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Reaping the Gains: Specialization and Capital Flows

Christina Ortseifer* Jakob Schwab †

January 2015

Abstract

This paper gives a new answer to the old question of whether international trade and capital flows are substitutes or complements. In contrast to conventional intuition, we show that when Heckscher-Ohlin trade takes place in high-skill and low-skill intensive goods, this does create incentives for capital flows. Technically, we incorporate capital as a composite factor in a tractable 3-factor neoclassical trade model. It shows that countries for whom trade induces greater trade specialization observe larger capital inflows. By using data on revealed comparative advantage while controlling for common factors, we provide empirical evidence for our results.

Keywords: Trade and Capital Flows, Specialization, Three-factor models

JEL: F11, F21

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1 Introduction

Differences in factor endowments between countries are (still) a relevant driver of international trade (Romalis (2004), Morrow (2010)). The classical and prominent Heckscher-Ohlin-Mundell paradigm ¹ states that the indirect trade of factors via commodities would replace incentives for international capital flows. Still, we do observe both, international trade in goods and capital flows, both in rapidly increasing volume over the past 50 years. At the same time, it shows that specialization patterns go along the lines of high skill and low skill labor, rather than in terms of capital endowments. Theories that incorporate these three factors do allow for the endurance of factor price differences and hence capital flows, but they still do not point at a clear direction regarding the question of whether trade and capital flows are substitutes or complements in the sense that one tends to increase or decrease the volume of the other.

We in this paper show that in this type of analysis, there is an effect that makes trade and capital flows complementary. The intuition behind it is that the increased efficiency of factor allocation in terms of skill levels when exporting and importing on the world market raises the return of the third, composite factor capital and hence leads to capital inflows. We then test whether this mechanism is of relevance in reality by constructing an index of skill level specialization and testing whether increased specialization in either direction (high skill or low skill) induces capital inflows.

In our model, both high-skill and low-skill labor, as well as capital are involved in production. When countries open up for trade, they increase their real income by producing for the world market those goods that use the skill class intensively that they are endowed with abundantly, and import the other goods for cheaper from the world market. If now production additionally requires capital, which then obtains a share of the production value as returns, then the increased efficiency also affects the capital return and hence creates incentives for capital flows. Capital reaps part of the gains from using the skill level that a country is abundantly endowed with for production on world markets.

Technically, we thus implement a 2-sector, 3-factor model. In this type of model, trade does not necessarily induce full factor price equalization between countries.² There are always two 'extreme' factors which drive (incomplete) specialization patterns, and one 'middle' factor (Ruffin (1981)). If this middle factor is the mobile factor, which we consider the empirically

¹As treated formally in Mundell (1957).

²See e.g. Woodland (1982) for a treatment of models where $N(\text{factors}) > M(\text{goods})$.

relevant case, the question of whether trade specialization induces capital flows is isomorphic to the question of how the return to the mobile factor in countries is affected by trade. Jones and Easton (1983) show that the effect of trade on the middle factor's return depends on how complementary it is to either of the extreme factors in production, i.e. how relatively important it is for production of the comparative advantage good in a country. In the present paper, we abstract from this complementarity-effect to isolate a further effect of trade liberalization: Even if capital is equally important in the production of both high- and low-skill-intensive goods, this does affect the real return to the middle factor capital, and it unambiguously increases it. We shut down the factor-complementarity effect to show that a second force of increased factor allocation efficiency always works in favor of composite capital. This effect does not depend on whether a country exports high-skill or low skill intensive goods, i.e. the direction, but rather only on the degree of specialization.³

For symmetric specialization patterns, the efficiency increasing effect of trade liberalization raises rental rates in both countries and hence does not imply a certain direction of capital flows, or any flows at all. It only implies symmetric worldwide gains for capital, in contrast to the asymmetric ones for labor skill classes between trading countries. For these, Stolper-Samuelson type effects prevail, even in the presence of capital mobility (see Ethier and Svensson (1986)). However, given any differences in the relative intensity that bilateral trade induces for the participating countries, it implies differentiated effects on capital returns in the sense that a higher degree of specialization also implies larger potential gains for capital and hence capital inflows into the more strongly specializing country.

Despite the long-held assertion that actual trade-capital flows-complementarity can only be found in other reasons for trade than differences in factor endowments (Markusen (1983)), there is other, more specific, literature that incorporates factor endowment driven trade and capital flows. This usually focuses on trade in the mobile factors themselves, which are then subject to some type of friction. In Jin (2012), capital investment underlies adjustment costs, which allows capital abundant countries to specialize in capital intensive goods and still attract capital flows out of savings from the world. Antràs and Caballero (2009) in

³Our analysis focusses on incomplete specialization patterns only, because these yield nice solutions and convey the basic intuition. Also, this shows the contrasting effect to standard 2x2-worlds, where trade equalizes factor prices only if countries still produce both types of goods in equilibrium. Full specialization along abundant factor endowments also then imply a deviation from factor price equalization and hence perfect substitution between trade and capital flows, but do not necessarily imply complementarity either, as capital returns are likely to have diverged strongly before trade liberalization as well if endowments are so different as to lead to full specialization. This is also pointed out by Jones (1956).

turn allow for different affectedness by financial restrictions between sectors that interact with the level of financial frictions in countries such that countries specialize along the goods that their financial development supports, and hence create higher returns for capital in the production of unrestricted sectors in capital scarce countries. Technically, this resembles an endogenous Ricardo-Viner structure with internationally mobile sector-specific capital. This is also the approach of Neary (1995), who finds that this generally should be the more appropriate view. However, general sector-specificity of capital, as in his model, seems more relevant for the short, but not the long run. Abstracting from any type of frictions, our model thereby attempts to capture a more general relationship, both in scope, and time dimension.

Trade theories that explicitly account for the firm level also rather predict a tendency for substitutability of trade and capital flows. As discussed by Buckley and Casson (1981), individual firms face the decision to either incur higher fixed costs of setting up a subsidiary in a foreign country or incurring higher variable transport costs when directly exporting (proximity-concentration trade-off). Helpman et al. (2004) show that when firms are heterogeneous, the more productive firms will choose the former and less productive firms the latter. This can explain the coexistence of both FDI and trade flows in aggregate. It still makes both types of supplying foreign market substitutes, in the sense that falling trade costs should make more firms choose concentrated home production and direct exporting, and less foreign investment, as Neary (2009) points out. He then argues that instead when trade costs fall, firms would set up subsidiaries in single countries to serve complete trade blocs, thereby generating capital flows and trade (export-platform-FDI). Other extensions, such as that of Krautheim (2013) go in the same direction, arguing that serving foreign markets via goods trade may require or favor the acquisition of wholesale and retail trading firms, such that also FDI works export-supporting.

Whereas these arguments concern horizontal internationalization by firms, vertical integration may also lead to within-company trade, and possibilities to trade may encourage FDI. Helpman (1985) develops a factor endowment model where the trade of headquarter services and intermediate products goes into opposing directions, where the acquisition of production sites can be interpreted as a capital flow. Markusen (2004) advances this idea for multinational corporations that pursue both, horizontal, and vertical integration.

Our model is much less specific and could generally include all these cases, as long as the reason for trade are factor endowment differences. Given the importance and extent of the

comovement of trade and capital flows, we hence attempt to identify an underlying force behind the strong positive relationship between the two. We conjecture from our analysis that whenever countries make use of their abundant factor to export on the world markets, they should experience capital inflows. The gains from increased trade and the potential to use certain skill classes as demanded by the world market should attract capital. When testing whether this is indeed happening, we want to delineate it from other possible mechanisms relating trade and capital flows. We therefore construct a measure of particularly Heckscher-Ohlin specialization for countries. By using data on skill embodied in goods classes and countries' trade data, we can analyze how skill intensive a country's overall exports are. We then relate this once to the country's imports and once to the average skill embodied in all countries' exports, to generate a comparable measure of both high skill and low skill intensive specialization which is positive in both directions of deviation from no visible factor emphasis in exports (or imports). Furthermore, we control for the level of capital market integration and general investment climate to isolate the effect of intensified trade specialization on capital flows only, not concurrent integration into world goods and factor markets. The results strongly support our hypothesis that more factor intensity in exports, i.e. more Heckscher-Ohlin type specialization, leads to capital inflows in a country. The remainder of the paper is structured as follows. Section 2.2 lays out the basic structure of the model and how autarky equilibrium is determined. Then, section 2.3 describes the structure of the international capital market and how this can be seen separately from the possibility to trade goods. Section 2.4 then shows how an opening up to goods trade affects the real rental rate in a small opening economy. Because when trade is bilateral, capital returns increase in all participating countries due to an increase in general efficiency of production, section 2.5 discusses how the world equilibrium is determined and in which direction capital will flow accordingly. Section 3 then presents the empirical test and results on the derived hypothesis on the complementarity between (factor endowment) trade and capital flows. Section 4 concludes and gives an outlook.

2 Model

2.1 Setup

The model is constructed such as to most conveniently transfer the intuition from Heckscher-Ohlin-Samuelson models of trade with high-skill and low-skill intensive goods, to a setting where capital is involved in production.

We consider that there are two goods $i \in 1, 2$ which are produced by constant returns to scale production technologies. Both goods are produced by three factors F: capital (K), high-skill labor (H) and low-skill labor (L). The distributive shares of capital and labor are the same in both sectors, whereas those of the two types of labor differ between the sectors. The production functions for both sectors read:

$$\begin{aligned} Y_1 &= K_1^\alpha H_1^\beta L_1^{1-\alpha-\beta} \\ Y_2 &= K_2^\alpha H_2^\gamma L_2^{1-\alpha-\gamma} \end{aligned} \tag{1}$$

where $\alpha, \beta, \gamma < 1$.

Factor markets are competitive. Firms take factor prices r , s and w as given and minimize costs. The production functions (1) then correspond to unit cost functions of

$$\begin{aligned} C_1 &= r^\alpha s^\beta w^{1-\alpha-\beta} \Delta_1 \\ C_2 &= r^\alpha s^\gamma w^{1-\alpha-\gamma} \Delta_2 \end{aligned} \tag{2}$$

where $\Delta_1 = \alpha^{-\alpha} \beta^{-\beta} (1 - \alpha - \beta)^{-(1-\alpha-\beta)}$ and $\Delta_2 = \alpha^{-\alpha} \gamma^{-\gamma} (1 - \alpha - \gamma)^{-(1-\alpha-\gamma)}$.

Without loss of generality we assume that $\beta > \gamma$. By Shephard's Lemma, taking the derivative of (2) yields the unit input coefficients of factors F, denoted by $a_{iF} \equiv \frac{F_i}{Y_i}$, and shown explicitly in appendix A. Relative skill intensities are then given by

$$\begin{aligned} \frac{a_{1H}}{a_{1L}} &= \frac{w}{s} \left(\frac{\beta}{1 - \alpha - \beta} \right) \\ \frac{a_{2H}}{a_{2L}} &= \frac{w}{s} \left(\frac{\gamma}{1 - \alpha - \gamma} \right) \end{aligned} \tag{3}$$

This implies that sector 1 is the high skill intensive sector (defined by $\frac{a_{1H}}{a_{1L}} > \frac{a_{2H}}{a_{2L}}$).

Note that this holds independent of the factor price of capital. This simplification will greatly facilitate the analysis and lead to results of relative production that are closely related to standard 2-sector-2-factor production patterns with only high-skill and low-skill labor. The assumption of strict equality in capital-labor shares in production of the two goods implies that capital is not particularly complementary to either type of labor. This shuts down the effect of capital being a 'friend' of one of the two other factors and hence of one of the sectors. By doing so, we will be able to isolate a further effect of trade liberalization that holds for specialization in either sector, not the only the one that capital is complementary to. In reality, both effects should be present. By abstracting from one, we will be able to concentrate on the other that is of interest for us here.

We will also assume that countries always produce both goods in equilibrium, such that specialization will never be never complete, even under free trade. This is to stay as close to the analytically most interesting case and to common Heckscher-Ohlin intuition. Extending the analysis to full specialization would require extensive taxonomical exposition and not generate much insight beyond that from standard 2x2 models in this case (see e.g. Jones (1956)), and the one provided here.

The solution of the model thus closely follows 2-sector general equilibrium models with only 2 factors of production, only with one additional equilibrium condition.

Free entry implies that firms make zero profits. Hence, goods prices have to equal unit costs, such that $p_i = C_i(r, s, w)$. Solving this together with (2) gives a simple expression for the relation between the relative goods price and the relative wages of high-skill and low skill workers, given by

$$\frac{w}{s} = \left(\phi \frac{p_2}{p_1} \right)^{\frac{1}{\beta-\gamma}} \quad (4)$$

where $\phi = \frac{\gamma^\gamma (1-\alpha-\gamma)^{1-\alpha-\gamma}}{\beta^\beta (1-\alpha-\beta)^{1-\alpha-\beta}} = \frac{\Delta_1}{\Delta_2}$.

The rental rate for capital, r , does not depend on the relative price of the two goods because its price enters unit costs symmetrically.

Full employment conditions of factors F read $F = a_{1F}Y_1 + a_{2F}Y_2$. Solving the system of full employment conditions of L & H yields production volumes of the respective sectors as

functions of r , s , w and factor endowments L & H :

$$\begin{aligned}
Y_1 &= \left(\frac{w}{r}\right)^\alpha \left(\frac{w}{s}\right)^\beta \frac{1}{\Delta_1(1-\alpha)(\beta-\gamma)} \left[\frac{s}{w}(1-\alpha-\gamma)H - \gamma L\right] \\
Y_2 &= \left(\frac{w}{r}\right)^\alpha \left(\frac{w}{s}\right)^\gamma \frac{1}{\Delta_2(1-\alpha)(\beta-\gamma)} \left[\beta L - \frac{s}{w}(1-\alpha-\beta)H\right]
\end{aligned} \tag{5}$$

Because, again, r enters symmetrically, and using (4), relative production only depends on aggregate supplies of H & L , and the relative price of the two goods, and is given by

$$\begin{aligned}
\frac{Y_1}{Y_2} &= \frac{p_2 \left(\frac{p_2}{p_1}\right)^{\frac{1}{\gamma-\beta}} \phi^{\frac{1}{\gamma-\beta}} (1-\alpha-\gamma)H - \gamma L}{p_1 \beta L - \left(\frac{p_2}{p_1}\right)^{\frac{1}{\gamma-\beta}} \phi^{\frac{1}{\gamma-\beta}} (1-\alpha-\beta)H} \\
&\equiv \frac{p_2}{p_1} \Gamma(H, L, p_2/p_1)
\end{aligned} \tag{6}$$

Capital now accrues a constant share α of production, which can be shown by solving the full employment condition of K for r , which yields:

$$r = \frac{\alpha}{1-\alpha} \cdot \frac{wL + sH}{K} \tag{7}$$

For given prices p_2/p_1 and a numeraire chosen, the production side can be solved for r , s , w , Y_1 , Y_2 . Endowments, relative production, firms optimization and factor market clearing conditions yield unique solutions. The intuition behind these closely resembles that of standard 2-good, 2-factor models, except for that the capital endowment K scales production and hence incomes.⁴ The following relations hold for the division of factors between the two

⁴One equation more, the factor market clearing condition for capital, or (7), solves for one additional unknown, r .

sectors:

$$\begin{aligned}\frac{K_1}{K_2} &= \Gamma(H, L, p_2/p_1) \\ \frac{H_1}{H_2} &= \frac{\beta}{\gamma} \Gamma(H, L, p_2/p_1) \\ \frac{L_1}{L_2} &= \frac{1 - \alpha - \beta}{1 - \alpha - \gamma} \Gamma(H, L, p_2/p_1)\end{aligned}\tag{8}$$

The demand side is made up by standard homothetic preferences over the two goods which will be identical across countries. The consumers' utility function is given by

$$U = X_1^\theta X_2^{1-\theta}\tag{9}$$

Consumers take goods prices as given and optimize their expenditure to maximize utility. Their resulting relative consumption of the two goods reads

$$\frac{X_1}{X_2} = \frac{\theta}{1 - \theta} \frac{p_2}{p_1}\tag{10}$$

The price to obtain 1 unit of utility is thus given by the standard Cobb-Douglas price index

$$P = \left(\frac{p_1}{\theta}\right)^\theta \left(\frac{p_2}{1 - \theta}\right)^{(1-\theta)}\tag{11}$$

2.2 Autarky

In autarky, capital supply K is given by domestic endowment, and consumption of both goods must equal production. Equilibrium is determined by equalizing relative demand $\frac{X_1}{X_2}$ as given in (10) and relative supply $\frac{Y_1}{Y_2}$ as in (6). This yields the resulting relative autarky

equilibrium price

$$\left(\frac{p_2}{p_1}\right)_a = \frac{1}{\phi} \left[\lambda \frac{L}{H} \right]^{(\beta-\gamma)} \quad (12)$$

where $\lambda = \frac{\theta(1-\alpha-\beta)+(1-\theta)(1-\alpha-\gamma)}{\theta\beta+(1-\theta)\gamma}$.

From this, the autarky equilibrium is obtained. Countries that have a larger relative endowment in high-skill labor produce relatively more of the high-skill intensive good 1, which then has a lower relative price. Capital does not affect relative production, but overall production of the two goods.

The rental rate is higher in countries that are endowed with less capital, but both wage income and salary are smaller, as is overall income.⁵

2.3 Capital returns and international investment

In order to analyze our central question, we want to analyze the effect of trade liberalization on capital flows without a concurring liberalization of the capital market. We will henceforth counterintuitively keep the level of capital market openness constant while considering a movement towards free trade. Without complete free trade, relative goods prices $\frac{p_2}{p_1}$, and hence the price level P , will differ between countries (of different factor endowments). Because with having the numeraire chosen identically (good 1 in our case), comparing incomes thus must correct for the different purchasing power in countries. $1/P$ may thus be interpreted as the purchasing power of 1 unit of the numeraire good. Whereas within a country, common factor prices equal between sectors in nominal and in real terms, between countries this is different. In order for a foreign investor to consume the two goods in the proportions desired, any payment in the numeraire good must in parts be traded for the other good. The same holds true if investment is in the non-numeraire sector and factor payments were in terms of production shares. If the foreign investor could trade these at her home for the domestic relative prices, between sector rental equality would not hold anymore, at least for foreign investors (and production/consumption identity would not hold for the transactions in each country). Investors must hence trade their factor payments into the goods basket they wish to consume in the country where they invest. P/P^* can thus be interpreted as

⁵To see this, consider equation (7) together with (1) and (8) to see that an increase in capital will increase both wage and salary incomes and reduce the rental.

an exchange rate between the home and a foreign country. Factor payments are consequently valued in their *real* return.⁶ Thus, this real return to capital will also be decisive for investment decisions. The real return to capital is given by r/P . If there is barriers to international investment that translate to investment costs $\delta \geq 1$, then investors choose to invest in a country as long as

$$\frac{r}{P} \geq \delta \frac{r^*}{P^*} \quad (13)$$

where an asterisk denotes world market variables, or those in the foreign investors' home country, respectively.

From solving the zero profit conditions, (4) and (7), and using (11), for any given actual capital stock, the real rental in a country reads

$$\frac{r}{P} = \Theta \left[\left(\frac{p_2}{p_1} \right)^{\frac{\gamma}{(\beta-\gamma)(1-\alpha)}} L + \phi^{\frac{1}{(\gamma-\beta)}} \left(\frac{p_2}{p_1} \right)^{\frac{-(1-\alpha-\gamma)}{(\beta-\gamma)(1-\alpha)}} H \right]^{(1-\alpha)} \left(\frac{p_2}{p_1} \right)^{\theta} K^{\alpha-1} \quad (14)$$

where

$$\Theta = \theta^{\theta} (1-\theta)^{(1-\theta)} \frac{\Delta_1^{\frac{\gamma}{(\beta-\gamma)}}}{\Delta_2^{\frac{\beta}{(\beta-\gamma)}}} \left(\frac{(1-\alpha)}{\alpha} \right)^{(\alpha-1)}$$

We can thus see that the return to capital depends negatively on the current capital stock. When returns are low, capital will flow into the country such that (13) will hold with equality. Also, if the rental rate in a country increases, more capital will move in, until respective returns equal again. This does not influence relative prices (as given by (12)).

2.4 Small open economy

Now consider what happens if a country opens up its goods markets to a world market price p_2^*/p_1^* . Prices in the home country will adapt and change relative production patterns, shifting resources to the sector which relative price has increased. Stolper-Samuelson effects will occur for high- and low-skill laborers. What does this imply for the real return to capital?

⁶A different view on this would be to simply assume that factor rewards have to be consumed where they accrue, hence that capital owners move with their capital.

With a change in relative prices, the real rental changes according to

$$\frac{\partial(\frac{r}{P})}{\partial(\frac{p_2}{p_1})} = \Theta K^{\alpha-1} \left[\left(\frac{p_2}{p_1}\right)^{\frac{\gamma}{(\beta-\gamma)(1-\alpha)}} L + \phi^{\frac{1}{(\gamma-\beta)}} \left(\frac{p_2}{p_1}\right)^{\frac{-(1-\alpha-\gamma)}{(\beta-\gamma)(1-\alpha)}} H \right]^{-\alpha} \left(\frac{p_2}{p_1}\right)^{\frac{\gamma}{(\beta-\gamma)(1-\alpha)} - (1-\theta)} \left[\frac{\gamma + (\beta - \gamma)\theta}{(\beta - \gamma)} L - \frac{(1 - \alpha - \gamma) - (\beta - \gamma)\theta}{(\beta - \gamma)} \phi^{\frac{1}{(\gamma-\beta)}} \left(\frac{p_2}{p_1}\right)^{\frac{1}{(\gamma-\beta)}} H \right] \quad (15)$$

$\frac{r}{P}(\frac{p_2}{p_1})$ has hence an extremum where this is zero. This is only the case if the second bracket is zero, which is true only at

$$\frac{p_2}{p_1} = \frac{1}{\phi} \left[\lambda \frac{L}{H} \right]^{(\beta-\gamma)} \quad (16)$$

which is exactly the autarky price level. Appendix B shows that it is indeed a minimum ($\frac{\partial^2(\frac{r}{P})}{\partial(\frac{p_2}{p_1})^2} > 0$ at the autarky relative price level given by (16)). Hence, the real rental is lowest at the autarky price and increases monotonously for both increasing and decreasing relative goods prices from the autarky level. Figure 1 depicts the real rental r/P as a function of the relative goods price.

Hence, if relative goods prices change due to opening up for goods trade, the real rental rate will increase and capital will flow into the country. This does not depend on whether a country specializes in one good or the other. Whether the relative price increases or decreases, the real rental rate will always increase. The reason is that specialization always entails efficiency gains, as one good can be bought cheaper on the world market, which frees resources for production of the other good, which is now worth more. When capital is involved in production, it gets part in these changes and profits from increased productivity. It hence partly reaps the gains from specialization. In different words, capital flows in when labor can be used more efficiently to produce for the world market. Only the inflow of capital can hold the real rental rate at its equilibrium level given by (13) holding with equality.⁷ Hence, for a small open economy, opening up for trade, and specializing in one good or the other to produce for the world market along its abundant factor, will lead to capital inflows.

⁷See again (14) for how an inflow of capital reduces the real rental rate back to its exogenous equilibrium level.

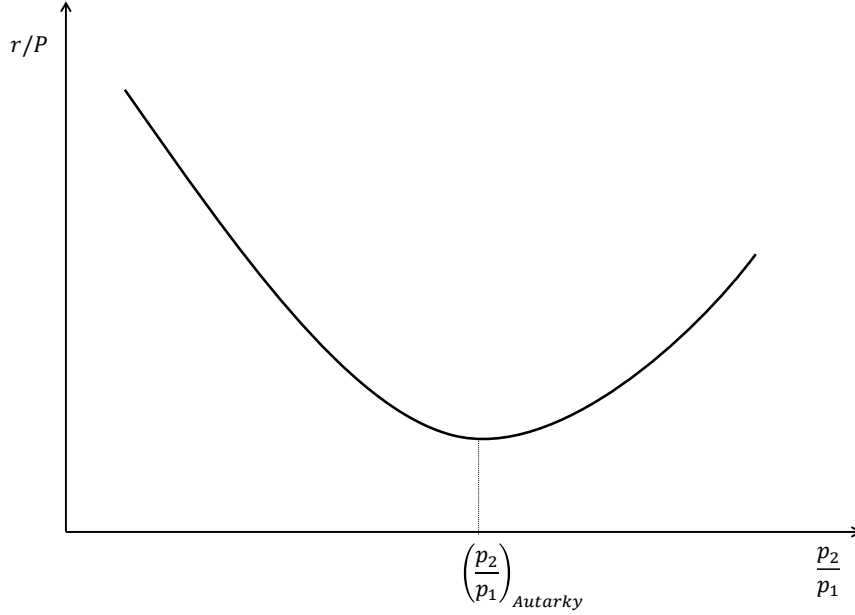


Figure 1: The real rental rate and world market goods prices

2.5 Two and Many Countries

When opening up to trade in a two- or more-country setting, goods prices change in both countries, only in different directions. Thus, also the real rental will increase in both countries. It is not per se clear in which direction capital will flow. The question is, for whom the price changes relatively more and for whom this is more influential when together reaching a new world market price.

Whereas in a 2-factor setting worldwide production of the two goods is the same as for one, large country with the combined endowments of both countries, and hence international trade yields the same result as complete international integration, here this is different. Because capital endowments additionally scale production of the two goods, it depends on the division of the worldwide stock of capital onto the two countries to determine how much of the goods in which they specialize in can be produced. Combining worldwide production of the two goods given in (5), to determine relative world supply Y_1/Y_2 , and equalizing with relative world demand, making use of (4) yields the following implicit definition of the world

wage-salary ratio:

$$\left(\frac{w}{s}\right)^{-1} = \lambda \left[= \frac{L + L^* \left(\frac{K^*}{K}\right)^\alpha \left(\frac{L + \left(\frac{w}{s}\right)^{-1} H}{L^* + \left(\frac{w}{s}\right)^{-1} H^*}\right)^\alpha}{H + H^* \left(\frac{K^*}{K}\right)^\alpha \left(\frac{L + \left(\frac{w}{s}\right)^{-1} H}{L^* + \left(\frac{w}{s}\right)^{-1} H^*}\right)^\alpha} \right] \quad (17)$$

By again using (4), which holds equally in both countries due to identical technologies, this uniquely determines the world market goods price.

It is not directly obvious, for which country this is a greater difference to the autarky price level and how strongly this affects the real rental rate. But from the intuition from 2-factor models, we can get a good grasp of what determines in which country production becomes more attractive to capital: From (7), we know that, for a given capital stock, the nominal rental rate is a direct monotone function of income, I , in a country, given by $r = \frac{\alpha}{K} I$. Hence, r/P is also a direct monotone function of I/P , which is by definition equal to the level of utility $U = I/P$, such that

$$\frac{r}{P} = \frac{\alpha}{K} \frac{I}{P} = \frac{\alpha}{K} U \quad (18)$$

Hence, the real rental rises linearly in the level of utility. The question of which country's real rental rises more due to trade integration and hence will experience larger capital inflows, is isomorphic to the question of which country gains more from bilateral trade.⁸ By Heckscher-Ohlin logic, utility rises in the degree of specialization. Figure 2 depicts how the level of utility increases with the difference in trade prices to autarky prices. If two or more countries simultaneously open up for bilateral trade with each other, this price effect will be differ between the countries. *Ceteris paribus*, a smaller country gains more from trade, because its own relative endowment of high-skill and low-skill labor has less effect on the world market relative price, which hence differs more from its own autarky price. Small here means also in terms of capital, not only absolute endowments of H and L , hence economically small. Then also, the more extreme a country's relative endowments are, the more it will specialize in the production of the good that uses this factor intensively, and hence diverge from the production pattern of autarky.

No matter the reason in terms of endowments, the greater the price change, the greater will also be the degree of specialization (as a move on the production possibilities frontier).

⁸Note that this only concerns utility increases *without* those that a following capital inflow entails.

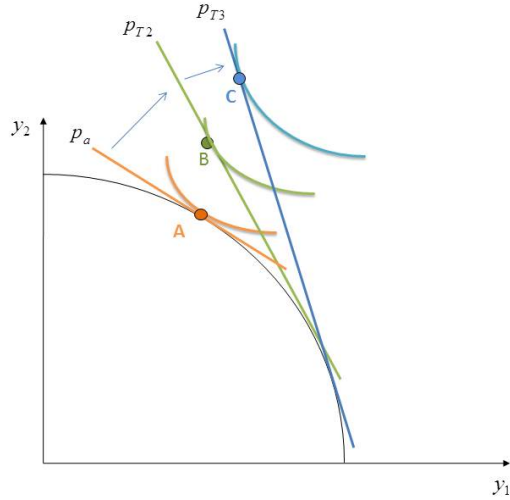


Figure 2: Prices and Utility

Hence, with bilateral trade integration, the degree of specialization and the effect of the real rental are the result of the same underlying force in the model. The more a country specializes in the production of one type of good, the more capital will it see flowing in compared to other countries (which may experience outflows despite trade liberalization), because capital is attracted by the increase in efficiency due to production for the world market.

3 Empirical Test

Data and approach

It follows from the theoretical analysis that for an individual country, relatively more Heckscher-Ohlin-trade specialization in high- or low-skill intensive goods should also lead to increased capital inflows. Both are likely to be correlated in the data for other reasons than the one that our theory puts forward, as trade and capital flows may both be the common result of greater overall political and economic integration into world markets. To test our hypothesis, we therefore have to separate the two effects. We do so in a very general way, constructing a measure for relative overall trade specialization in either skill class and at the same time

control for the degree of financial account liberalization and overall investment risk in a country in a given year. We then run a panel regression including country and time fixed effects. Our baseline regression thus looks like the following:

$$CapInflows_{ct} = \beta_0 + \beta_1 * HOS_{c;t} + \beta_2 * CapOpen_{c;t}^{dejure} + \beta_3 * InvRisk_{c;t} + \alpha_t + \alpha_c + \epsilon_{ct} \quad (19)$$

Our dependent variable are the net capital inflows in country c in year t . Our interest is in the coefficient β_1 on the measure of Heckscher-Ohlin skill specialization (as explicated below). From our theory, we would expect it to have a positive sign. We then control for the degree of *de jure* capital market openness, and the overall investment risk in the country at that time. We use time fixed effects in order to control for a time trend in both trade and capital flows and country fixed effects to single out peculiar characteristics such as geographical or cultural proximity to other countries.

The measure of capital openness needs to be a *de jure* measure because *de facto* measures are by definition constructed out of capital inflows themselves and would thus make our test pointless. A measure of *de jure* capital market openness is provided by Chinn and Ito (2006). It is constructed as to measure the extent of capital controls that are enforced in a country and hinder capital inflows regardless of the general attractiveness of the country to capital flows. A higher value of *CapOpen* implies more *de jure* financial account openness.

Investment risk is measured by an index provided by the International Country Risk Guide on the investment risk profile in a countries. It is constructed to measure the risk of private investment in a country and captures the level of and danger associated with viability/expropriation, profits repatriation, and payment delays for international investment. Unfortunately, this index is only available from 1984 on, but for a wide range of countries. The index runs from 0 to 12, where a higher number indicates less risk.

As our dependent variable, we use *net* capital inflows in a country in given year. We restrict the analysis to equity investment only, since this should be most directly affected by the increased possibilities to use the abundant factor efficiently for production for the world market. We therefore once report the effect on FDI flows only, because this is the most intuitive application of the idea of productive foreign investment. Since investment can also be on a smaller scale when direct investment is profitable, we also use the sum of FDI and portfolio equity investment as overall investment. In order to exclude valuation and growth effects, we divide the level of (positive or negative) capital inflows by GDP. Net inflows yield

a positive value of *CapInflows*, net outflows a negative one. All Data on capital flows is taken from the IFS Financial Statistics. GDP data is taken from the World Bank WDI. Our independent variable of interest is the degree of specialization in either high-skill oder low-skill labor. There is however no direct data on the skill content of countries exports available, and calculation is problematic. For example, the measure of skill intensities used most regularly in the trade literature is the number of production and non-production workers in a particular industry as provided by the US census for manufactures. However, an assignment of this industry-level data to bilateral trade data only available in product classification is only reliably feasible at the 3-digit level. At this highly aggregated level, there is first of all not much variation in skill intensities, and second, this will partially miss specialization patterns, since these will go along the product chain within industries, as e.g. pointed out by Krugman (2008).⁹

We therefore construct a different measure of countries' actual specialization patterns along skill levels. The UNCTAD RFI database (documented in Shirotori et al. (2010)) reports skill intensities in production on the SITC2 4-digit product level on an even more differentiated scale. This measure is constructed by taking data on factor endowments of exporting countries (for skill abundance, the authors use data on schooling obtained from Barro and Lee (2001)) and relating these to factual exports to gather from this the skill intensity embodied in product classes. For our purpose, this has the advantage that this measure is directly drawn from actual trade data, and thus reveals factual specialization patterns. At the same time, it is computed from worldwide observations, so that we can directly apply it on the country level without being tautological. On the SITC 4-digit level, there are 651 different product classes for which we have data on skill intensities. These are available for each year in our sample, even though the variation over time within product classes is small. $H_{i,t}$ represents the skill level embodied in the respective product class in year t .¹⁰ For exposition, table 1 shows the 13 least and most skill intensive product classes from the RFI Database for the year 2000, the last year in our sample. Less skill intensive goods tend to be textiles and basic agricultural exports, whereas the most skill intensive goods tend to be chemical products.¹¹

⁹We still will use 3-digit classifications for robustness checks.

¹⁰Note that the relative skill intensity is, in line with our theory, equal for all countries (by (3)) Because our theory also abstracts from changing technologies, we for robustness also use constant values H_i , taking the data from 2000. The results do not change.

¹¹But also, some agricultural goods that are produced on large scales, such as barley, have relatively high skill intensity measures. This may be true, as the production of these is highly automated, but it may also

Since we want to know about a country's overall specialization level, we here take this

Table 1: Skill Intensities of Product classes

| Most skill intensive Product classes | $H_{i;2000}$ | Least skill intensive Product classes | $H_{i;2000}$ |
|---|--------------|---|--------------|
| Ores and concentrates of uranium and thorium | 11.03811 | Oils, animal & vegetable, boiled, oxidized, etc. | 2.625086 |
| Mechanical wood pulp | 10.79112 | Cotton, carded or combed | 2.703924 |
| Sawlogs in the rough, whether/not stripped of bark | 10.32102 | Tea | 2.759669 |
| Barley, unmilled | 10.24047 | Jute & other textile bast fibres, raw/processed | 2.792496 |
| Other phenols and phenol-alcohols | 10.22291 | Copra | 2.96619 |
| Cresols, n.e.s., and their salts | 10.22291 | Carpets of other textile materials | 2.97924 |
| Halogenated, sulphonated, etc. derivatives of phenol | 10.22291 | Carpets of wool or fine animal hair | 2.97924 |
| Phenol (hydroxybenzene), chemically pure, & its salts | 10.22291 | Groundnuts (peanuts), green, whether or not shelled | 3.106773 |
| Other phenols and phenol-alcohols | 10.22291 | Cotton seeds & Cotton seed oil | 3.109285 |
| Organo-mercury compounds | 10.21946 | Sheep and lamb skin leather | 3.669646 |
| Seep's or lambs' wool, greasy or fleece-washed | 10.16085 | Groundnut (peanut) oil | 3.711931 |
| Horses, asses, mules and hinnies, live | 10.13878 | Tin ores and concentrates | 3.713806 |

product-level data to construct country-year observations. We hence aggregate our observations to a country's overall skill level embodied in its exports. Countries' exports and imports on the SITC2 4-digit product level are taken from the NBER-United Nations Trade Data, as documented in Feenstra et al. (2005). We then combine this with the skill intensity of exported products. The sum of all skill embodied in product level exports is therefore divided by the value of overall exports to obtain average skill level per export value.

This average skill level embodied in a country's exports has no direct interpretation. Therefore we assign the level of skill embodied in exports to a specialization pattern. We thus once relate the skill embodied in exports to the average skill embodied in worldwide exports, and once to the skill embodied in the respective country's imports to obtain two measures of skill level specialization. The formulas for these two measures read

$$H1_{c;t} = \frac{\frac{\sum_i H_{i;t} * EX_{c;i;t}}{\sum_i EX_{c;i;t}}}{\frac{\sum_j \sum_i H_{i;t} * EX_{j;i;t}}{\sum_j \sum_i EX_{j;i;t}}} \quad (20)$$

$$H2_{c;t} = \frac{\frac{\sum_i H_{i;t} * EX_{c;i;t}}{\sum_i EX_{c;i;t}}}{\frac{\sum_i H_{i;t} * IM_{c;i;t}}{\sum_i IM_{c;i;t}}}$$

reflect one weakness of using actual trade data, namely that export subsidies for low skill intensive goods in high-skill abundant countries lead to these as being measured relatively high skill intensive. Apart from crops, however, we consider this problem to be rather small.

where $EX_{c;i;t}$ and $M_{c;i;t}$ are the exports and imports of country c in product class i at time t . Hence, the first index measures average skill embodied in a country's exports relative to average skill embodied in worldwide exports, and the second index represents the average skill embodied in a country's exports relative to the average skill embodied in its imports in a certain year. Both measures are highly correlated (0.90).

In our sample, there are only very few countries, for which this measure is greater than one. For reasons that will become clear further below, we thus relate a country's skill intensity in exports to the median country's skill intensity in that respective year in our sample and form this into a measure of specialization that increases for deviation from this specialization patterns in both directions of specialization. The resulting measure is defined as:

$$\begin{aligned} HOS1_{c;t} &= \left| \ln \left(\frac{H1_{c;t}}{H1_{MED;t}} \right) \right| \\ HOS2_{c;t} &= \left| \ln \left(\frac{H2_{c;t}}{H2_{MED;t}} \right) \right| \end{aligned} \tag{21}$$

By taking the absolute value of logs of a fraction, both measures are always greater than zero and increase, the more distant the fraction is from 1. Thus, we interpret a higher value in both measures as a greater level of specialization, as compared to the median worldwide pattern in a given year.

The descriptive statistics are given in table 2. The data on investment risk is only available

Table 2: Descriptive Statistics

| Variable | Obs | Mean | Std. Dev. | Min | Max |
|----------------|-------|------------|-----------|-----------|----------|
| $H_{i;t}$ | 30080 | 6.500017 | 1.908917 | 0.4108673 | 11.87007 |
| H_i | 651 | 7.828983 | 1.502626 | 2.625086 | 11.03811 |
| $H1$ | 6156 | 0.7789046 | 0.2225288 | 0.1225655 | 1.317003 |
| $H2$ | 6131 | 0.7822829 | 0.2573527 | 0.124897 | 4.972053 |
| $HOS1$ | 6156 | 0.2485256 | 0.1960654 | 0 | 1.626207 |
| $HOS2$ | 6131 | 0.265278 | 0.2104879 | 0 | 2.123068 |
| Net FDI / GDP | 2986 | 0.0122775 | 0.0468844 | -0.552422 | 1.618238 |
| Net Inv. / GDP | 2722 | 0.0119369 | 0.0496237 | -0.552422 | 1.618238 |
| CapOpen | 3890 | -0.1992764 | 1.465446 | -1.863972 | 2.439009 |
| Inv. Risk | 2657 | 6.814042 | 2.427348 | 0 | 12 |

from 1984 on and our trade data only goes until 2000, such that including all variables, the

regressions cover a sample over the time span from 1984 to 2000. For some countries there are no observations in some years, so that are left with around 1500 country-year observations in our sample, coming from 119 countries.

Results

We run regressions of type (19) with both dependent variables, net FDI and overall investment inflows, each on both measures of skill specialization in a country. Standard errors are clustered on the country level. The results are presented in table 3.

Table 3: Results

| VARIABLES | (1) | (2) | (3) | (4) |
|-----------------------|---------------------------------------|------------------------|---------------------------|------------------------|
| | Net FDI / GDP | | Net For. Investment / GDP | |
| HOS1 | 0.0197* (0.0100) | | 0.0349** (0.0154) | |
| HOS2 | | 0.0204** (0.0100) | | 0.0364** (0.0164) |
| CapOpen | 0.00151 (0.00156) | 0.00141 (0.00158) | 0.00128 (0.00265) | 0.00105 (0.00264) |
| Inv. Risk | 0.000749 (0.000642) | 0.000751 (0.000642) | 0.000717 (0.000765) | 0.000730 (0.000775) |
| Constant | 0.0133** (0.00559) | 0.0134** (0.00561) | 0.0125 (0.00831) | 0.0127 (0.00830) |
| Country Fixed Effects | yes | yes | yes | yes |
| Time Fixed Effects | yes | yes | yes | yes |
| Observations | 1,533 | 1,532 | 1,369 | 1,368 |
| R-squared | 0.069 | 0.070 | 0.054 | 0.055 |
| Countries | 119 | 119 | 118 | 118 |
| | Robust standard errors in parentheses | | | |
| | *** p<0.01, ** p<0.05, * p<0.1 | | | |

The estimated coefficients are indeed positive and statistically significant for the entire sample. Heckscher-Ohlin specialization does generally go along with net capital inflows. All other coefficients also go in the direction as expected, even though capital market openness is not statistically significant in any specification.¹²

These findings could also result from theoretical considerations on complementarity of capital

¹²Since we analyze net flows, this is not too surprising in general, as there are both countries that tend to have net in- and outflows in our sample. For the fact that the investment risk profile is not very meaningful, we take as an explanation that it is highly correlated with capital market openness. If either one is excluded, however, we get no meaningful results on the data.

with either one skill class and an unbalanced sample. If capital were e.g. high skill complementing then relative specialization in high skill intensive goods would create incentives for capital inflows. The the mechanism that we propose here should instead lead to capital inflows whenever a country specializes relatively more in either skill class. In order to test our mechanism more precisely, we therefore split our sample in two groups. We then run the regression as in (19) once on only those countries, who have a higher relative specialization in skill level and once on those that show a lower relative specialization in skill level than the median country in a respective year. These may be different groups, depending on which definition of specialization is considered. For those regressions that use $HOS1$ as regressor (hence relating specialization to average world export skill level), we split the sample by whether $\frac{H1_{c;t}}{H1_{MED;t}}$ is greater or smaller than 1. For those regressions that use $HOS2$ (hence relating average exported and imported skill level embodied in goods), the relevant split point is $\frac{H2_{c;t}}{H2_{MED;t}}$, and whether this is greater or smaller than 1. Here, the definition that relates skill specialization to the median country in a year helps us to keep both samples of relevant size, in order to retrieve reliable statistical inference for both groups, those that specialize relatively more high skill and those that specialize relatively more low skill intensive. The results are shown in table 4, columns 1-4 for the relatively high skill exporting countries and columns 5-8 for those that relatively specialize in low skill intensive goods.

Even though reducing the sample size takes a little power from the model, we see that the results for either group still show the same pattern, and also the coefficients are in similar dimensions for both as for the entire sample. We do see that the results overall appear a bit stronger for the relatively more high skill specializing countries, but also for relatively low skill specializing countries, a stronger relative specialization in these low skill intensive goods is going along with net capital inflows. We also see that for high skill exporting countries (which tend to be more developed countries), portfolio equity investment appears to react slightly stronger, whereas for low skill exporting countries (predominantly emerging and developing economies), FDI shows the slightly more clear response to trade specialization. Overall, even though we cannot exclude other effects than the one proposed in our model to be at work, too, the above findings show that countries who specialize relatively more in goods of either skill class tend to observe larger capital inflows.

Our findings hence support our theoretical predictions. When countries specialize in a skill class in their trade pattern, and hence can be said to pursue Heckscher-Ohlin type of trade, this also increases net capital inflows.

Table 4: Results by Type of Specialization

| VARIABLES | High Skill Exporting Countries | | | | Low Skill Exporting Countries | | | |
|-----------------------|--------------------------------|------------------------|----------------------------------|----------------------------------|-------------------------------|-------------------------|----------------------------------|----------------------------------|
| | (1) Net FDI / GDP | (2) Net FDI / GDP | (3) Net For. Investment / GDP | (4) Net For. Investment / GDP | (5) Net FDI / GDP | (6) Net FDI / GDP | (7) Net For. Investment / GDP | (8) Net For. Investment / GDP |
| HOS1 | 0.0849 (0.0513) | | 0.116* (0.0635) | | 0.0170** (0.00772) | | 0.0174 (0.0117) | |
| HOS2 | | 0.0913** (0.0401) | | 0.142** (0.0553) | | 0.0132* (0.00753) | | 0.0123 (0.0112) |
| CapOpen | -0.000193 (0.00307) | -0.000841 (0.00292) | 0.00281 (0.00609) | 0.00219 (0.00643) | 0.00279 (0.00175) | 0.00246 (0.00165) | 0.000639 (0.00177) | 0.000187 (0.00172) |
| Inv. Risk | -0.000325 (0.00113) | -0.000727 (0.00105) | -0.000171 (0.00156) | -0.000455 (0.00156) | 0.00149* (0.000750) | 0.00193** (0.000854) | 0.000849 (0.000865) | 0.00141 (0.000982) |
| Constant | 0.0133** (0.00656) | 0.0158** (0.00663) | -0.0226 (0.0152) | -0.0324*** (0.0117) | 0.0104 (0.00659) | 0.0125 (0.00900) | 0.0174** (0.00824) | 0.00818 (0.00727) |
| Country Fixed Effects | yes | yes | yes | yes | yes | yes | yes | yes |
| Time Fixed Effects | yes | yes | yes | yes | yes | yes | yes | yes |
| Observations | 791 | 772 | 718 | 697 | 739 | 753 | 648 | 665 |
| R-squared | 0.062 | 0.066 | 0.040 | 0.047 | 0.134 | 0.146 | 0.166 | 0.178 |
| Countries | 78 | 78 | 76 | 77 | 66 | 68 | 64 | 67 |

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

4 Conclusion and Outlook

The basic intuition behind our model is quite straightforward. As trade entails efficiency gains, capital should, as a residual factor, also profit from specialization in terms of skill intensities of immobile labor in worldwide production. Therefore, in countries that are relatively well endowed with one type of labor and that open up their goods markets to the rest of the world, production should shift towards these goods that use the abundant factor intensively. Our theoretical analysis shows that this will always increase the return to capital that is used in production of both goods and thus create incentives for capital to flow into specializing countries. Our stylized model allows us to single out this effect, that would then still be relevant when interacting with other effects, such as capital-skill complementarity, that may also shape the direction of capital flows.

This finding is in stark contrast to standard Heckscher-Ohlin trade theory, where trade replaces incentives for capital to flow across borders, if it is one of the factors of production. We here account for the fact, that indeed specialization along the lines of factor endowments is taking place in immobile high skill and low skill labor, whereas capital is relatively free to cross borders. Incorporating these facts into a simple and tractable model allows us to in the logic of exactly the same determinants of trade draw diametrically opposing conclusions

regarding the incentives for capital flows that trade induces.

We then test our hypothesis empirically to see whether the proposed mechanism is of empirical relevance and can be found in the data. Therefore, we construct a measure of skill-level specialization of countries and find strong support for our hypothesis. Trade specialization does lead to overall capital inflows, both for relatively high skill and low skill intensive specializing countries.

We believe that our framework has a very intuitive grasp, but still forcefully explains findings of concurrent trade specialization and capital flows. We have thus deliberately refrained from extending the model to account for more complex production structures to keep it tractable. However, the framework can easily be extended to incorporate different effects than the one pointed out here. Still, the effect of internationally mobile capital participating in gains that trade specialization entails should in our view be considered in the discussion the many (and one) face(s) of globalization.

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A Factor input coefficients a_{iF}

By solving the cost minimization problem, firms in the 2 sectors choose the following optimal inputs of the 3 factors:

$$\begin{aligned}
a_{1K} &= r^{\alpha-1} s^\beta w^{1-\alpha-\beta} \left(\frac{\alpha}{1-\alpha-\beta} \right)^{1-\alpha} \left(\frac{\beta}{1-\alpha-\beta} \right)^{-\beta} \\
a_{1H} &= r^\alpha s^{\beta-1} w^{1-\alpha-\beta} \left(\frac{\alpha}{1-\alpha-\beta} \right)^{-\alpha} \left(\frac{\beta}{1-\alpha-\beta} \right)^{1-\beta} \\
a_{1L} &= r^\alpha s^\beta w^{-\alpha-\beta} \left(\frac{\alpha}{1-\alpha-\beta} \right)^{-\alpha} \left(\frac{\beta}{1-\alpha-\beta} \right)^{-\beta} \\
a_{2K} &= r^{\alpha-1} s^\gamma w^{1-\alpha-\gamma} \left(\frac{\alpha}{1-\alpha-\gamma} \right)^{1-\alpha} \left(\frac{\gamma}{1-\alpha-\gamma} \right)^{-\gamma} \\
a_{2H} &= r^\alpha s^{\gamma-1} w^{1-\alpha-\gamma} \left(\frac{\alpha}{1-\alpha-\gamma} \right)^{-\alpha} \left(\frac{\gamma}{1-\alpha-\gamma} \right)^{1-\gamma} \\
a_{2L} &= r^\alpha s^\gamma w^{-\alpha-\gamma} \left(\frac{\alpha}{1-\alpha-\gamma} \right)^{-\alpha} \left(\frac{\gamma}{1-\alpha-\gamma} \right)^{-\gamma}
\end{aligned} \tag{22}$$

B Proof of real rental minimum

The derivative of r/P , as given in (14), is by (23):

$$\begin{aligned}
\frac{\partial(\frac{r}{P})}{\partial(\frac{p_2}{p_1})} &= \Theta K^{\alpha-1} \left[\left(\frac{p_2}{p_1} \right)^{\frac{\gamma}{(\beta-\gamma)(1-\alpha)}} L + \phi^{\frac{1}{(\gamma-\beta)}} \left(\frac{p_2}{p_1} \right)^{\frac{-(1-\alpha-\gamma)}{(\beta-\gamma)(1-\alpha)}} H \right]^{-\alpha} \left(\frac{p_2}{p_1} \right)^{\frac{\gamma}{(\beta-\gamma)(1-\alpha)} - (1-\theta)} \\
&\quad \left[\frac{\gamma + (\beta - \gamma)\theta}{(\beta - \gamma)} L - \frac{(1 - \alpha - \gamma) - (\beta - \gamma)\theta}{(\beta - \gamma)} \phi^{\frac{1}{(\gamma-\beta)}} \left(\frac{p_2}{p_1} \right)^{\frac{1}{(\gamma-\beta)}} H \right]
\end{aligned} \tag{23}$$

and its zero is given by the autarky price (16). At this, the second derivative of r/P with respect to $\frac{p_2}{p_1}$ reduces to

$$\begin{aligned}
\frac{\partial^2(\frac{r}{P})}{\partial(\frac{p_2}{p_1})^2} &= \Theta K^{\alpha-1} \left[\left(\frac{p_2}{p_1} \right)^{\frac{\gamma}{(\beta-\gamma)(1-\alpha)}} L + \phi^{\frac{1}{(\gamma-\beta)}} \left(\frac{p_2}{p_1} \right)^{\frac{-(1-\alpha-\gamma)}{(\beta-\gamma)(1-\alpha)}} H \right]^{-\alpha} \left(\frac{p_2}{p_1} \right)^{\frac{\gamma}{(\beta-\gamma)(1-\alpha)} - (1-\theta)} \\
&\quad \left[- \left(\frac{1}{(\gamma - \beta)} \right) \frac{(1 - \alpha - \gamma) - (\beta - \gamma)\theta}{(\beta - \gamma)} \phi^{\frac{1}{(\gamma-\beta)}} \left(\frac{p_2}{p_1} \right)^{\frac{1}{(\gamma-\beta)} - 1} H \right] > 0
\end{aligned} \tag{24}$$

When we look at an extremum, $\frac{(1-\alpha-\gamma)-(\beta-\gamma)\theta}{(\beta-\gamma)}$ must be greater than zero, because otherwise (23) could not be zero (and there was no local extremum of r/P). Hence, (24) must be positive.

This implies that the extremum of r/P as a function of the relative goods price at the autarky price given by (16) is indeed a minimum. Since there is no other extremum, the function of (14) looks like depicted in Figure 1 and is increasing in both directions from the autarky price.