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# Gains and Losses from Trade when Countries differ in Public Knowledge Stocks

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**Hans Jarle Kind**

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# Gains and Losses from Trade when Countries differ in Public Knowledge Stocks.

Hans Jarle Kind

Hans.Kind@nhh.no

**Abstract**

Following the insight from endogenous growth theory, we assume that countries with advanced production structures have high levels of public knowledge. The purpose of this paper is to analyze whether a developing country should trade with countries that are more or less advanced than itself. We argue that it is particularly harmful to trade with advanced countries if international transaction costs are high and capital internationally immobile, in which case welfare may be higher in autarky than with trade. For low levels of transaction costs it may be most beneficial to trade with relatively advanced countries, in particular if capital is internationally mobile.

**Non-technical summary**

During the last two decades we have witnessed an increasing research interest in the question of how peripheral regions are affected by trade liberalization with central regions. The research typically indicates that liberalization is beneficial if international trade costs are sufficiently reduced, but that peripheral regions otherwise may be harmed. This insight is valuable, but the models invariably assume that countries have access to the same production technology. They are thus not particularly suitable for analyzing how Mexico is affected by closer integration with the US, how Turkey and Greece are affected by closer integration with Germany and France, or how the Philippines is affected by closer integration with South Korea and Singapore. In this paper we extend the prevailing framework in order to allow the countries to have different production technologies. The purpose of this extension is to shed some light on the question of whether developing countries should primarily trade with other developing countries or with technologically more advanced countries.

In line with the classical development literature we assume that developing countries have a comparative advantage in an "agriculture" sector, where the wage level is higher the less labour it employs. Additionally, we follow the new trade theory and assume that there is international trade in specialized producer services that are manufactured under increasing returns to scale. More specifically, we assume that new producer services are developed by using labour and a national stock of public knowledge as inputs, and that these services are used as inputs in the manufacturing sector. A country which has a relatively high stock of public knowledge is advanced in the sense that it is able to develop a relatively large set of producer services. This country has a comparative advantage in the manufacturing sector.

In the formal model we show that domestic factor income in developing countries falls if they trade with more advanced countries, and that employment in the manufacturing sector decreases. The latter means that the poor country becomes more dependent on imports of producer services. This is particularly harmful if international trade costs are high and capital internationally immobile, in which case welfare may be higher in autarky than with trade. We also show that trade with

advanced countries tends to be less beneficial the less responsive wages are with respect to changes in agricultural employment. This can be explained by the fact that the cost advantage for the entrepreneurs in the less developed country is then relatively small.

An advantage of trading with relatively advanced countries is the fact that domestic manufacturers gain access to a wider range of specialized producer services, which tends to reduce production costs. This effect is particularly strong for low levels of trade costs. Furthermore, provided that capital is internationally mobile, an advanced trading partner offers more profitable investment opportunities than does less advanced trading partners. Consequently, trading with an advanced country tends to be beneficial if trade costs initially are low and capital is internationally mobile.

# 1 Introduction

We have witnessed an increased interest in the question of how peripheral regions will be affected by trade liberalization with central regions, not least due to the European integration process.[1] Krugman and Venables (1990), in a very important paper, have shown that trade liberalization may harm peripheral regions. In particular, firms producing under increasing returns to scale may flee to central regions with high local purchasing power when trade is liberalized. However, peripheral regions need not be harmed. The reason is that they typically have low factor costs, and this effect tends to make them more attractive when trade is liberalized. In a series of papers Krugman and Venables (e.g., 1990, 1995a, 1995b) have shown that the first effect is likely to dominate for high levels of transaction costs, while the latter effect is likely to dominate for lower levels of transaction costs. This insight is valuable, but the models invariably assume that the countries have access to the same production technology. They are thus not particularly suitable for analyzing how Mexico is affected by closer integration with the US, how Turkey and Greece are affected by closer integration with Germany and France, or how the Philippines is affected by closer integration with South Korea and Singapore.

The purpose of the present paper is to shed some light on the question of whether developing countries should primarily trade with other developing countries or with technologically more advanced countries. We address the question by combining insight from the new trade theory and traditional development economics.

As is well known, the simplest Heckscher-Ohlin and Ricardian frameworks predict that there are gains from international trade if, and only if, the participating countries are asymmetric in some respect. Symmetric countries, on the other hand, should have no incentives to trade. This clearly suggests that developing countries would be better off trading with industrialized countries than with other developing countries.

The prediction that we should not observe trade between similar countries does

[1] Throughout this paper we will use the terms trade liberalization, economic integration and reduced international transaction costs interchangeably.

not conform well with empirical data. The new trade theory, initiated by Norman (1976), Krugman (1979), and Dixit and Norman (1980), departs from neoclassical trade theories in that it presupposes scale economies, imperfect competition and product differentiation. In this set-up we may expect intraindustry trade in consumer goods and producer services to generate gains from trade between symmetric as well as between asymmetric countries. At least since the seminal papers of Ethier (1979, 1982) it has been recognized that import and export of differentiated producer services, which reduce production costs for manufactured goods, constitute a major reason for trade to be welfare enhancing.

There is also a large strand of literature arguing that trade may reduce welfare, particularly for developing countries that trade with industrialized countries. According to classical development economists like Prebisch (1950), Singer (1950), Baran (1957), Myrdal (1957), and Hirschman (1958) trade may lead to first-mover advantages for advanced countries, and hinder development and industrialization in poor countries. Thereby poor countries become specialized in low-tech sectors that are intensive in natural resources. By trading with other poor countries, on the other hand, developing countries will be less dependent on natural resources and may be able to improve their technological capabilities.

In line with the classical development literature we assume that developing countries have a comparative advantage in an "agriculture" sector with decreasing returns to scale. Additionally, we follow the new trade theory and assume that there is international trade in specialized producer services that are manufactured under increasing returns to scale. More specifically, we assume that blueprints for differentiated producer services are developed by using labour and a national stock of public knowledge as inputs, and that these services are used as inputs in the manufacturing sector. A country that has a relatively high stock of public knowledge is advanced in the sense that it is able to develop a relatively large set of producer services. This country has a comparative advantage in the manufacturing sector.

Other things being equal, manufacturing costs are lower the larger the set of producer services that a country has access to. This effect suggests that the welfare gains from trade are higher the more advanced the trading partner. However, do-

mestic factor incomes will decrease if the trading partner is more advanced, since a larger share of the country's labour force will be employed in the agriculture sector. The higher employment in the agriculture sector moreover means that a smaller set of producer services will be produced domestically. This latter effect is particularly disadvantageous if there are large international transaction costs on producer services. In the formal model we show that it may be most beneficial to trade with advanced countries if transaction costs are low, while it is most beneficial to trade with less advanced countries if transaction costs are low.

The consumers own the firms that develop blueprints for producer services, and we consider both the cases with internationally mobile and immobile capital. The fact that a smaller set of producer services will be produced domestically the more advanced the trading partner, becomes particularly severe if capital is internationally immobile. The reason is that the investment opportunities will then be smaller. Indeed, we show that the welfare level may be lower with than without trade if transaction costs are high and the trading partner is relatively advanced. Furthermore, we show that trade with advanced countries tends to be less beneficial the less responsive wages are to changes in agriculture employment. This can be explained by the fact that the cost advantage for entrepreneurs in the less developed country then is relatively small.

The rest of this paper is organized as follows. The formal model is presented in section 2, and in the following sections we discuss how the welfare level depends on the trading partner's stock of public knowledge, and on the level of transaction costs. Section 3 treats the case where capital is freely mobile, while capital is assumed to be internationally immobile in section 4. Concluding remarks, and some suggestions for further research, are offered in section 5. Some mathematical derivations are relegated to the appendix.

# 2 The model

There are two countries in the formal model, called country $h$ (home) and $f$ (foreign). Each country contains two production sectors, agriculture and manufacturing.

Country $j = h, f$ is endowed with $L_j$ units of labour, $F_j$ units of land, and $K_j$ units of country specific public knowledge. We denote $w_j$ as the wage rate and $\pi_j$ as the land rent. Factor intensities differ between sectors, but not across countries. For simplicity we shall assume that land is used in the agriculture sector only, while public knowledge - which does not receive any rents - is used as input in production of blueprints for specialized producer services to the manufacturing sector. Labour is assumed immobile between countries, and we abstract from population growth.

## 2.1 Demand side

A representative consumer demands goods from an agriculture ($z$) and a manufacturing ($m$) sector, and chooses consumption so as to maximize the homothetic and time separable utility function

$$U_j = \int_0^\infty m(t)_j^\eta z(t)_j^{1-\eta} e^{-\rho t} dt, \tag{1}$$

where $\rho > 0$ is the subjective discount rate (and $0 < \eta < 1$). With this utility function we may write the momentaneous consumer price index as

$$q_j = p_{mj}^\eta p_{zj}^{1-\eta}, \tag{2}$$

where $p_{mj}$ is the price of the manufacturing good, and $p_{zj}$ the price of the agriculture good.

Each consumer holds one unit of labour and a share $1/L_j$ of the fixed factor land, $F_j$. Both factors are supplied inelastically, and the intertemporal budget constraint is given by

$$\int_0^\infty \left[p_{mj}(t)m_j(t) + p_{zj}(t)z_j(t)\right] e^{-\int_0^t r_j(v)dv} = \int_0^\infty \left[w_j(t) + \frac{\pi_j(t)F_j}{L_j}\right] e^{-\int_0^t r_j(v)dv} + \frac{\Omega_j(0)}{L_j}. \tag{3}$$

The symbol $\Omega_j(0)$ denotes the present value of aggregate financial wealth in country $j$, $r_j$ the interest rate, $w_j$ the wage level, and $\pi_j$ the land rent.

Let $E_j(t)$ denote consumer expenditure and define $dE_j(t)/dt \equiv \dot{E}_j(t)$. Maximization of (1) subject to (3) yields the Euler equation

$$\dot{E}_j(t)/E_j(t) = r_j(t) - \rho, \tag{4}$$

which describes the optimal consumption path.

## 2.2 The supply side

There is free entry in both the agriculture and the manufacturing sector. The agriculture good is produced by using labour and land in a constant returns to scale technology, and the production function is given by $Z_j = L_{zj}^{\beta} F_j^{1-\beta}$. The corresponding unit cost function is equal to $k_\beta w_j^{\beta} \pi_j^{1-\beta}$, where $k_\beta = \beta^{-\beta}(1-\beta)^{\beta-1}$. The agriculture good may be traded costlessly across the countries, and will thus have a unique world price. By taking the agriculture good as numeraire ($p_{zj} = p_z \equiv 1$), it follows that in equilibrium

$$k_\beta w_j^{\beta} \pi_j^{1-\beta} \geq 1, \quad Z_j \geq 0, \quad (k_\beta w_j^{\beta} \pi_j^{1-\beta} - 1) Z_j = 0. \tag{5}$$

It further follows that

$$L_{zj} = \left[ \frac{\beta \pi_j}{(1-\beta) w_j} \right]^{1-\beta} Z_j. \tag{6}$$

Due to the shape of the utility function we also know that

$$p_z \left( Z_h + Z_f \right) = (1-\eta)(E_h + E_f). \tag{7}$$

The manufacturing good is produced by using differentiated producer services, which are internationally tradeable, as inputs. We assume the simple CES production function

$$M_j = \left[ \sum_{k=1}^{n} \tilde{x}_k^{(\sigma-1)/\sigma} \right]^{\sigma/(\sigma-1)}, \tag{8}$$

where $n = n_h + n_f$ is the available number of services, $\tilde{x}_k$ the quantity of service number $k$, and $\sigma > 1$ is the elasticity of substitution between any pair of varieties. Producer services are thus the only inputs in production of the manufacturing good.[2]

[2] We could easily have assumed that the modern good is manufactured by using both labour and producer services, but this would not add anything new qualitatively.

The restriction that the elasticity of substitution in (8) is greater than one, $\sigma > 1$, implies that no input is essential in production, and it is easy to show that the productivity of the intermediate inputs is strictly increasing in $n$.[3] As in Ethier (1982), Romer (1987), and Evans, Hokapohja, and Romer (1998) we interpret this as though the production process is more specialized the higher the number of intermediates that is available. We shall thus take $n(s)$ as an index of the global technological level at time $s$.

By choice of scale, it takes one unit of labour to supply one unit of producer service. All producers in a given country will charge the same price since the inputs enter symmetrically in the production function and are produced with the same technology. We will follow Dixit and Stiglitz (1977) and assume that $n$ is "large". Thereby, we may abstract from strategic interactions, and can use the inverse elasticity rule to find that the *f.o.b.* price equals

$$p_j = \frac{\sigma}{\sigma - 1} w_j. \tag{9}$$

International trade in producer services involves some transaction costs. These costs should be interpreted as everything that, other things being equal, makes it more expensive to buy services that are produced abroad than domestically. This includes factors such as pure communication and transportation costs and handling of red tape.[4] We model the transaction costs to be of the Samuelson iceberg type, and assume that only $1/\tau$ of each unit shipped actually reaches its destination $(\tau \geq 1)$. This implies that the *c.i.f.* price of an imported good is $\tau$ times higher than the *f.o.b.* price, so the production costs for the manufacturing good (the dual

[3] This is most easily seen if we assume that $x_k = \bar{x} \vee k$, in which case (8) simplifies to $M_j = n^{\frac{\sigma}{\sigma-1}} \bar{x}$. We then see that the average productivity of inputs, $\frac{M_j}{n\bar{x}} = n^{\frac{1}{\sigma-1}}$, is strictly increasing in $n$.

[4] Part of these costs may be policy determined, though we treat them as purely exogenous in this paper. The *de facto* international transaction costs for firms in East Asia, for instance, were presumably significantly reduced when circumstantial trade procedures and bureaucratic interference were gradually abolished from the late 1960's (see, e.g., Aoki, Kim, and Okuno-Fujiwara, 1997).

of $M_j$) is

$$P_j = \left[ n_j p_j^{1-\sigma} + n_i (p_i \tau)^{1-\sigma} \right]^{\frac{1}{1-\sigma}}. \tag{10}$$

There is perfect competition in the manufacturing sector, implying that the consumer price is equal to production costs; $p_{mj} = P_j$. Consumers allocate a share $\eta$ of their income to the manufacturing good, and we thus have

$$P_j M_j = (1-\eta) E_j. \tag{11}$$

With the CES price index in equation (10), the aggregate market shares domestically and abroad for suppliers of producer services are equal to $s_{jj} = n_j \left(p_j / P_j\right)^{1-\sigma}$ and $s_{ji} = n_j \left(p_j \tau / P_i\right)^{1-\sigma}$, respectively. Using this, it is straightforward to show that (gross) sales volumes of each variety equal

$$x_{jj} = \frac{s_{jj} \eta E_j}{p_j n_j}, \text{ and } x_{ji} = \frac{s_{ji} \eta E_i}{p_j n_j}, \tag{12}$$

where the first subscript refers to producer country and the second subscript to consumer country. We then have $x_j \equiv x_{jj} + x_{ji}$.

The instantaneous profit flow accruing to a supplier of producer services equals $(p_j - w_j) x_j = p_j x_j / \sigma$. We will focus on steady state solutions, in which case $r_j = \rho$, and can express the present value of making a producer service as

$$v_j = \frac{p_j x_j}{\sigma \rho}. \tag{13}$$

Blueprints for new producer services are developed by using labour and the national knowledge stock $K_j$ as inputs, and the innovating firm receives a patent with infinite life that holds in both countries.[5] We chose the scale such that it takes $1/K_j$ units of labour to develop a new design. The cost of making a blueprint is thus $w_j / K_j$. If this cost is greater than the present value $v_j$ of a producer service, then it cannot be profitable to develop a new variety, and we must have $\dot{n}_j = 0$. Otherwise,

[5] The common knowledge stock is taken to be a non-rivalrous input that receives no rent. See Romer (1990 a,b) and Grossman and Helpman (1991) for detailed discussions.

free entry ensures that $v_j = w_j/K_j$ in equilibrium. The free entry condition therefore implies

$$w_j/K_j - v_j \geq 0, \quad \dot{n}_j \geq 0, \quad (v_j - w_j/K_j)\dot{n}_j = 0. \tag{14}$$

The labour requirement of making a blueprint is thus inversely related to $K_j$, reflecting the fact that innovators are more productive the higher the national knowledge stock. We will say that country $h$ is more advanced than country $f$ if $K_h > K_f$, and vice versa.[6]

Combining equations (13) and (14) we find that the equilibrium quantity of each variety of producer services equals

$$x_j = \rho(\sigma - 1)/K_j. \tag{15}$$

The consumers hold the shares in the firms that supply producer services, and do not posses any other financial assets. In the following we will distinguish between states where financial capital is internationally mobile ($CM$) and not mobile ($NCM$). Denoting the financial wealth in these two states by $\Omega_j^s$, $s = CM$, $NCM$, instantaneous consumer expenditure in the steady state may be written as the sum of factor income plus the annuity of the financial wealth:

$$E_j = \pi_j F_j + w_j L_j + \rho\Omega_j^s. \tag{16}$$

Welfare in country $j$ in the steady state may be expressed as the ratio of income over the consumer price index:

$$u_j = \frac{E_j}{p_{mj}^{\eta} p_z^{1-\eta}}. \tag{17}$$

[6] With this specification we have implicitly assumed that knowledge does not flow from one country to another. The qualitative results of this paper would not change if we had allowed imperfect international knowledge spillovers. What is essential is that knowledge flows more easily within than between countries. This is in accordance with empirical studies, see, e.g., Branstetter (1996), and Eaton and Kortum (1996)

It takes $n_j x_j$ workers to satisfy demand for producer services, while $\dot{n}_j/K_j$ workers are needed to develop blueprints. Labour market equilibrium thus requires (with $\dot{n}_j \geq 0$)

$$L_j = n_j x_j + \frac{\dot{n}_j}{K_j} + L_{zj}, \tag{18}$$

where agriculture employment $L_{zj}$ is given from equation (6). In the steady state we have $\dot{n}_j = 0$.

Throughout this paper the countries are assumed to possibly be asymmetric in only one respect, namely in their level of public knowledge ($K_h \neq K_f$). In particular, we will assume that endowments of labour and land are the same.

For an autarky, and in a trade equilibrium with completely symmetric countries, the welfare level is strictly increasing in the stock of public knowledge.[7] Moreover, reducing the level of transactions costs between symmetric countries unambiguously increases welfare.[8] However, in the subsequent sections we will show that it is ambiguous whether it is preferable to have a trading partner with a relatively high or a relatively low knowledge stock. We will also show that welfare may fall if transaction costs are reduced between asymmetric countries. In particular, with internationally immobile capital, a country may be better off as an autarky than if it trades with a more advanced country.

# 3 Free capital mobility

In this section we will assume that financial capital is perfectly mobile internationally, so that consumers are free to invest in whatever country they like. With Cobb-Douglas utility functions consumers save a fixed share of their income, and the aggregate steady state financial wealth in country $j$ equals

$$\Omega_j^{CM} = \frac{E_j}{E_h + E_f} \left[ n_h v_h + n_f v_f \right]. \tag{19}$$

Consumers in country $h$ own a share $E_h/(E_h + E_f)$ of the firms in country $f$, and for this they receive a dividend equal to $\rho n_f v_f E_h/(E_h + E_f)$ each period.

[7] See Appendix A1.

[8] See Appendix A2.

Consumers in country $f$ likewise receive $\rho n_h v_h E_f/(E_h + E_f)$ from country $h$. Net import of producer services and of the agricultural good in country $h$ equal $n_f p_f x_{fh} - n_h p_h x_{hf} \gtrless 0$ and $(1-\eta)E_h - p_z z_h \gtrless 0$, respectively. Balanced trade thus requires

$$\frac{\rho\left[n_f v_f E_h - \rho n_h v_h E_f\right]}{E_h + E_f} - n_f p_f x_{fh} + n_h p_h x_{hf} - \left[(1-\eta)E_h - p_z z_h\right] = 0 \qquad (20)$$

We will focus on diversified equilibria, where both countries produce both the agricultural good and producer services (the latter implying that $v_j = w_j/K_j$). The steady state equilibrium values are then found by simultaneously solving equations (5)-(12), (16), and (18)-(20). Due to the fact that the system is highly non-linear, we will basically rely on numerical simulations.[9]

## 3.1 Welfare effects of trade between asymmetric countries

The size of the foreign public knowledge stock affects the home country in four different ways. Two of these are positive if the home country trades with a more advanced country while the other two are negative, and vice versa.

*Positive effects of trading with a more advanced country*

$(i)$ The larger the stock of public knowledge in the foreign country, the lower the foreign innovation costs. A high value of $K_f$ thus implies that $n_f$ is large. This signifies a high global technological level, and tends to reduce the cost of producing the manufacturing good. To see this formally, we may differentiate $P_h$ from equation (10) w.r.t. $n_f$ to find:

$$\left.\frac{\partial P_h}{P_h}\right|_{n_h, p_h, p_f} = -1/(\sigma - 1)s_{fh}\frac{\partial n_f}{n_f} < 0. \qquad (21)$$

This specialization effect goes back to Young (1928); production costs are decreasing in the number of differentiated producer services, because it allows for more indirect use of labour. The cost reduction is inversely related to the size of $\sigma$, and reflects that the inputs are less differentiated the larger the elasticity of substitution (the

[9] It is a standard procedure to use numerical simulations in this kind of general equilibrium models; see Fujita, Krugman and Venables (1999).

inputs become homogenous in the limit $\sigma \to \infty$).[10] Note that, since the foreign firms' market share in the home country ($s_{fh}$) is inversely related to $\tau$, the benefit of a higher value of $n_f$ is decreasing in the level of transaction costs.[11]

(*ii*) The fact that innovation costs in the foreign country are decreasing in its stock of public knowledge, also indicates a positive financial income effect of trading with an advanced country. The reason is that, with free international capital mobility, a relatively high value of $K_f$ means that consumers in the home country gain access to more profitable investments. Other things being equal, the steady state income level is therefore an increasing function of $K_f$ (c.f. equations (16) and (19)).

*Negative effects of trading with a more advanced country*

(*iii*) A negative effect of trading with an advanced country is the fact that the less advanced country will be relatively specialized in agriculture production. Thus, the higher the value of $K_f$, the larger the agriculture employment in country $h$. Since there is decreasing returns to labour in the agriculture sector, factor income in $h$ is decreasing in $K_f$.[12] This effect has been much debated in the development literature.

(*iv*) Finally, it should be noted that higher agriculture employment is mirrored in lower employment in the manufacturing sector. Thereby a high value of $K_f$ means that a smaller number of the inputs is produced domestically, and this international relocation tends to increase production costs for manufactured goods in $h$.[13]

[10] See also Ethier (1982) for an early formal discussion of welfare gains of international trade in producer services, and Evans, Hokapohja and Romer (1998) for an application to endogenous growth theory. Matsuyama (1995) offers an excellent survey.

[11] Assume $\tau = 1.0$. If $p_h$ and $n_h$ were equal to $p_f$ and $n_f$, respectively, the partial effect of a one per cent increase in $n_f$ would be to reduce production costs for the manufacturing good in $h$ by $\frac{1}{2(\sigma-1)}$ per cent. The cost reduction approaches zero as $\tau \to \infty$.

[12] See Appendix A3.

[13] Equation (12) showed that $x_j = \rho(\sigma - 1)/K_j$, and thus independent of the foreign knowledge stock. Since agriculture employment in $h$ is increasing in $K_f$, the number of varieties produced in $h$ is decreasing in $K_f$.

*The relationship between the foreign knowledge stock and domestic welfare*

The relocation effect is weak when trade is inexpensive, and at $\tau = 1.0$ geographical location does not matter *per se*. Thus, even though domestic factor incomes fall if the trading partner is relatively advanced, welfare tends to be an increasing function of $K_f$ if transaction costs are low. If transaction costs are high, however, the relationship between domestic welfare and $K_f$ is more ambiguous. This is illustrated in Figure 1, which measures welfare $u_h$ on the vertical axis and $K_f$ on the horizontal axis. Here we have assumed that $\tau = 2.0$, which means that transaction costs constitute fifty per cent of the import price.[14] In this case we have a U-shaped relationship between welfare in the home country and the foreign knowledge stock.

To see why the curve is U-shaped, suppose first that the trading partner is less advanced than the home country ($K_f < K_h$). Then labour will be shifted from the agriculture sector to the manufacturing sector in the home country, and increase domestic factor income. Additionally, the relocation effect will also be positive, since the home country becomes relatively specialized in the manufacturing sector and saves trade costs on import of producer services. If the trading partner is relatively advanced ($K_f > K_h$), on the other hand, the consumers benefit from more better investment opportunities and a higher global technological level.

Note that there will be no change in firm location, no change in agriculture employment, and no change in investment opportunities if $K_h = K_f$. The only effect of trade between symmetric countries is to enlarge the available set of differentiated producer services. We thereby end up with the result that the gains from trade are largest when the countries are different ($K_f \neq K_h$) at this level of transaction costs.

[14] In all the simulations $L_h = L_f = 1$, $F_h = F_f = 1$, $K_h = 1$, $\sigma = 3$, $\rho = 0.01$ and $\eta = 0.5$. In the figures in this section we have chosen $\beta = 0.7$. The qualitative relationship between $u_h$ and $K_f$ does not depend on $\beta$ - the share of labour in the agriculture good - when capital is internationally mobile. With immobile capital, on the other hand, the size of $\beta$ possibly plays a decisive role. This will be shown in the next section.

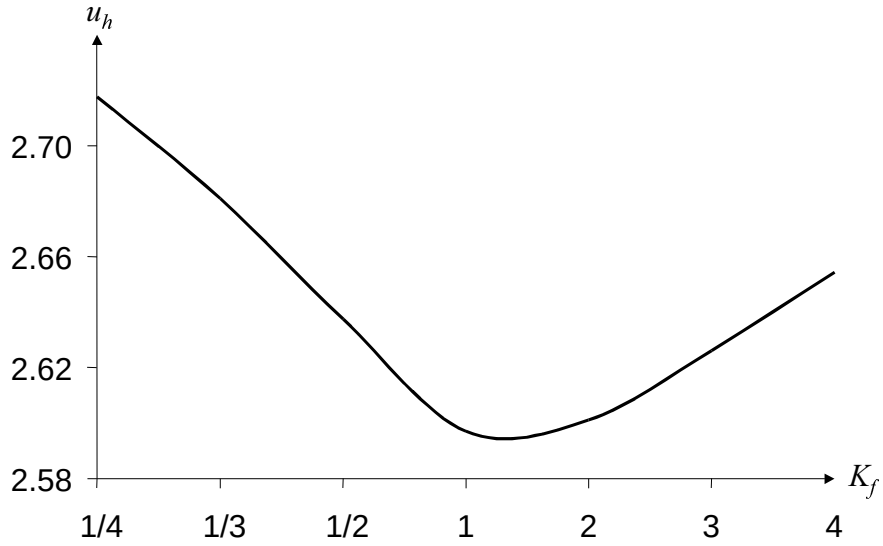


Figure 1: $CM$, $\beta = 0.7$, $\tau = 2.0$, $K_h = 1$.

*The relationship between the foreign knowledge stock, transaction costs and domestic welfare*

Figure 1 illustrated how the domestic welfare level depends on $K_f$, holding all other variables constant. In Figure 2, which measures $\tau$ on the horizontal axis and $u_h$ on the vertical axis, we extend the analysis by showing how the welfare depends on both the level of transaction costs and on the stock of foreign public knowledge (i.e., for $K_f = 4$, $K_f = 1$, $K_f = 1/4$). In this figure we can identify three qualitatively different areas:

**Proposition 1:** Suppose that international transaction costs are

(i) low ($\tau < \tau_1$). The gains from trade are larger the more advanced the trading partner; $u_h(K_f = 4) > u_h(K_f = 1) > u_h(K_f = 1/4)$.

(ii) moderate ($\tau_1 < \tau < \tau_2$). The gains from trade are smallest between symmetric countries, and largest if the home country is less advanced than the trading partner; $u_h(K_f = 4) > u_h(K_f = 1/4) > u_h(K_f = 1)$.

(iii) high ($\tau > \tau_2$). The gains from trade are smallest between symmetric countries, and largest if the home country is more advanced than the trading partner; $u_h(K_f = 1/4) > u_h(K_f = 4) > u_h(K_f = 1)$.

The intuition behind Proposition 1 (and Figure 2) is very much the same as that for Figure 1, and is most easily understood if we consider the extremes of low and high transaction costs, respectively. As discussed above, the geographical location of firms is relatively unimportant for low levels of $\tau$ , and it is advantageous to trade with a relatively advanced country. This allows domestic firms to use a more sophisticated production technology (a larger set of specialized inputs) and gives the consumers access to more profitable investment opportunities. If $\tau$ is high, on the other hand, it is expensive to import inputs from the other country and the positive specialization effect of trading with an advanced country is weak (c.f. equation (21), where $s_{fh}$ will be small). Thus the relocation effect dominates, and it is most beneficial to trade with a less advanced country. The latter also reflects the importance of having a large domestic manufacturing base when trade is expensive. In any case, it can be shown that

**Lemma 1:** Suppose that capital is internationally mobile. In that case welfare is higher with than without trade for all levels of transaction costs. The welfare level with trade is inversely related to $\tau$, and approaches the autarky welfare level as $\tau \to \infty$.

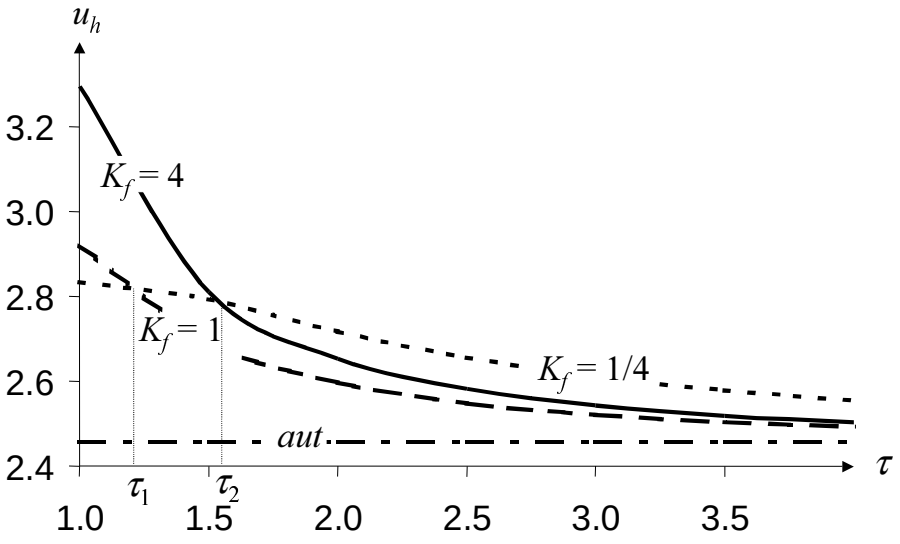


Figure 2. $CM$, $\beta = 0.7$, $K_h = 1$.

# 4 No capital mobility

With no capital mobility, the firms supplying producer services are owned by domestic shareholders. In the steady state the consumers will thus have financial wealth equal to

$$\Omega_j^{NCM} = n_j v_j. \tag{22}$$

With immobile capital the equation for balanced trade from the former section (equation (20)) must be changed to

$$n_h p_h x_{hf} - n_f p_f x_{fh} - [(1-\eta)E_h - p_z z_h] = 0 \tag{23}$$

The steady state equilibrium values are then found by simultaneously solving equations (5)-(12), (16), (18), (22).

## 4.1 Welfare effects of trade between asymmetric countries

The relationship between welfare in the home country and the size of the foreign knowledge stock possibly depends crucially on the share $\beta$ of labour in the agriculture good when capital is immobile. Figure 3, where we have chosen a relatively low value of $\beta$, shows that the home country is better off the more advanced the trading partner when transaction costs are low ($u_h(K_f = 4) > u_h(K_f = 1) > u_h(K_f = 1/4)$ at $\tau < \tau_1$). This is the same result as we found when capital were assumed to be mobile. It is also still true that for intermediate levels of transaction costs the gains from trade are lowest if the countries are symmetric (as illustrated by the area $\tau_1 < \tau < \tau_2$). Note, however, that the welfare level in the home country is decreasing in the stock of foreign knowledge when transaction costs are high. Indeed, it can be shown that welfare under autarky may be higher than the one obtained with trade when trade is expensive and $K_f > K_h$.

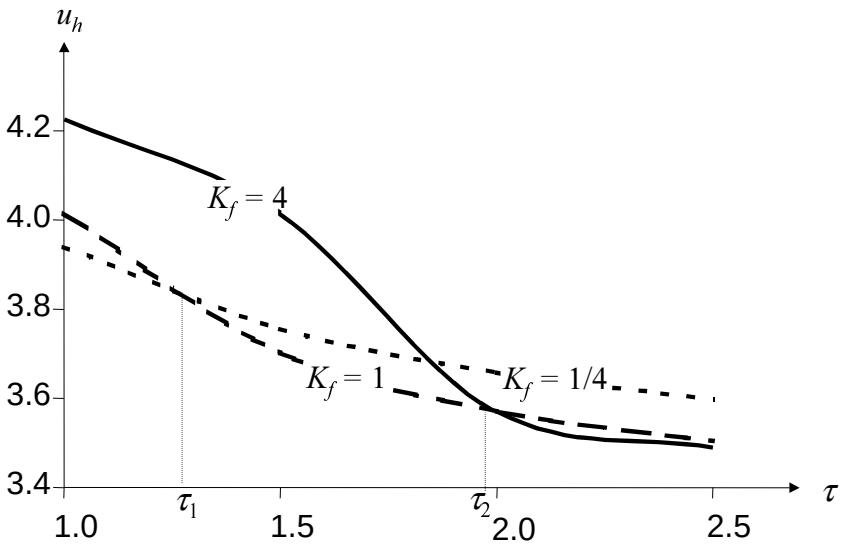


Figure 3. $NCM$, $\beta = 0.3$, $K_h = 1$.

The reason why it may be harmful to trade with an advanced country when capital is internationally immobile, but not when it is mobile, is that the investment opportunities do not improve in the former case. With mobile capital a high $K_f$ implies that consumers in the home country gain access to the more profitable investments abroad; this is not true with immobile capital. Financial income in the home country is therefore unambiguously decreasing in the foreign knowledge stock.

The fact that it may be harmful to trade with countries which have a larger knowledge stock when capital is internationally immobile, is most easily seen if we assume that $\beta = 1$. With costless trade in the traditional good, it must then be the case that the wage levels in the two countries are equal if the good is produced in both countries ($w_h = w_f = p_z$). Suppose that $\tau = 1.0$, which effectively means that the product markets are completely integrated. Suppliers of producer services will then charge the same price, and have the same revenue, independent of whether they are located in country $h$ or country $f$. Even if $K_f$ is only infinitesimally larger than $K_h$, it must then be unprofitable to develop blueprints in country $h$. Thereby, because they have no investment opportunities, consumers in $h$ will be worse off than if $K_h = K_f$.

The consequences of trading with a more advanced country is less dramatic if both land and labour are used to produce the agriculture good ($\beta < 1$). The reason

is that the wage level in this case will be decreasing in the level of employment in the agriculture sector, so that $w_h < w_f$ if $K_h < K_f$. Thereby suppliers of producer services in $h$ will have a relative cost advantage, partly offsetting the fact that it is relatively expensive to make blueprints in that country.

Since wages are less sensitive to changes in the level of agricultural employment the larger the $\beta$, the strength of the relocation effect is also increasing in $\beta$.[15] If $\beta$ is high, it may be therefore always be preferable to trade with a less advanced country, independent of the level of transaction costs. This is illustrated in Figure 4, where $\beta = 0.7$. The parameter values are the same as in Figure 2 (where capital was assumed to be mobile), but unlike the earlier results the welfare in $h$ is now strictly decreasing in $K_f$ for all values of $\tau$.

Summing up the discussion in this section, we have:

**Proposition 2:** Suppose that capital is internationally immobile, and that $\beta$ is sufficiently low. Then it is preferable to trade with relatively advanced countries if trade is inexpensive. Otherwise, it is preferable to trade with less developed countries.

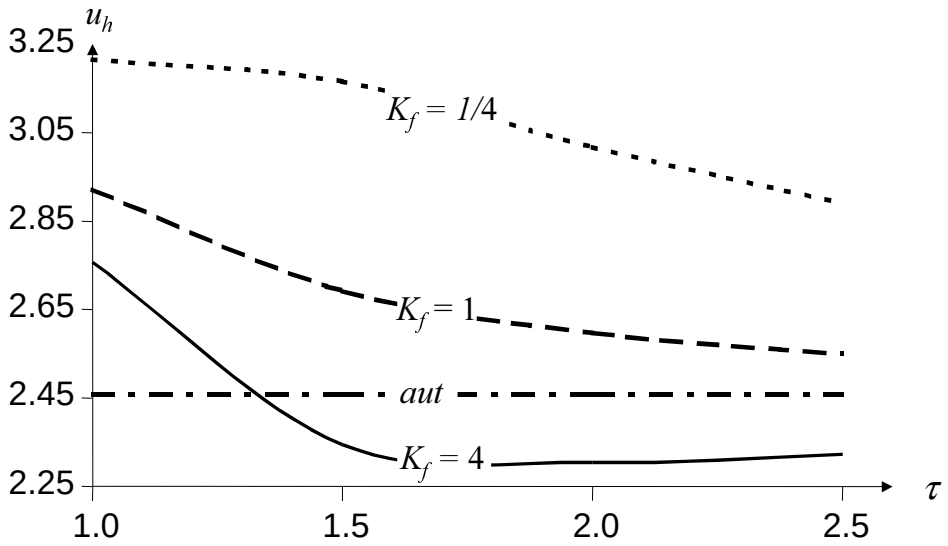


Figure 4. $NCM$, $\beta = 0.7$, $K_h = 1$.

Figure 4 also illustrates that trade may be harmful if $K_h < K_f$: welfare would

[15] See Appendix A4.

be higher under autarky if $\tau > 1.4$. Unlike the case where capital is internationally immobile, we thus have:

**Lemma 2:** Suppose that capital is internationally immobile. Then welfare may be lower with than without trade if the trading partner has a relatively large knowledge stock.

Note that the curve for $K_f = 4$ is U-shaped, demonstrating that increasing the transaction costs is harmful if transaction costs are initially low, while it is beneficial if transactions costs initially are high. The intuition for this result is to be found in the fact that there are two opposing effects of higher transaction costs ($d\tau > 0$). First, the market access to the foreign country deteriorates. This affects export income negatively. Secondly, the domestic market becomes more sheltered from import competition, contributing to increase profitability. These effects cancel each other if the countries are symmetric. Now, suppose that the knowledge stock in $f$ is larger than in $h$. The foreign country will then have the higher consumer income, and thus constitute a larger market for suppliers of producer services. Evidently, also firms in $h$ will make the larger share of their revenues in the foreign market when transaction costs are low. Starting from low values of $\tau$, an increase in the level of transaction costs is thus harmful to producers in $h$ because access to the most important market is deteriorated. If $\tau$ is initially high, on the other hand, export income is relatively unimportant - the larger share of the revenue is earned domestically. Higher transaction costs then imply that the domestic market becomes more sheltered from import competition, thereby increasing the profitability of supplying producer services.

# 5 Conclusion

The purpose of this paper has been to analyze whether a developing country should trade with countries that are more or less advanced than itself. One disadvantage of trading with more advanced countries is that domestic factor incomes fall, since employment in the agriculture sector increases. The subsequent reduction of manu-

facturing employment means that the country becomes more dependent on imports of producer services. This is particularly harmful if transaction costs are high and capital internationally immobile, in which case welfare may be higher in autarky than with trade. We also show that trade with advanced countries tends to be less beneficial the less responsive wages are with respect to changes in agriculture employment. This can be explained by the fact that the cost advantage for the entrepreneurs in the least developed country is then relatively small.

An advantage of trading with relatively advanced countries is that domestic manufacturers gain access to a wider range of specialized producer services, thus tending to reduce production costs. This effect is particularly strong for low levels of transaction costs. Further on, provided that capital is internationally mobile, an advanced trading partner offers more profitable investment opportunities than does less advanced trading partners. Consequently, it tends to be beneficial to trade with an advanced country if transaction costs are low and capital is internationally mobile.

An interesting extension of the paper would be to assume that transaction costs and the degree of capital mobility are partly policy determined, and analyze a game between the countries. An important consideration would then be how the governments weight the different income groups - land owners and labour may have conflicting interests. In that respect it could also be relevant to include income generating tariffs on both producer services and the agriculture good.

Finally, it should be noted that the technology specifications in this paper have certain similarities with the ones used by Grossman and Helpman in a number of growth models.[16] A second interesting extension of the paper would thus be to consider whether it becomes more or less preferable to trade with advanced countries when long-term endogenous growth is incorporated.

[16] See, for instance, Grossman and Helpman (1990, 1991).

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# 7 Appendix

**A1 Symmetric countries: effects of changes in the level of public knowledge**

With symmetric countries we may drop country subscript, and write consumer expenditure in the steady state as

$$E = \pi F + wL + \rho n v. \tag{24}$$

This holds whether international capital mobility is assumed or not.

The value of demand for the agriculture good equals $(1-\eta)E$, of which the fixed factor $F$ receives a share $(1-\beta)$. Using (24) and $v = w/K$ it thus follows that

$$E = \frac{L + \rho n/K}{1-(1-\beta)(1-\eta)} w. \tag{25}$$

Inserting for $L_z$ from equation (6) into equation (18), labour market equilibrium can be expressed as

$$L = nx + \left(\frac{\beta}{1-\beta}\right)^{1-\beta} \left(\frac{\pi}{w}\right)^{1-\beta} (1-\eta)E. \tag{26}$$

The zero profit condition in the agriculture sector implies that $k_\beta w^\beta \pi^{1-\beta} = 1$ (c.f. equation (5)), and from (12) we know that $x = \rho(\sigma-1)/K$. Using this together with equations (25) and (26) we find, after some manipulations, that

$$n = \frac{\eta L K}{\{\sigma\left[1-(1-\beta)(1-\eta)\right]-\eta\}\rho}. \tag{27}$$

With the Cobb-Douglas production function for the agriculture good we know that $\frac{\pi F}{wL_z} = \frac{1-\beta}{\beta}$. Inserting for $L_z$ from equation (6), and using $k_\beta w^\beta \pi^{1-\beta} = 1$, give us

$$w = \frac{1}{k_\beta}\left[\frac{(1-\beta)(1-\eta)(L+\rho n/K}{1-(1-\beta)(1-\eta)}\right]^{\beta-1}.$$

Combining this with (27) we arrive at

$$w = \beta\left[\frac{\sigma\left[1-(1-\beta)(1-\eta)\right]-\eta}{\beta\sigma(1-\eta)L}\right]^{1-\beta}. \tag{28}$$

It further follows that

$$\pi = (1-\beta)\left[\frac{\beta\sigma(1-\eta)L}{\sigma\left[1-(1-\beta)(1-\eta)\right]-\eta}\right]^{\beta}. \tag{29}$$

Both $w$ and $\pi$ are thus independent of the level of public knowledge, while the number of varieties $n$ produced in each country is proportional to $K$. Equation (24) thus makes it clear that consumer expenditure is independent of $K$. Since the price $p_m$ of the manufactured good is strictly decreasing in $n$, it follows that welfare is strictly increasing in the level of public knowledge.

**A2 Symmetric countries: effects of changes in the level of transaction costs**

With symmetric countries welfare is given by $u = \frac{E}{p_m^{\eta} p_z^{1-\eta}}$, where the price of the manufacturing good equals $p_m = \left[np^{1-\sigma} + n(p\tau)^{1-\sigma}\right]^{\frac{1}{1-\sigma}}$. We thus have $\frac{du}{u} = \frac{\eta}{\sigma-1}\left[\frac{n(p\tau)^{1-\sigma}}{np^{1-\sigma}+n(p\tau)^{1-\sigma}}\right]\frac{d\tau}{\tau}$, or

$$\frac{du/u}{d\tau/\tau} = \frac{\eta}{\sigma-1}s_{ij} > 0.$$

Due to more inexpensive import of producer services, welfare is thus increasing when transaction costs fall and the countries are symmetric.

**A3 The relationship between agriculture employment and domestic factor income**

The production function for the traditional good is given by $Z_j = L_{zj}^{\beta} F_j^{1-\beta}$, where supply of land ($F_j$) is fixed. Agriculture employment in country $j$ must increase by $(1/\beta)$ per cent if $Z_j$ increases by one per cent;

$$dL_{zj}/L_{zj} = (1/\beta)dZ_j/Z_j \tag{30}$$

Differentiation of equation (6) further implies that

$$dL_{zj}/L_{zj} = (1-\beta)\left[d\pi_j/\pi_j - dw_j/w_j\right] + dZ_j/Z_j. \tag{31}$$

Using (30) and (31) together with $k_\beta w_j^{\beta}\pi_j^{1-\beta} = 1$ we thus find

$$dw_j/w_j = -(1-\beta)/\beta \tag{32}$$

and

$$dr_j/r_j = 1. \tag{33}$$

The change in factor income in country $j$ by one per cent increase in $Z_j$ will then be equal to $d(w_jL_j) + d(r_jF_j) = L_{zj}dw_j + d\pi + (1 - L_{zj})dw_j$. Letting $L_j = F_j = 1$, and inserting for (32) and (33), we have

$$d(w_jL_j) + d(r_jF_j) = -\frac{1-\beta}{\beta}w + \pi. \tag{34}$$

If the foreign capital stock is so high that country $h$ is completely specialized in production of the agriculture good ($L_{zh} = L_h = 1$), the wage rate will be equal to $\beta$ and the rental rate will be equal to $(1-\beta)$. In that case $d(w_hL_h)+d(r_hF_h) = 0$. Since $w > \beta$ and $r < 1-\beta$ if $L_{zj} < 1$ it follows that the change in factor income will be negative if agriculture employment increases.

**A4 The relocation effect and the share of labour in the agriculture good** Suppose that we are initially in a symmetric equilibrium, and consider the effect of an increase in $K_f$ which increases agriculture employment in $h$ and reduces agriculture employment in $f$. In order to simplify the algebra, we will consider only the case where $\tau = 1.0$ and the countries are initially symmetric ($n = n_h = n_f$).

Keeping consumer expenditure fixed, we find $\frac{dx_{hh}}{x_{hh}} = -\sigma\frac{dp_h}{p_h} - \frac{d(n_hp_h^{1-\sigma})+d(n_fp_f^{1-\sigma})}{n_hp_h^{1-\sigma}+n_fp_f^{1-\sigma}}$ from equations (12) and (10). Assuming that $dZ_h/Z_h = -dZ_f/Z_f > 0$ we know from Appendix A3 (c.f. equation (32)) that $\frac{dw_h/w_h}{dZ_h/Z_h} = -\frac{dw_f/w_f}{dZ_f/Z_f} = -\frac{1-\beta}{\beta}$. Due to constant markup it must also be true that $\frac{dp_h/p_h}{dZ_h/Z_h} = -\frac{dp_f/p_f}{dZ_f/Z_f} = -\frac{1-\beta}{\beta}$. Using this in the expression for $dx_{hh}$ and simplifying we arrive at $dx_{hh} = -\sigma(-\frac{1-\beta}{\beta})x_{hh} - \frac{1}{2}\left(\frac{dn_h}{n_h} + \frac{dn_f}{n_f}\right)x_{hh}$. For the export sales to country $f$ we similarly have $dx_{hf} = -\sigma(-\frac{1-\beta}{\beta})x_{hf} - \frac{1}{2}\left(\frac{dn_h}{n_h} + \frac{dn_f}{n_f}\right)x_{hf}$. In the symmetric equilibrium with zero transaction costs each supplier of producer services will sell equally much domestically and abroad. From equation (15) it thus follows that $x_{hh} = x_{hf} = \frac{1}{2}\frac{\rho(\sigma-1)}{K}$, and adding $dx_{hh}$ and $dx_{ff}$ we have

$$dx_h = \frac{1}{2}\frac{\rho(\sigma-1)}{K}\left[2\sigma\frac{1-\beta}{\beta} - \left(\frac{dn_h}{n_h} + \frac{dn_f}{n_f}\right)\right]. \tag{35}$$

In equilibrium $x_h$ does not depend on $K_f$, so $dx_h = 0$. Equation (35) can therefore be written as $dn_h = 2\sigma\frac{1-\beta}{\beta}n - dn_f$. Inserting for $n$ from equation (27), we thus have $dn_h = A(\beta, \sigma, \eta) - dn_f$, where the function $A$ is given by

$$A(\beta, \sigma, \eta) = \frac{2\sigma(1-\beta)\eta LK}{\beta\left\{\sigma\left[1-(1-\beta)(1-\eta)\right]-\eta\right\}\rho}. \tag{36}$$

It is worth noting the following about the function $A$. First, it is decreasing in $\beta$. This reflects the fact that there will be a steep fall in the wage level in $h$ as agriculture employment increases if there is only a small share of labour in the agriculture good. This gives suppliers of producer services in the home country a large cost advantage relative to those in the foreign country. Thereby a lower $\beta$ implies that it becomes more profitable to make blueprints for producer services in $h$, and there will be a smaller reduction of $n_h$ as $n_f$ increases. Secondly, it can be shown that $A$ is increasing in $\sigma$. The reason for this is that the producer services become more homogenous the larger the elasticity of substitution, making demand more price elastic. Thirdly, $A$ is increasing in $\eta$. The intuition for this result is that the more important the manufacturing good is in consumption, the smaller is labour demand in the agricultural sector. Indeed, it is easy to show that $n_h$ is independent of $K_f$ in the limit when $\eta = 1$ (or if $\beta = 0$).