the capital that results from current investment is employed in the next period.[10] We assume that savings flow to the country with the higher return. More precisely, the foreign investment decision is made as follows. All of home savings (S) moves abroad if the future foreign rental rate of capital r_+^* is higher than $r_+ + \Delta$, where Δ is a premium required for foreign investment. That premium covers costs due to exchange rate volatility, transaction costs due to information barriers, and other possible risks. Δ is considered an arbitrarily small positive number, so that it constitutes no essential barrier for capital movements.[11] This leads to the following aggregate best response correspondences.

$$S^a = \begin{cases} 0 & \text{if} \quad r_+^* < r_+ + \Delta \\ [0, S] & \text{if} \quad r_+^* = r_+ + \Delta \\ S & \text{if} \quad r_+^* > r_+ + \Delta \end{cases} \quad \text{and} \quad S^{a*} = \begin{cases} 0 & \text{if} \quad r_+^* > r_+ - \Delta \\ [0, S^*] & \text{if} \quad r_+^* = r_+ - \Delta \\ S^* & \text{if} \quad r_+^* < r_+ - \Delta \end{cases} \tag{2}$$

Finally, foreign inflow $S^{\mathrm{a}*}$ and the part of domestic funds that stay in the home country S^{d} are available for and transformed into home country investments. The analogue of this is true in the foreign country.

$$I = S^d + S^{a*} \quad I^* = S^{d*} + S^a \tag{3}$$

Now we solve for the equilibrium.

[10] This may seem a short-sighted criterion for foreign investment as the capital gains or losses that may accrue due to the change in the price of the capital good should also play a role in the decision process. But, in this model, the capital good is good 1, and its price is the same in both countries due to free trade. Hence, capital gains or losses are the same in both countries.

[11] As mentioned in the introduction, D prevents indeterminacy. Without D, any allocation of world investment across countries is an equilibrium. With any positive D, no matter how small, $S=I$ and $S^*=I^*$ are the unique equilibrium outcome whenever FPE holds.

Solving the Model Note that none of the necessary assumptions for the FPE result are altered in our setting. Consequently, the factor returns are equalized in the next period. With $r_+^* = r_+$, Eq. 2 implies that S^a=0 and S^{a^*}=0. Using Eq. 1, we know that S=S^d and S^*=S^{d^*}. In other words, savings stay within its own country. Substituting these four equalities in Eq. 3, we obtain I=S and I^*=S^*. Thus, in equilibrium, we find the equality of saving and investment, which is the basis of the FH puzzle. The equality of the returns (due to FPE) leaves no incentive for savings to move abroad.

In Fig. 1, we depict the standard Lerner–Pearce diagrams with the familiar unit-value isoquants and unit isocost lines. Initially (solid lines), we have equal rates of return to capital at home and abroad, i.e. r=r^*, due to FPE. We do the following experiment. The foreign country (*) is the high saving and investing country, i.e. $s^*>s$. For simplicity in the diagrams, we set s=0, so that the home country does not save, and as a result it does not invest or accumulate capital. We increase K^* while keeping K, L and L^* the same.

The arrow in Fig. 1 represents capital accumulation. (The home country endowment point, E=(L,K), stays the same, while the foreign endowment increases from E^*=(L^*,K^*) to $E_+^* = \left(L^*, K_+^*\right)$—only K^* changes.) The foreign country observes a shift in production from the labor intensive towards the capital intensive sector as it accumulates capital (Rybczynski Theorem). The change in the world endowment can, however, cause a change in all goods and factor prices to change. (If the capital accumulation does *not* change the equilibrium world prices p_1 and p_2, the factor prices remain the same.) Figure 1 is drawn assuming a fall in p_2. The dashed lines represent the new situation after the price change. Although the factor prices change, their *equality* is preserved, as long as the endowment points (E_+ and E_+^*) are still inside the diversification cone. Again, no incentive is left for international capital movements.

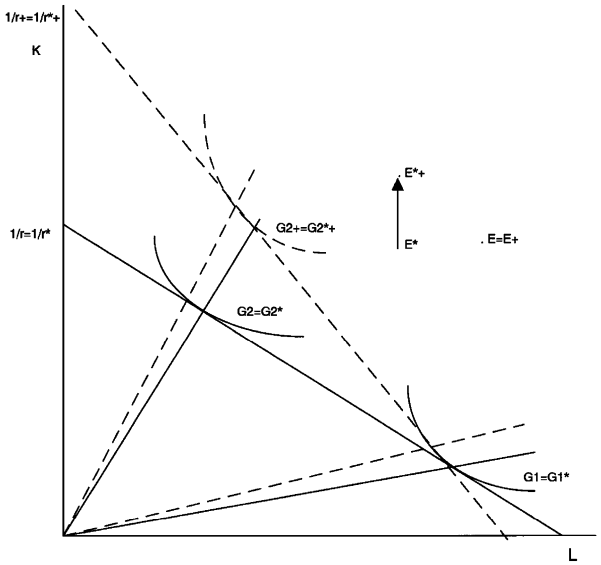

Fig. 1 Diagram with the familiar unit-value isoquants and unit isocost lines

3 Robustness of the HO and FPE results

As with most models in economics, some of the assumptions in the HO Theory are not realistic. Furthermore, the HO predictions have not been borne out empirically. We discuss in this section whether these unrealistic assumptions and empirical failures provide sufficient grounds to dismiss neoclassical trade theory as a way to understand saving–investment correlations.

The FPE, Rybczynski and Stolper–Samuelson Theorems are not restricted to the 2×2×2 case. In the 2×2×2 world, the FPE Theorem requires that the country endowments lie in the cone of diversification, which is a similarity requirement for the country endowments. Deardorff (1994) generalizes this condition to the case of an arbitrary number of goods and countries. He introduces a higher dimensional counterpart of "lying in the diversification cone," called the "Lens Condition" that can be applied to a multi-sector and multi-country world. This condition tells us how dissimilar the endowments of a group of countries can be for a given set of capital-labor ratios used in the production of the different goods. Also the Rybczynski and Stolper–Samuelson Theorems have "correlation" versions in higher dimensions. (Ethier (1984) for the Rybczynski and Deardorff and Stern (1995) for the Stolper–Samuelson Theorem.)

As pointed out by Leamer and Levinsohn (1995), the literature has neglected to explicitly check the appropriate similarity condition before judging the empirical relevance of FPE. The observed wage differences between a developed and a developing country do not give any information about the validity of the FPE Theorem. With apparent dissimilarity of endowment structure and likely differences in technology between the developed and developing world, the FPE Theorem would not predict equalization of factor prices in the first place.

FPE need not necessarily involve the whole world. As argued by Debaere and Demiroglu (2003) it can hold among a subset of countries as long as they have identical technologies and similar factor proportions. Using the lens condition of Deardorff (1994), Debaere and Demiroglu (2003) study the endowments of the developed OECD countries considered by FH and also those of a group of 34 countries that includes both the OECD and developing countries.[12] We consider both the case with and without factor-augmenting productivity differences between countries. In both cases, the lens condition is violated for the group of countries that includes both OECD and developing countries, whereas it is not for the OECD countries. The extent of the difference in country endowments makes FPE impossible between developed and developing countries and there will be incentives for capital to move because of the international differences in returns. On the other hand, FPE is possible depending on the extent of technology differences among OECD countries. Technological differences across developed OECD countries may not be large enough to matter strongly for the long-term averages that FH consider, but even if they are, as we will argue in the next section, the mechanism that we describe can still be applicable for the OECD.

[12] See also Schott (2003).

One might object that there were substantial capital flows in the nineteenth century from the UK to overseas (Obstfeld 1994). Given the dissimilarity of the endowments of the UK and the economies of the new world at that time, the returns to capital are not expected to have been equalized by trade. Hence, the observed net capital flows are not surprising. Another situation where the saving–investment correlation is not as strong is the case of developing countries (Montiel 1994; Dooley et al. 1987), in spite of the fact that these countries have much stronger restrictions on capital movements.[13]

Another condition for FPE, the equality of international goods prices, is less of a concern for the same group of OECD countries. Tariff rates are low and have been decreasing. Although purchasing-power-parity does not hold at every moment in time, major price differences are leveled out over longer periods. Note again that Feldstein and Horioka (1980) take a fairly long time horizon for the averages of saving and investment in their regressions.

As mentioned earlier, a factor that may have made economists reluctant to consider the relevance of the HO Framework is its poor empirical performance in explaining the actual patterns of trade. It started with Leontief's paradox and more recently continued with the failing predictions of the Heckscher–Ohlin–Vanek (HOV) Theorem uncovered by Trefler (1995) and others. The HOV Theorem states that the relative factor abundance of countries should be reflected in their net factor content of trade. The net factor content of trade prediction hinges critically upon the strong assumption of identical homothetic preferences, whereas the FPE, Rybczynski or Stolper–Samuelson Theorems do not. These three theorems depend only on the production side of the economy, and are valid irrespective of the consumption patterns. As a matter of fact, the HOV prediction may not be satisfied in our very model, as we do not impose any restrictions on the consumption side.[14] We need the HO Model in this paper only because it provides us with an already established, familiar framework to analyze the *multi-sector* world.

4 With differences in technologies

The assumption of identical technologies is fairly reasonable when we consider a limited group of high-income countries such as the major OECD countries over an extended period of time. Yet, as shown in this section, one can go beyond FPE. The mechanism that forms the basis of the Rybczynski Theorem, i.e., the response of the sectoral output mix to changes in factor endowments can still bring the returns to

[13] These existing capital flows may reflect aid or funds from the IMF and the World Bank rather than private capital looking for higher gains. Nevertheless, they are consistent with the analysis of the endowments mentioned above. Another point one can raise is that the existence of net capital inflows to LDCs implies that there should be corresponding net capital outflows from developed countries. However, the size of LDC economies is small compared to output of developed economies. Thus, capital flows that are significant for the LDC economies are relatively insignificant for the developed countries.

[14] Even if we assumed identical-homothetic preferences, the HOV prediction would not likely be true in the model of Section 2. Our high saving country has a higher investment rate and thus absorbs more of the capital intensive good. As such, the capital abundant country may well be a net importer of capital.

capital together even when technologies across countries are different.[15] The analysis in this section is by no means a general treatment of technological differences. It presents two special examples that help gain insight into what happens when the technologies are not identical. The message is that trade may remove the need for capital flows even when there are technological differences among countries.

The setup of Section 2 is retained except for the identical technology assumption. The home country is assumed to be more productive in a Hicks-neutral fashion. In other words, if the production function of sector j is $A_j^* F(K,L)$ in the foreign country, it is A_jF(K,L) in the home country with $A_j > A_j^*$. As there is a separate cone for each country in this case, the assumption regarding the diversification cone is replaced by the requirement that "both countries are diversified," so that each country produces both goods. The effect of an increase in the capital stock in the foreign country is analyzed graphically in Fig. 2a. We start from an initial situation where r=r*. This initial equality of r and r* can be justified on the basis of past capital movements.[16] In Fig. 2a, this makes the vertical intercept of the unit factor cost lines for both countries the same point, (0,1/r). Again, note that the horizontal intercept for the unit factor price line equals 1/w, and therefore in Fig. 2a the foreign wages are lower.[17] (As before, the solid lines depict the initial situation in both countries and the dashed ones represent the new equilibrium.)We compare the initial capital returns, r and r*, with the returns in the new equilibrium, r_+, and r_+^*. If the foreign country is small, the effect of changes in that country on world prices is negligible and factor prices stay the same in the world. Consequently, as predicted by the Rybczynski Theorem, the foreign country that accumulates capital produces more of the capital intensive and less of the labor intensive good. As the equality of the returns is left intact, no incentive arises for capital to move.

Even with a large foreign country, the saving–investment equality may not be a surprise. Figure 2b depicts that case. As before, when the foreign country accumulates capital, more of the capital intensive and less of the labor intensive good is produced in that country. This changes the pattern of world production, and that, in turn, may influence the world prices p_1 and p_2 as in the previous section. In Fig. 2b we consider a fall in the price of the capital intensive good p_2, while p_1 is kept the same (as good 1 is the numeraire). In response to that price change, the Stolper–Samuelson Theorem tells us that the return to capital in each country falls, as shown in Fig. 2b by the steeper factor price lines. These lines may, though need not, have the same vertical intercept. In the Appendix, we show that in the case of Cobb–Douglas production functions and Hicks-neutral technological differences, the changes in the rental rate are the same in both countries, and hence, $r_+ = r_+^*$. In other words, the equality is preserved in the new equilibrium even though there are no capital flows.

[15] The identical technology assumption is only needed for FPE and not for the Rybczynski and Stolper–Samuelson Theorems. The latter two theorems are still operational in this section.

[16] In our model, capital is mobile with no essential barriers to its movements (the required premium D is assumed to be arbitrarily small). Thus, r=r* is a reasonable starting point, as previous capital movements would have eliminated the return differentials if they existed. In this section we try to obtain the equality in the *future* period$\left(r_+ = r_+^*\right)$ without resorting to any further capital movements.

[17] The rental price of capital and the goods prices the producers face are the same in both countries, but foreign firms have inferior technology. This disadvantage for the foreign firms is offset by lower wages.

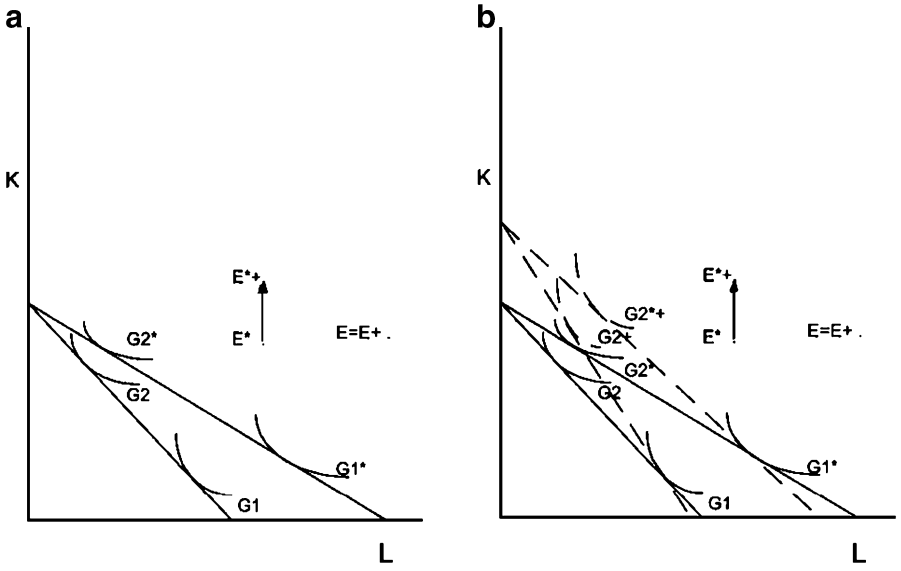

Fig. 2 The effect of an increase in the capital stock in the foreign country (**a**). The fall in the price of the capital in the foreign countries (**b**)

In general, the sizes of the changes in r and r^* may be different. Yet the directions of the changes are always the same in this setup; as stated by the Stolper–Samuelson Theorem, a decrease in the relative price of the capital intensive good reduces the rental price of capital. This is true as long as the same good is capital intensive in the two countries.

Below, we show that the possible difference of r_+ and r_+^* has an interesting implication (although it is difficult to derive an intuition from it): the country that accumulates more capital may well end up with a higher rental rate. This means that the country that accumulates more capital emerges as the more attractive direction for capital flows, contrary to what we would expect in a one-sector neoclassical model. Consider the following setup that uses Leontief technologies, $F_1(K,L)= A_1 \min\{2K,L\}$ and $F_2(K,L)=A_2 \min\{K,2L\}$. The equilibrium interest rate in this case is $r = (4/3)(p_2A_2 - p_1A_1/2)$, and that gives a partial derivative of r with respect to p_2 of $(4/3)A_2$, and, similarly, in the foreign country $\partial r^*/\partial p_2 = (4/3)A_2^*$. If the foreign country is the country that accumulates capital, and if $A_2 > A_2^*$, the fall in p_2 causes a drop in r^* in the foreign country. One should note, however, that r^* falls by *less* than r in the home country. The final outcome is $r_+ < r_+^*$.[18]

[18] One might argue that capital movements will yield the initial equality of returns to capital in the 2×2×2 case with technological differences, yet that they are also likely to lead to specialization in the production of one good in one of the countries. This specialization would make the comovements of the returns to capital impossible. On the other hand, with many goods, complete specialization is less likely. That is why we consider the case of diversification in our 2×2×2 analysis. (As for the comovements of factor returns, the correlation version of the Stolper-Samuelson Theorem (Deardorff and Stern 1995) is applicable to the case of multiple goods.)

5 Concluding remarks

The long-standing FH observation is less of a puzzle once trade theory is taken into account. In a multi-sector world, countries with high investment rates can still employ the additional capital without a decline in returns as they shift production and exports toward more capital intensive goods. The intuition based on the neoclassical view of investment can be misleading in a multi-sector context with international trade. In fact, as an example with technological differences shows, the incentive may actually be for capital to move from the low to the high saving-investing country.

We emphasize that the insights from the theoretical HO model and the FPE result should not be discarded on the grounds that the maintained assumptions are not realistic. We point out that trade can cause the returns to capital in different countries to move together even with different technologies and different wage rates. In particular, with Cobb–Douglas technology and Hicks neutral technological differences, the returns to capital across countries stay equal due to trade and there is no incentive for capital flows.

Note that this paper does not have much relevance for the two other major puzzles regarding international capital movements — the lack of international portfolio diversification and correlation of consumption across countries. Those two are puzzles because they conflict with the desire to diversify risk. The FH observation is primarily a puzzle because it conflicts with the diminishing returns to capital associated with a neoclassical production function. This paper addresses only the latter.

While we do not offer a formal empirical test of whether the proposed shifts in the composition of national production and exports do take place in practice, our explanation accords well with some broad historical trends. In accordance with the argument that highly saving and investing countries should experience a shift towards capital intensive sectors, Japan (the highest saving country in the FH sample) developed an increasing presence during the post World War II period in the auto and steel industries, two major capital intensive sectors. A similar case could be made for Germany. Two other observations that support our explanation are the capital flows in the 19th century between the UK and the new world, and the weakness of the saving–investment correlation in the case of the developing countries. Both are instances of dissimilar factor endowments, and, therefore, unlikely cases for international trade alone to enable countries to employ their factors efficiently through shifts in the sectoral mix of production. In the terminology of the HO Theory, these may be cases where endowments are not in the cone of diversification.

Appendix

The following proposition states that, starting from a situation with identical returns to capital in the two countries, the change in r is the same in response to a change in prices in the case of Cobb–Douglas production functions with multiplicative technological differences.

Proposition *Suppose that r=r*, and the production functions in each sector of the home and foreign country are, respectively,*

$$F_i(K_i, L_i) = A_i K_i^{\alpha_1} L_i^{1-\alpha_1} \text{ and } F_i^*(K_i, L_i) = A_i^* K_i^{\alpha_1} L_i^{1-\alpha_1} \tag{4}$$

where i=1, 2 is the index for the sectors. Then $\partial r/\partial p_2 = \partial r^*/\partial p_2$.

Proof For a given price p_i and factor prices w and r, the revenue function is $p_i A_i K_i^{\alpha_i} L_i^{1-\alpha_i}$ and the profit function in sector i can be written as $\pi_i(K_i, L_i) = p_i A_i K_i^{\alpha_i} L_i^{1-\alpha_i} - wL_i - rK_i$. Maximization of $\pi_i(K_i, L_i)$ with respect to K_i and L_i yields

$$K_i = \frac{\alpha_i}{1-\alpha_i} \frac{w}{r} L_i. \tag{5}$$

With perfect competition and constant returns to scale production functions, profits will be zero in the equilibrium, i.e., $\pi_i(K_i, L_i)=0$. Substituting Eq. 5 in $\pi_i(K_i, L_i)=0$ and solving for w, we obtain

$$w = (1-\alpha_i)\alpha_i^{\frac{\alpha_i}{1-\alpha_i}} (p_i A_i)^{\frac{1}{1-\alpha_i}} r^{-\frac{\alpha_i}{1-\alpha_i}}. \tag{6}$$

Equation 6 will hold for both of the sectors, i=1, 2, with the same w and r:

$$w = (1-\alpha_1)\alpha_1^{\frac{\alpha_1}{1-\alpha_1}} (p_1 A_1)^{\frac{1}{1-\alpha_1}} r^{-\frac{\alpha_1}{1-\alpha_1}}, \text{ and } w = (1-\alpha_2)\alpha_2^{\frac{\alpha_1}{1-\alpha_2}} (p_2 A_2)^{\frac{1}{1-\alpha_2}} r^{-\frac{\alpha_2}{1-\alpha_2}}. \tag{7}$$

Using the pair of Eq. 6, one can solve for r as

$$r = c(p_2 A_2)^{\beta_2} \Big/ (p_1 A_1)^{\beta_1}, \tag{8}$$

where $\left(\text{letting } \gamma = \left(\frac{\alpha_2}{1-\alpha_2} - \frac{\alpha_1}{1-\alpha_1}\right)\right) \beta_i = [\gamma(1-\alpha_i)]^{-1}$, i=1, 2, and $c = \frac{\alpha_2^{\alpha_2\beta_2}}{\alpha_1^{\alpha_1\beta_1}} \left(\frac{1-\alpha_2}{1-\alpha_1}\right)^{\frac{1}{\gamma}}$. Without loss of generality, consider a change in p_2, From Eq. 8, the partial response of r is

$$\frac{\partial r}{\partial p_2} = c \frac{\beta_2 p_2^{\beta_2 - 1} A_2^{\beta_2}}{p_1^{\beta_1} A_1^{\beta_1}} \tag{9}$$

Similarly, for the foreign country, we have

$$r^* = c\left(p_2 A_2^*\right)^{\beta_2} \Big/ \left(p_1 A_1^*\right)^{\beta_1}, \tag{10}$$

and

$$\frac{\partial r^*}{\partial p_2} = c \frac{\beta_2 p_2^{\beta_2 - 1} A_2^{*\beta_2}}{p_1^{\beta_1} A_1^{*\beta_1}}. \tag{11}$$

Since $r=r^*$ initially, we equate the right hand sides of Eqs. 8 and 10. That yields

$$\frac{A_2^{\beta_2}}{A_1^{\beta_1}} = \frac{A_2^{*\beta_2}}{A_1^{*\beta_1}}. \tag{12}$$

Finally, Eqs. 9, 11 and 12 imply that $\partial r/\partial p_2 = \partial r^*/\partial p_2$. □

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