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(UNU-MERIT, August 2008)

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Abstract

In this paper we seek to explain the causes and consequences of Northern penetration in Southern subsistence markets in order to reach the countless masses at the **B**ottom **o**f the (Income) **P**yramid. To this end we formulate a One-North-Many-Souths model, inspired by the Krugman (1979) North-South model. In our model, Southern countries are differentiated with respect to population size, but also the degree of internal connectedness as a proxy for the cost involved in reaching the local subsistence market. Northern subsistence goods production in Southern countries takes place under increasing returns to scale, why local production of subsistence goods takes place under constant returns to scale. Using this set-up, we show what kind of Southern countries would be penetrated first, and under which conditions this would happen. From the point of view of Northern producers, Southern countries can be divided into three classes: the broad class of partner- and non partner countries, and within the class of partner countries, the sub-classes of small and large partners. In this context, small partners are so small, that all of local subsistence production is taken over by the North, while in large countries part of subsistence consumption must still be met out of local subsistence production. The main insights coming from numerical simulations with the model are that Northern penetration on Southern markets releases (labor) resources that can then be used for producing tradable luxury goods. This has a negative terms of trade effect for the South, but a positive income effect, while, moreover, the latter effect tends to outweigh the former. In addition, small partner countries generally stand to gain more from Northern penetration than large countries, as in small partner countries relatively more resources would be released when shifting production of subsistence goods from local to Northern technologies. Using numerical simulations in which we increase the rate of imitation, we show that this leads to higher terms of trade for the South, and consequently, a higher penetration of the North in Southern countries with respect to subsistence production. The reason is that the opportunity cost of using Northern labor in Northern luxury goods production falls, and consequently more Northern labor is allocated to its alternative use of managing subsistence goods production in Southern countries. Thus we are able to 'explain' the recent penetration of Northern firms in subsistence goods production in countries like India and China (which have become increasingly important as manufacturing trading partners), as the latter countries are both large in population terms as well as relatively well connected.

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1. Introduction

Much of the wealth in the world is concentrated in the hands of relatively few people. Most of these people are situated in the Western world, i.e. the United States and Europe, whereas poverty rules in large parts of Africa, Asia and South America. From a demand point of view, the structure of the world market resembles a pyramid, with a numerically small but rich part at the top and a much larger but poor part at the bottom. Multinational corporations have routinely ignored the bottom of the pyramid (henceforth BOP). To some extent this is because the margins on products sold there are necessarily small, but it is also because the products affordable by poor buyers are necessarily low-cost products. Indeed, the cost-price of a product should be just about enough to cover the cost of embedding its core functional characteristics (i.e. its 'essence') into the product, but not enough to differentiate it from otherwise similar products through carefully designed marketing campaigns.[1] Indeed, many of the high-tech products widely used in Western societies these days thrive on fleeting product fads. Users of mobile phones, games consoles, cars, kitchen appliances and even holidays put a high premium on variety and temporary exclusivity and suppliers happily oblige by providing the variety one is looking for in the product market niches created by their own marketing activities.

The poor of the world, in contrast, are striving to expand their consumption goods spectrum largely to cover their basic needs more completely. Because of their low income, they often fall short of covering the complete basic needs spectrum. However, it may well be possible to service the basic needs of the poor more completely by selling products that have been stripped down to the bare functional essentials at prices that enable (nearly) everyone to obtain these products. In the latter case volumes sold could be practically infinitely high and even with very small but still positive margins, profits are potentially very large indeed. So, if products, but also the way in which products are brought to the local market, could be geared more directly to the needs of the people at the bottom of the income pyramid, both consumers and producers could gain.

[1] Prahalad and Hammond claim that … "It is hard to argue that the wealth of technology and talent within leading multinationals is better allocated to producing incremental variations of exisiting products than to addressing the real needs- and real opportunities- at the bottom of the pyramid." (Prahalad and Hammond (2002, p.11)). On this matter, see also Prahalad (2006).

The reason why we underline the importance of the way in which products are brought to the local market is that doing so is intrinsically more difficult in BOP societies than in Western societies. The latter societies are densely connected through both physical infrastructure like (rail-) roads, airlines and shipping networks, and a variety of information and communication channels. In BOP societies, by contrast, such connections are often sorely lacking. The lack of true mass media and other means of long-distance communication make it difficult to raise awareness for the existence of a product, since marketing campaigns using television broadcasts or newspapers are not an option. Instead, advertisement needs to be explicitly geared towards local, small shop suppliers, cf. Prahalad (2006). The same applies to actually making the product available. Somewhat perversely, the sparsely connected BOP societies often bear higher transportation costs than is typically the case in Western societies, while these same societies can ill afford to pay these higher costs.

To illustrate the working of the main principles involved, we construct a model that distinguishes between a rich North and a poor South, in the tradition of Krugman (1979), but also Helpman (1993) and Grossman and Helpman (1991) and many others since, cf. Chui c.s. (2002) for an overview. Unlike Krugman (1979), in our model the South consists of many countries that differ both in population size and in 'connectedness', a catch-all that represents the cost of reaching the market and can stand for both the density of the transportation network as well as those used for (tele-) communication. Again unlike Krugman (1979), we subdivide the goods produced into two main groups, one homogeneous subsistence good and a multitude of luxury goods. Furthermore, we will make the assumption that consumption of the subsistence good at the subsistence level generates a zero level of utility, while subsistence good consumption over and above subsistence level yields no additional utility. For luxury goods we assume that any positive level of consumption generates positive utility in a Love of Variety way (cf. Krugman (1979)). This implies that the relative demand for goods and services in rich countries will be tilted towards luxury goods, and the other way around in poor countries, ceteris paribus. The demand structure for a Southern country is highlighted in Figure 1 below. It resembles a structure with different income-elasticities for subsistence and luxury goods as implied by the use of non-homothetic utility functions as in Matsuyama (2000), for example. However, in our case, we can keep the model relatively simple by assuming two modes of operandi for demand: the case where actual income is

below subsistence income, and no luxury goods will be demanded, and the other case in which free disposable income (the excess of actual income over subsistence income) is spent on luxury goods.

In this Figure, the utility function which is behind the demand structure is represented as a set of communicating vessels. The liquid represents the flow of total consumption expenditures. The vessel at the left hand side communicates with the other vessels through a one-way-valve[2] in the middle of the wall that separates the subsistence vessel from the LOV-vessels, while the LOV-vessels in turn communicate at the bottom. Thus they mimic Love of Variety, as expenditures on luxury goods automatically get spread over all luxury goods available. It should be noted that the ordering between subsistence expenditures and luxury goods expenditures is lexicographical, since Love of Variety-based utility can only be generated if the subsistence good is consumed at subsistence level.

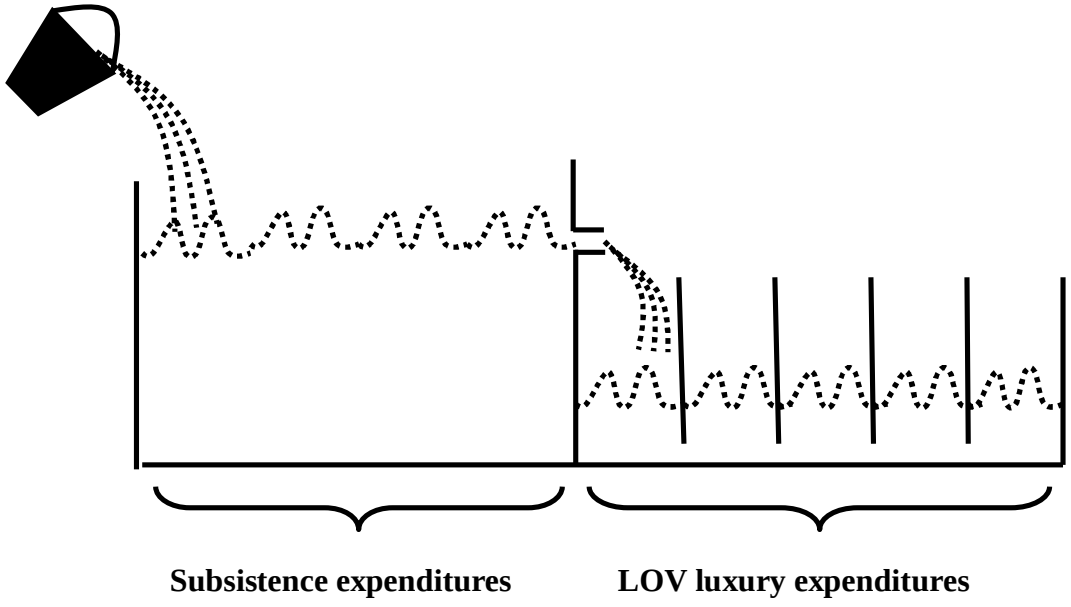


Figure 1. Southern subsistence and luxury goods expenditures

If we normalize the width of the subsistence level vessel to 1, the subsistence level consumption expenditures are given by the height of the valve. The latter is determined by the consumer price of the subsistence good. So, lowering prices means that for the same level

[2] The valve should actually be a one-way-pump if the fluid level within the LOV vessels exceeds the level in the subsistence vessel.

of nominal income, i.e. for the same contents of the bucket, more of that income will overflow into the luxury goods section.

It follows immediately from the Figure that the demand for Northern products may increase via three different channels:

1. a higher income in the South, leading to more 'spill-overs' into the luxury vessels;
2. reduced vessel height (lower price) in the group of subsistence goods;
3. Northern entry in Southern subsistence goods production.

The first two channels are largely out of the control of individual Northern firms, but the third one is not. In order to find out why and in which type of Southern countries Northern firms would want to enter the market for subsistence goods, we develop a simple theoretical model and look at the plausibility of the predictions that this model generates regarding Northern activity on Southern BOP markets.

The paper is further organized as follows. In section 2 we describe the structure of the model, while section 3 contains the results of several numerical simulations, a base run and some experiments regarding the sensitivity of the outcomes to different parameter values. In section 4 we provide some concluding remarks.

2. The Model

2.1 General Setting

In order to keep the model as simple as possible, we use the Krugman (1979) model as a template to which we add the production of subsistence goods as well as the demand for those goods. The demand and supply of luxury goods is modeled using essentially the same structure as in Krugman. To simplify matters somewhat, we will assume that the North does not demand any subsistence goods.

The general subsistence goods production setting is that of many Southern local producers who are in perfect competition with each other. Southern producers produce locally, i.e. they do not centralize production, whereas Northern producers do, and can thus realize economies of scale due to the concentration of production and the sharing of high-skilled management resources. The downside of this centralized mode of production are the

distribution and marketing costs that must be incurred to reach the overall market, which is spread out over the entire country. We only implement economies of scale in subsistence goods production by the North, as we would like to follow Krugman as closely as possible with respect to the rest of the model.

Contrary to Krugman, we assume that labour is heterogeneous, i.e. the North has a relatively abundant supply of high-skilled labour, while the South is relatively low-skill abundant. In fact, we make the grossly simplifying assumption that all labour in the North is high-skilled, and all labour in the South is low-skilled.

As in Krugman (1979), the North produces 'new' luxury goods using high-skilled labor, while the South may use low-skilled labour to produce either subsistence goods or 'old' luxury goods, after the luxury goods production technology has matured enough so that it can be used in the South using just low-skilled labour.

As stated above, with respect to the production of subsistence goods, we assume that the South's traditional mode of subsistence goods production is decentralized under conditions of perfect competition. However, the North can also produce subsistence goods within the South. It even outperforms the South in certain circumstances as it is able to produce under conditions of increasing returns to scale by centralizing production, at the expense of higher distribution and marketing costs. The economies of scale are linked to the use of high-skilled management resources that need to be 'imported' from the North, and that have alternative uses there (particularly the production of 'new' luxury goods). Following Krugman again, we use labor as the only factor of production, while assuming that the productivity of production labor is constant.

Thus we arrive at a minimum configuration model with two uses for Northern labour (i.e. the production of 'new' luxury goods and the generation of 'management' services in the South), whereas Southern labour has three uses: the production of subsistence goods using local or Northern production technologies, and the production of 'old' luxury goods.

In the remainder of this section we cover the production and distribution of subsistence goods in the South in somewhat greater detail, as the cost of marketing and distribution is of particular importance for the development of BOP markets Prahalad (2006). Then we show how these distribution and marketing costs in combination with the idea of fixed management costs leads to an optimum serviceable subsistence goods market-size from the

point of view of Northern firms, which sometimes would want to take over all of the local market, and sometimes just the most densely connected part of that market, while leaving the rest of the market to local subsistence goods producers.

We show that when Southern countries differ with respect to such characteristics as population density, infrastructure per head, technological 'backwardness', income per head, and so on, we can define a rule that separates Southern countries into two sets: those that would be selected as potential Northern partners in subsistence goods production and a set of countries that would be left on their own by Northern firms.

2.2 Innovation and Imitation

As regards innovation and imitation in luxury goods, we use the same assumptions as in Krugman (1979). This implies that the total number of luxury good varieties, further called *A*, will grow at an exogenously given rate of innovation $\hat{\mu}$. Each moment in time, a fraction κ of all varieties not yet imitated will indeed be imitated. This implies that *B*, being the total number of varieties imitated by the South, will grow at a rate $\hat{B} = \kappa \cdot (1-\varsigma)/\varsigma$ where $\varsigma = B/A$. The steady state value of ς, i.e. $\bar{\varsigma}$, is obtained by requiring that $\hat{\varsigma} = \hat{B} - \hat{A} = \kappa \cdot (1-\varsigma)/\varsigma - \mu = 0 \Rightarrow \bar{\varsigma} = \kappa/(\kappa+\mu)$.

2.3 The Demand for Luxury Goods

In order to keep the model as simple as possible, we ignore subsistence goods demand by the North, as subsistence consumption in the North is generally a negligible part of total consumption. In the South this may be totally different, so we will explicitly cover Southern subsistence goods demand. In that context, it should be noted that the role of subsistence goods in generating utility is totally different from luxury goods. As stated before, we assume that consumers in the South use their income first to fulfill their subsistence needs, and then spend the remainder of their income - if there is any - on luxury goods. Thus, for the South the budget spent on luxury goods is equal to total labor income less expenditures on subsistence goods, while the North spends all its income on luxury goods.

With regard to luxury goods, we assume that their demand follows from a Love of Variety utility function as in Krugman (1979) again. But in addition to the Krugman specification, we allow for decreasing returns to variety: luxury good varieties that are

invented later may not contribute as much to utility as earlier inventions. Old luxury goods are produced under perfectly competitive conditions, as every Southern country has access to the corresponding 'matured' technologies. In the North, however, 'new' luxury goods are produced under imperfectly competitive conditions, as Northern producers have temporary monopoly rights on the production of a particular variety of luxury goods, again as in Krugman (1979). These temporary monopoly rights on new luxury goods give rise to wage differentials between the North and the South.

Let all luxury goods be indexed on the continuous range [*0,A*]. Let the goods with the lowest indices be invented first, in which case variety expansion can be thought of as a process that leads to an increase in *A* over time. Let the sub-range [*0,B*] cover all varieties that have matured, and that can be produced by the South. Imitation can then be thought of as a process that increases *B* over time. In this setting, there are two kinds of luxury goods: matured/old luxury goods with indices $i \in [0,B]$ and 'new' luxury goods with indices $i \in (B,A]$.

Let us call the level of consumption per head of the *i-th* 'old' luxury good c_i^o, and that of the *i-th* 'new' luxury good c_i^n. Furthermore, let σ be the elasticity of substitution between individual luxury goods in each person's utility function. As in Krugman (1979), this function is given by:

$$U = \left(\int_0^B \alpha_i \cdot (c_i^o)^{\frac{\sigma-1}{\sigma}} di + \int_B^A \alpha_j \cdot (c_j^n)^{\frac{\sigma-1}{\sigma}} dj \right)^{\frac{\sigma}{\sigma-1}} \qquad (1)$$

where *U* represents utility per individual. The only difference with respect to Krugman's utility function is the presence of variety-specific distribution parameters α_i and α_j, that we have introduced in order to be able to study the consequences of the possibility of decreasing returns to variety, i.e. decreases in the direct contribution to utility of a new variety.[3]

[3] We can implement such a notion by requiring that $\partial \alpha_A / \partial A < 0$, i.e. the newer a variety is, the smaller its contribution to utility may become. We will come back to this later.

We can use (1) to formulate a typical utility maximization problem involving a budget constraint with associated Lagrange multiplier λ, which has the usual interpretation of the inverse of the (minimum-) cost of one unit of utility (a 'util') in monetary terms:

$$\lambda = U / X^L \;\Leftrightarrow\; 1/\lambda = X^L / U \tag{2}$$

In equation (2), X^L is the budget that a representative consumer spends on luxury goods (we will be using X^S later on to denote consumer expenditures on subsistence goods). Using (1) and (2), as well as the FOC's of the utility maximization problem with respect to each single variety, we obtain the following demand equation per variety, as well as the definition of λ in terms of the corresponding consumer prices of each variety:

$$c_i^j = X^L \cdot \left(p_i^j / \alpha_i\right)^{-\sigma} \cdot \lambda^{1-\sigma} \quad with \;\; j = o \;\forall\; 0 \le i \le B, \;\; j = n \;\forall\; B < i \le A \tag{3}$$

where p_i^o is the consumer price of the *i-th* 'old' variety, and p_i^n is the consumer price of the *i-th* 'new' variety. For λ we obtain the expression:

$$1/\lambda = \left(\int_0^B (\alpha_i)^\sigma \cdot \left(p_i^o\right)^{1-\sigma} di + \int_B^A (\alpha_j)^\sigma \cdot \left(p_j^n\right)^{1-\sigma} dj \right)^{1/(1-\sigma)} \tag{4}$$

From (4) one can see that the price of a 'util' is linear homogeneous in the consumer prices of individual varieties. Equation (3), for a given value of λ, will function as the demand constraint for the Northern suppliers of individual luxury goods varieties.[4] As we will explain later on, prices of all 'old' varieties are the same, and this also holds for prices of all 'new' varieties, given our assumption that the linear production technologies of luxury goods are all the same. There may be price differences between 'old' and 'new' varieties, though. In that case, equation (3) implies that total expenditures on luxury goods are distributed over 'old' and 'new' varieties, as follows:

[4] This assumes that there are so many varieties already on the market that the impact of a marginal change in the price of an old or new variety on the average market price of a 'util' can be ignored, i.e. individual suppliers of luxury goods are small relative to the entire luxury goods market.

$$X^o / X^n = \frac{p^o \cdot \int_0^B c_i^o di}{p^n \cdot \int_B^A c_j^n dj} = \left(\frac{p^o}{p^n} \right)^{1-\sigma} \cdot \frac{\int_0^B (\alpha_i)^\sigma di}{\int_B^A (\alpha_j)^\sigma dj} \quad (5)$$

where X^o and X^n are the parts of the budget spent on 'old' and 'new' varieties, respectively. From (5) it follows that we need to specify the distribution coefficients α first in order to obtain the distribution of total luxury goods expenditures over 'old' and new' varieties. However, it is clear that the expenditure ratio will in any case depend positively on B, and negatively on A, *ceteris paribus.*

To keep the utility function as tractable as possible, we specify the distribution coefficients as an exponentially declining function of the corresponding variety index. In particular we assume:

$$\alpha_i = \alpha_0 \cdot e^{-\gamma \cdot i} \quad (6)$$

where $\alpha_0 = 1$, and $\gamma \geq 0$ is a constant parameter that represents the percentage drop in the contribution coefficient of each luxury good variety with an increase of the variety index by 1 unit. Note that setting $\gamma = 0$ would yield Krugman's symmetric case.

Before describing supply behavior in more detail, we have to look into the conditions under which Northern producers would want to enter subsistence goods production in Southern countries. This is the subject of the following section.

2.4 Southern Production and Distribution Characteristics

We assume that Southern producers of subsistence goods produce strictly locally and under perfectly competitive conditions, under relatively high unit costs, and constant returns to scale. Northern firms can outperform these local producers through lower unit variable cost at the expense of incurring fixed management cost. This provides an incentive for the North to centralize production in each Southern country because of economies of scale. This drive for centralization, however, is limited by the presence of transportation and marketing

costs. The latter depend on things like population density and the degree to which that population is connected, both physically and 'informationally', to Northern subsistence goods suppliers.

It is easy to show that the cost of reaching the population will rise more than proportionally with the size of the population reached, if the density of that population decreases while moving away from the population center of a country. To simplify matters, we will assume that communication and transportation efforts will rise quadratically with the size of the population to be reached, further called the 'targeted population'. We furthermore assume that the (low-skilled) labor efforts required to reach the targeted population are proportional to total transportation and communication efforts. The size of the market that can be serviced in a profitable way by a Northern subsistence firm is therefore determined not just by prices and unit production costs, but also by population density and the degree to which the population can be reached at relatively low marketing and distribution costs per person.

2.5 Northern Subsistence Goods Production

It is assumed that for the North to enter the BOP market of a Southern country, the North has to transfer scarce high-skilled management resources to the South, in order to oversee the use of Northern subsistence goods production technology by Southern low-skilled workers. For reasons of simplicity, we assume that both Northern and Southern production technologies use only low-skilled labor. However, the Northern technology uses less of that low-skilled labour per unit of output than the Southern technology, i.e. $1 > \nu^S \geq \nu^N$, where ν^S represents unit (low-skilled) labour requirements for the Southern subsistence good production technology, while ν^N represents the low-skilled unit labour requirements for the Northern technology.[5]

As stated above, the subsistence good is locally produced under perfectly competitive conditions, and it sells at a price *q* on the local market. In addition to this, we assume that

[5] The assumption that $\nu^S<1$, implies that it takes less than one low-skilled workers input to produce the required volume of subsistence goods. Otherwise, under the utility assumptions we have made here, the Southern countries would have nothing to trade, since all their labour would be tied up in subsistence goods production.

Northern and Southern subsistence goods are perfect substitutes, implying that the Southern cost-price is also the maximum selling price of Northern subsistence goods.

In order to determine the total volume of sales of a particular subsistence good we make the assumption that at each moment in time, the required level of consumption of a particular subsistence good is equal to one unit. Under these assumptions the quantity of the subsistence good that any Southern low-skilled worker inelastically supplying a unit of labour and earning a wage *w* can buy, is *w/q*. The volume of subsistence goods that an individual will actually buy is the minimum of *w/q* and 1. Consequently, *S* being the number of units of the subsistence good sold to a population with size *P*, will be given by:

$$S = P \cdot \min(\frac{w}{q},1) \tag{7}$$

Using (7), we find that the profits $\bar{g}$ for a Northern firm producing subsistence goods within some Southern country are given by:

$$\bar{g} = (q - w \cdot v^N) \cdot P \cdot \min(\frac{w}{q},1) - \frac{P^2 w}{2\theta} - \bar{h} \cdot w^N \tag{8}$$

where $\bar{h}$ is the amount of high-skilled Northern labor required in subsistence production in a Southern country, receiving the competitive wage w^N. The middle part of equation (8) is a quadratic function in *P* which serves as a direct indicator of the labour costs involved in reaching a group of customers of size *P* (either for advertising purposes or direct distribution purposes). These costs depend negatively on the economic "connectedness" of the country as measured by the parameter θ and quadratically on *P*, as stated above. The 2 is there for convenience sake.

Using (8), we can find the values of *P* and *q* that would maximize the gross operating surplus of a Northern firm active on the subsistence market. With respect to *q* we find that the first partial derivative of $\bar{g}$ w.r.t. *q* is always positive, and hence *q* should be as high as possible but low enough to capture the entire market, i.e. *q* should be only marginally below

the price of local varieties of subsistence goods. Hence, we find that under perfect competition between local producers the Northern firm would effectively set:[6]

$$q = w \cdot v^S \tag{9}$$

Using (8) and (9), we can find the value of *P* that maximizes $\bar{g}$, i.e. *P**. For some countries, this optimum value of *P* may be less than the entire population $\overline{P}$, i.e. $P^* < \overline{P}$. In other cases the size of the population will be a binding constraint on the maximization problem and so the entire population will be served, i.e. $P^* = \overline{P}$. The latter follows immediately from the fact that (8) defines $\bar{g}$ as a hump-shaped function of *P*. So if the population is not large enough to reach the global maximum of $\bar{g}$ then the largest value of *P*, such that $P \leq \overline{P}$ will do the trick, since $\partial \bar{g} / \partial P > 0 \; \forall \; P < P^*$. We will refer to the former group of countries as large and the latter as small countries. In a large country, therefore a part $\overline{P} - P^*$ will not be targeted by Northern firms, but will instead still have to be serviced by supply coming from local Southern firms.

Using (8) and (9), we find for the large country case that:

$$P^* = \theta \cdot \phi \tag{10}$$

where $\phi = (v^S - v^N) > 0$, i.e. φ measures the absolute difference in unit labor requirements between local Southern production technologies and Northern subsistence goods production technologies. It is therefore a measure of the technological advantage of the North in subsistence goods production.

In the small country case, equation (10) implies:

$$P^* \leq \overline{P} \Rightarrow \theta \leq \overline{P} / \phi \tag{11}$$

[6] Note that (9) in combination with our assumption that $v^S < 1$ implies that $\min(w/q, 1) = \min(1/v^S, 1) = 1$.

It should be noted that in our model set-up, we will only consider θ and $\overline{P}$ as parameters that may vary between countries. In that case (11) may be used to detect which countries have combinations of θ and $\overline{P}$ such that they can be considered to be 'large countries' in our terminology. We will come back to this issue later on in more detail.

Assuming that Northern producers want to engage in the production of Northern subsistence varieties in some Southern country only if they could make a net profit, we can calculate the characteristics of both large and small countries for which this would be the case, i.e. we can set $\overline{g}$ equal to some predetermined value and obtain the combinations of $\overline{P}$ and θ that would generate this value. The corresponding curve in the $\theta, \overline{P}$-plane would be the corresponding 'Iso-Net-Operating-Surplus-curve' (further called INOS-curve), as given by the final row in Table 1. The latter Table briefly summarizes the results we have obtained so far for both the large and the small country cases.

It follows from the results in the Table that in both the small and the large country cases the net operating surplus will rise with ϕ, and so does the size of the targeted market *P** in the large country case. Note too that the size of the targeted market is invariant to the Southern wage *w*. In addition, a higher degree of connectedness (i.e. a higher value of θ) will lead to a larger population being targeted and also higher profits, *ceteris paribus*. Lastly, for large countries profits are independent of the actual population size.

Variable	Large country case	Small country case
P^*	$\theta \cdot \phi$	$\overline{P}$
$\overline{g}$	$\frac{1}{2} \cdot w \cdot \phi^2 \cdot \theta - w^N \cdot \overline{h}$	$\overline{P} \cdot w \cdot \phi - \frac{\overline{P}^2 \cdot w}{2 \cdot \theta} - w^N \cdot \overline{h}$
θ	$\frac{2 \cdot \left(\overline{g} + w^N \cdot \overline{h}\right)}{w \cdot \phi^2}$	$\frac{\overline{P}^2 \cdot w}{2 \cdot \left(w \cdot \phi \cdot \overline{P} - \overline{g} - \overline{h} \cdot w^N\right)}$

Table 1. Large and small country results

As regards the INOS-curves that are given by the entries in the Table row labeled θ, we see that in the large country case, large values of w^N and $\overline{h}$ or low values of ϕ and *w* must coincide with large values of θ, as one would expect. This also holds for the small country

case, *mutatis mutandis*, but in addition to this, the actual country size (in combination with the other variables and parameters) now also matters. For very small countries an increase in country size goes together with a fall in θ, as in this case revenues rise faster than costs, whereas further increases in country-size go together with rising values of θ since in this case costs rise faster than revenues (because of decreasing population density for increasing targeted population sizes). Note that there is a large qualitative difference between the values of θ in the large and in the small country case. In the large country case, the population size is no limitation on the targeted market of that country. Hence the only thing that matters in that case is the connectedness of the country. In case of small countries, both the country-size (i.e. population size) as well as the connectedness of the country matter. Finally, it should be noted that a rise in $\overline{g}$ shifts the INOS-curve upwards, so that curves further away from the origin in the $\theta, \overline{P}$ -plane represent higher levels of the Net-Operating-Surplus.

The distinction between small and large countries is important, as is the distinction between countries with respect to their "connectedness". The reason is that the relative demand for high-skilled labour will depend on the number of prospective partner countries, and so will the available supply of low-skilled labour for matured luxury goods production. Whenever a Southern country becomes a partner country, this frees up low-skilled labour from local subsistence goods production in that Southern country (because the Northern technology is more productive by assumption). The low-skilled labour thus released is then available for luxury goods production, making old luxury goods less scarce in the process. This will provide the country with more goods to trade on the world market against Northern luxury goods. In the process, low-skilled wages are depressed somewhat, reducing the incentive for the North to enter additional Southern subsistence markets. High-skilled workers in the North, on the other hand, are now in higher demand, and high-skilled wages are driven up accordingly, also somewhat reducing the incentive to enter additional Southern subsistence goods markets.

In the next sections we will show how these mechanisms interact. To this end we will look more closely into the heterogeneity between Southern countries, and then use that heterogeneity to come up with aggregate world-market clearing wages for the low- and the high-skilled, as well as their corresponding equilibrium levels of employment, including their geographical distribution.

2.6 Southern Heterogeneity

There are many sources of heterogeneity between Southern countries that are relevant from the North's point of view in choosing particular Southern countries as partners in the local production of subsistence goods (cf. Table 1, line θ). For reasons of simplicity, however, we consider only the parameters θ and $\overline{P}$ to vary between Southern countries, while assuming that the other parameters and variables are identical. With respect to technology this is a simplifying assumption, whereas with respect to *w* this is implied by the previous assumptions of identical production technologies within Southern countries and the assumption of free trade.

To simplify matters even further, we will assume that θ and $\overline{P}$ are uniformly and independently distributed on the intervals $[0,\theta^{\max}]$ and $[0,\overline{P}^{\max}]$ respectively. This implies that if we would draw a plane in the $\theta,\overline{P}$ dimensions, the number of countries in each point such that $0 \le \theta \le \theta^{\max}$ and $0 \le \overline{P} \le \overline{P}^{\max}$ would be the same, as the frequency of any combination of characteristics would have to be identical. For reasons of simplicity, we take this frequency to be equal to 1 from now on.

The $\theta,\overline{P}$ - plane is drawn in Figure 2. All countries are within the rectangle enclosed by the horizontal and vertical dotted lines. The upward sloping dashed line within the plane is the asymptote of the hyperbolic function that separates partner countries from non-partner countries in the small country case. The corresponding 'small partner separating' function (as given by the INOS-curve in the small country case (see Table 1)), is labeled SPS. Points above the SPS-curve are small partner countries, while those below the SPS curve are not. Something similar holds for the LPS-line, that separates large partner countries in the large country case from non partners. In accordance with (10), the upward sloping SCS-line (short for 'Small Country Separator') separates small countries (above the SCS line) from large countries (below the SCS line). Consequently, large partner countries must be both above the LPS-line and below the SCS-line, as well as inside the dotted rectangle. The area which fits these constraints is marked using solid dots. Small partner countries are all those countries within the dotted rectangle which are above the SCS-line and above the SPS-line.

The precise shape of the set of partner countries is determined by the following features: Firstly, it is easy to show that the minimum value of θ of the top half of the hyperbolic function describing the SPS-curve coincides with the value of θ for the LPS-curve, as drawn

in the Figure. Secondly, the SCS-curve intersects with this minimum. Third, the vertical asymptote of the hyperbolic SPS-curve is exactly halfway point M and the origin. Finally, the tangent of $\lambda 1$ is twice as large as that of $\lambda 0$. In short, we have that $tg(\lambda 1) = \frac{1}{\phi}$, $tg(\lambda 1) = 2 \cdot tg(\lambda 0)$, $\theta(M) = \frac{2\left(\bar{g} + \bar{h} \cdot w^N\right)}{w \cdot \phi^2}$, $\bar{P}(N) = \frac{\bar{g} + \bar{h} \cdot w^N}{w \cdot \varphi}$ and $\bar{P}(M) = 2 \cdot \bar{P}(N)$, where we have used the notation $\theta(X)$ to denote the θ-coordinate of a point labeled X in Figure 2, while $\bar{P}(X)$ denotes the $\bar{P}$-coordinate of such a point X.

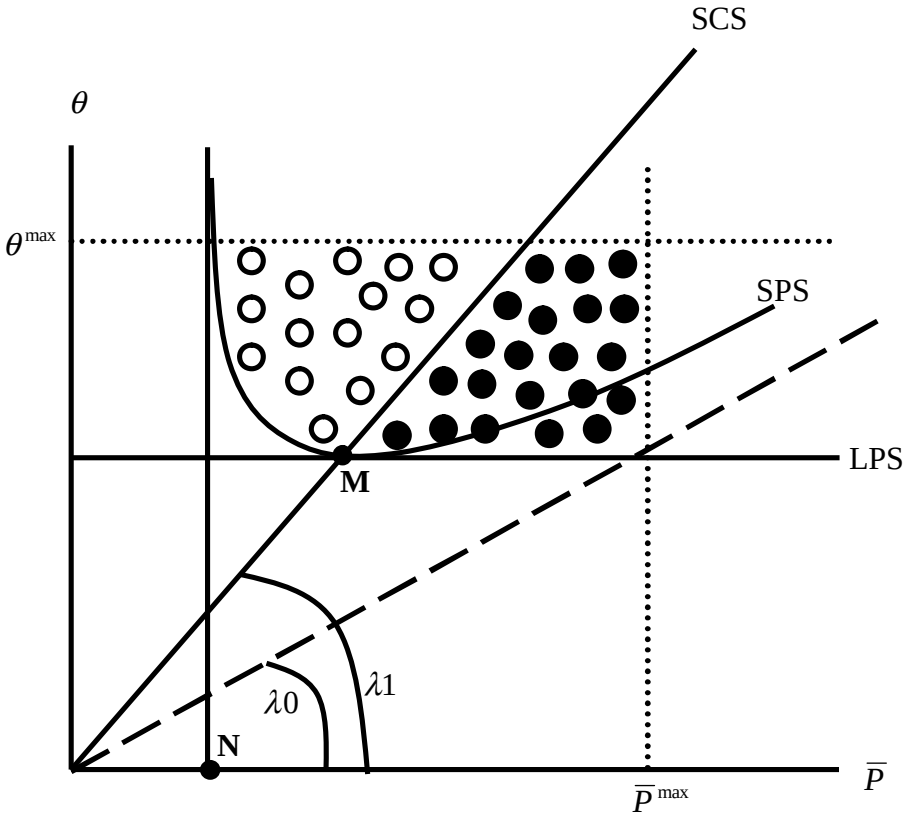


Figure 2. Northern subsistence goods production partners

It is instructive to see what happens if in this setting the Northern wage goes up. In that case the LPS-curve shifts upward and the hyperbolic SPS-curve shifts to the right, compressing the set of partner countries into the top-right corner of the dotted rectangle. The same happens for increases in $\bar{h}$. Higher wages for high-skilled workers make for a smaller number of Southern countries eligible for subsistence goods production partnerships. A rise in the Southern wage, on the other hand, shifts down the LPS-curve, while moving points M and N to the left. In addition, the SCS-curve gets flatter, and so does the upward-sloping

asymptote of the SPS-curve, leading to an expansion of the set of partner countries in the direction of the bottom-left corner of the dotted rectangle. A change in ϕ, i.e. the productivity difference between Northern and Southern subsistence goods production technologies, will have qualitatively similar effects as a change in the Southern wage. Interestingly, both 'technological backwardness' and a relatively high wage-income in the South, make for potentially profitable partnerships between the North and the South.

We conclude that changes in Northern and Southern wages will change the set of partner countries. The changes in this set will in turn have immediate consequences for the demand for labour within Southern and Northern countries, and hence, for a given supply of labour, for wages again. In order to see, therefore, how innovation, imitation and Southern heterogeneity interact, we will now turn to a description of the associated demand for labour. To this end, we must first cover the entry decisions of Northern firms in the Southern subsistence goods markets.

2.7 Northern Entry of Southern Subsistence Goods Markets

Contrary to Krugman's model, our set-up implies that Northern high-skilled workers have two competing uses; they can produce varieties of 'new' luxury goods in the North, but they can also engage in the management of subsistence goods production in the South. Given the limited supply of Northern high-skilled labour, Southern subsistence goods production by Northern firms therefore has an opportunity cost in the form of potential profits on Northern luxury good production foregone.

In order to derive the optimal allocation of Northern high-skilled labour over these two activities we define the profit function for a Northern producer, who we assume is a monopolist both in the production of luxury goods in the North and in subsistence goods production in the South. Thus we have for total profits ψ_i for the Northern producer of variety i, and for a given Northern wage w^N, that:

$$\psi_i = (p_i^n - w^N) \cdot c_i^n + \int_{\bar{g}_i}^{\bar{g}^{\max}} n(v).v \, dv \qquad (12)$$

In equation (12), c_i^n is the level of production of the *i-th* Northern luxury good variety. As we assume that it takes one unit of high-skilled labor to produce one unit of the variety, it also represents the level of employment necessary for the production of the *i-th* variety. The demand for this variety is given by equation (3). Furthermore, *n(v)* is the number of Southern countries with a net operating surplus exactly equal to v, while $\overline{g}_i$ is the smallest value of the net operating surplus on subsistence goods production in some country that the i-th Northern luxury good variety producer would want to engage in. $\overline{g}^{\max}$ is the value of the INOS-curve through the point $(\theta^{\max}, \overline{P}^{\max})$ in Figure 2. Consequently, $\int_{\overline{g}_i}^{\overline{g}^{\max}} n(v).v\,dv$ represents total profits from subsistence goods production by this Northern producer of variety i, therefore. The control variables for a Northern variety producer are p_i^n and $\overline{g}_i$. Recalling that the demand for the *i-th* Northern luxury goods variety has a constant price elasticity of demand equal to σ (cf. equation (3)), we find that maximisation of (12) w.r.t. the control variables then results in the following FOC's:

$$\partial\psi / \partial p_i^n = c_i^n + \partial c_i^n / \partial p_i^n \cdot (p_i^n - w^N) = 0 \Rightarrow p_i^n = \sigma \cdot w^N / (\sigma - 1) \qquad \text{(13.A)}$$

$$\partial\psi_i / \partial\overline{g}_i = -n(\overline{g}_i) \cdot \overline{g}_i = 0 \Rightarrow \overline{g}_i = 0 \qquad \text{(13.B)}$$

Equation (13.A) is the well-known Amoroso-Robinson pricing condition.[7] It is also consistent with the idea that the marginal profits at that price are equal to zero. Hence, equations (13.A) and (13.B) taken together imply that, for given Northern wages, i.e. given marginal costs, the scarce high-skilled labor resource should be distributed over Northern luxury goods production and Southern partner country management in such a way that the marginal profits in both cases are the same (and equal to zero).

Since all Northern luxury goods producers face the same marginal costs, they would set the same price and would want to enter the same Southern markets. To simplify matters, we will now assume that Northern producers divide markets among them rather than

[7] Note that also in the case where this Northern producer would hold the monopoly over a portfolio of products, (13.A)would describe the profit maximizing price for all products in that portfolio.See also footnote 9.

competing against each other in each individual Southern market.[8] A further, non trivial, simplification is to assume that the number of Northern suppliers remains fixed.[9] A final simplification can then be implemented by scaling the (fixed) number of Northern producers to 1. The next sections will now look into the closure of the model by means of the requirement of overall labour market equilibrium.

2.8 The Labour Market

It should be noted that we need to distinguish between the large and small country case again. In the small country case, there is no local subsistence goods production in the South by local producers. Hence, because of the productivity differences between Northern subsistence goods production technologies and local Southern technologies, a higher proportion of Southern workers will be available for 'old' luxury goods production: there will be more 'free' disposable labour available, than in large countries, ceteris paribus. This implies that small countries stand to gain more from subsistence production partnerships with the North than large countries. For the North, the situation is the other way around, since in large countries they are able to reach the maximum of their hump-shaped profit-curves, whereas in small countries they can not.

In order to determine how much Northern management labour needs to be allocated to Southern subsistence goods production, we need to calculate the area within the rectangle defined by $\theta^{\max}$ and $\overline{P}^{\max}$ (the dotted vertical and horizontal lines) in Figure 2 which is above the INOS-curve. We can then obtain the proportion of that area in the total area of the rectangle to obtain the total number of Southern subsistence goods production partner

[8] In this case, profits for the average Northern producer will be higher than when all producers would enter all markets at the same time, because of the fixed costs associated with each Northern activity in a Southern country. For the moment, variations on this market division assumption are left for future research.

[9] This is a non-trivial assumption, as an increase in the number of varieties, where each variety is produced/owned by a separate Northern firm, also implies, by the symmetry between Northern producers, that the number of firms who would want to be active on Southern markets would increase with the number of varieties. As each Northern activity in the South entails fixed costs, the expansion of varieties in the North, would then lead to a withdrawal of Northern production activities from the South from the marginal countries (the ones 'on the INOS-curve'), simply because we have more Northern potential suppliers for the Southern markets. Instead, we will assume that the number of Northern producers remains fixed, and that these producers therefore each produce an expanding sub-spectrum/portfolio of varieties, where the relative contribution of each sub-spectrum remains the same.

countries. The total number of management workers is then of course equal to $\bar{h}$ times the number of Southern partner countries.

In order to calculate the relative area enclosed by the marginal INOS-curve, we need to distinguish between five different situations which can occur in the model, as sketched in Figure 3. The dotted rectangle corresponds to the one present in Figure 2. The horizontal solid line is the LPS-curve from Figure 2, while the convex downward sloping curve that joins the solid horizontal line is the downward sloping part of the SPS-curve from Figure 2. The line emanating from the origin is the SCS line. Situations II and III differ in the point at which the SCS line intersects with the vertical dotted line. In Situation II the SCS line leaves the box at the top while in Situation III the SCS-line is flatter and therefore intersects the vertical boundary of the box.

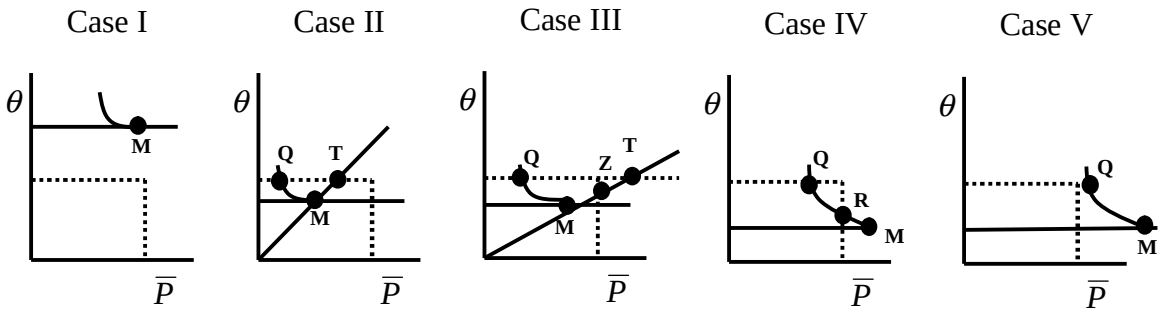


Figure 3. Possible INOS-curve constellations

Note that in cases I and V, there won't be any eligible Southern subsistence goods production partners, since partner countries must always be above the solid line and above the SPS curve, as well as within the dotted rectangle. This implies that only the areas of the North-East corners of the rectangles in as far as they are above the SPS-curve and the LPS-curve are indeed partner countries. So, in order to calculate total management labour demand, we need to be able to identify the five different cases.

Let Q be the (virtual) point of intersection of the convex SPS-curve with the horizontal dotted curve. Further, let M be the point where the convex curve joins the solid horizontal (cf. Figure 2 again) and let T be the point of intersection of the SCS curve with the horizontal line at $\theta^{\max}$. Case I will now obviously be identifiable by the requirement that the horizontal LPS-curve lies above $\theta^{\max}$. In order to identify case V, we must have $\bar{P}(Q) \geq \bar{P}^{\max}$. For case IV

point M must be to the right of the dotted vertical and point Q must be to the left of that vertical, i.e. $\overline{P}(Q) < \overline{P}^{\max}$ and $\overline{P}(M) \geq \overline{P}^{\max}$. Cases II and III share the requirements that $\overline{P}(Q) < \overline{P}^{\max}$ and $\overline{P}(M) < \overline{P}^{\max}$ and differ only in the value of $\overline{P}(T)$. For Case II we require that $\overline{P}(T) < \overline{P}^{\max}$, while $\overline{P}(T) \geq \overline{P}^{\max}$ holds in Case III.[10]

In order to see how exactly the supply of low-skilled labour for old luxury goods production can be determined, one is referred to the appendix, which highlights the principles involved in more detail than above. The appendix also shows how the number of partner countries and hence the distribution of high-skilled labour over its two uses can be determined. Finally, the appendix shows how aggregate Northern profits from subsistence goods production can be obtained.

2.9 Model Closure

In principle, the model is now fully specified, except for the choice of the numeraire, which we take to be the Southern wage. The Northern wage can then be determined by requiring equilibrium on the labor market.

The Northern wage can be calculated by considering that the demand for labor in the South for its different uses can be determined, for a given Northern wage, as the latter, in combination with the model-parameters defines the various separation curves, and hence the actual case of the five cases mentioned above that will apply for that given wage rate. Whether a country is a small or a large partner or no partner at all, is directly relevant, because in the no partner case, all subsistence goods need to be produced using local technologies. In the large partner case, only a part of the population needs to produce subsistence goods using local technologies, while in the small country case, subsistence goods are produced using the Northern technology only. This has immediate consequences for the level of supply of old luxury goods in those countries. However, the use of Northern production technologies in the South also determines how much of the total supply of Northern labor will be available for the production of Northern luxury goods in the North.

[10] We can infer from the last row in Table 1, what these identification requirements imply for the parameter and variable constellations (particularly with regard to Northern and Southern wages) of our model.

For, a rise in Northern wages, for example, will make for a decrease in the number of Southern partner countries, and hence for a higher level of Northern luxury goods supply.

Generally speaking, old luxury goods supply, but also subsistence goods supply using either local or Northern technologies for the South taken as a whole, can be obtained by means of direct integration over these concepts, taking the division of the South into large-, small- and no partner countries into account, as described for the 5 cases above. Looking at these cases more closely, we find that a lower Northern (relative) wage would move the LPS-curve down, whereas the vertical asymptote through point N in Figure 2 would move to the left, creating more Southern partners in the process, giving rise to a larger relative supply of Southern luxury goods (and consequently a lower relative supply of Northern luxury goods), *ceteris paribus*. Given the mark-up pricing relevant in case of luxury goods, a lower Northern relative wage would also lower Northern relative prices, and hence increase the relative demand for Northern luxury goods again. We thus have a relative demand curve for Northern goods (and high-skilled production labor) that is downward-sloping in relative Northern wages, and a Northern relative supply curve of Northern luxury goods (and high-skilled production labor) that is upward-sloping in relative Northern wages. The equilibrium wage rate is then defined as the point of intersection of the relative labor demand and supply curves.

3 Some Simulation Experiments

3.1 The Base Run

The only true state variables in the model are the number of old and new luxury goods, which change over time due to innovation and imitation. Changes in the relative sizes of these state variables drive the rest of the model, as in the original Krugman model. For example, a rise in the ratio *B/A*, increases the relative importance of old luxury goods in the generation of utility. For a given supply of Southern labor, this will decrease the supply per old luxury good variety and hence raise the price level of old luxury goods relative to new luxury goods. If the *B/A* ratio does not change, the relative scarcity of new versus old luxury goods remains unchanged as well, and so relative prices remain the same, as will the other model variables. This implies that the most interesting plots we may obtain using the model, are those coming from experiments that change the scarcity of luxury products, either

through changes in the rate of innovation μ (or the rate of imitation κ) or through changes in the direct contribution of individual luxury goods to utility (changes in γ). For the other experiments we have in mind, we will only present the percentage (point) deviations from the base-run, which are constant in the absence of transitional dynamics as indicated above.

In order to obtain the base run, we have used the parameter values given in Table 2. Several things should be noted about this particular constellation. Firstly, the Northern production technology for subsistence goods is more efficient by a factor of three compared to the decentralized mode of production used in the South. Secondly, the Southern population is larger than that of the North (1.5 as opposed to 1). Third, the demand for luxury goods is fairly price-elastic. Fourth, the North is a very productive innovator, while the South performs less well in imitating, in relative terms at least. Because of this, the North produces a much wider relative spectrum of luxury goods in equilibrium than the South ($(A-B)/A = 1-\kappa/(\kappa+\mu) = 4/5$).[11]

Parameter	Value	Parameter	Value	Parameter	Value
$\theta^{\max}$	3	v^S	0.75	κ	0.025
$\overline{P}^{\max}$	1	v^N	0.25	μ	0.1
w	1	P^{North}	1	A_0	5
$\overline{h}$	0.05	σ	4	B_0	1

Table 2. Base Run Parameter Values

3.2 Experimental Outcomes

To illustrate the working of the model and the evolution of the variables of interest over time, we will first solve the model numerically for a baseline combination of parameters. We

[11] See section 2.2. It should be noted that the experimental outcomes in the following section are obtained for initial values of the state variables that are consistent with their steady state ratio. From section 2.2, it follows immediately that the steady state ratio of the number of luxury products produced by the North and the number of luxury products produced by the South is equal to the ratio of the rate of innovation μ and the rate of imitation κ. With a value of $B_0=1$, we have therefore set $(A_0 - B_0) = \mu/\kappa \cdot A_0 \Rightarrow A_0 = 5$.

will then run some additional simulations for a period of 10 'years' in a row, for several alternative parameterizations and compare the results to the base run. The various experiments are listed in Table 3.

Exp. Nr.	Description	Parameter	Base Value	Exp. Value
1	Productivity Southern subs. techn. +10%	v_S	0.75	0.675
2	Productivity Northern subs. techn. +10%	v_N	0.25	0.225
3	Rate of innovation + 10 %	μ	0.1	0.11
4	Rate of imitation + 10 %	κ	0.025	0.0275
5	Southern Population +10%	$P^{\max}$	1.0	1.1
6	Northern Population +10%	P^{North}	1.0	1.1
7	Decreasing Returns to Variety	γ	0.00	0.01

Table 3. Partial Parameter Changes by Experiment

The outcomes of the experiments are listed in Table 4, except for the ones that influence the state variables directly (Experiments 3 & 4) and the one that influences the valuation of variety in the decreasing returns to variety experiment (Experiment 6). For these experiments, we will show the deviations with respect to the base run in the form of a number of plots. For the other experiments, those same deviations are listed in Table 4.

The Table and the plots show 16 variables, see the first column of Table 4, by means of which we sketch the events taking place. Variables 1-3 are the Southern employment shares in local subsistence goods production, Northern subsistence goods production and 'old' luxury goods production. Variable 4 denotes the absolute number of Southern partner countries, while variables 5-7 are the absolute figures for Northern profits from basic goods production and from new luxury goods production, as well as total profits for the North. Variable 8 denotes the share of basic goods profits for the North in total Northern profits, while variable 9 denotes the profit share of the North in Northern free disposable income. Variable 10 measures the ratio of free disposable income in the North and in the South (as stated before, free disposable income in the South equals gross income less expenditures on subsistence goods). Variable 11 provides the terms of trade, i.e. the price ratio of Northern and Southern luxury goods. Variables 12 and 13 measures the utility that the North and the

South derive from consuming both old and new luxury goods, while variable 14 measures the ratio of Northern and Southern utility. It should be noted that, because of the linear homogeneity of the utility function in consumption levels, the utility ratio is exactly equal to the free disposable income ratio. Finally, variables 15 and 16 measure the total number of luxury good varieties and the share of new goods in that total, respectively.

The plots in Figures 4.A-6.B cover the same variables in the same order. The first 8 plots per experiment cover the first 8 variables from Table 4, and the second batch of 8 plots per experiment cover variables 9-16. [12]

	Variable	BaseRun	Exp. 1	Exp. 2	Exp. 5	Exp. 6
1	Psubsloc/PS (%)	14.60	+5.70	-1.20	+0.50	-0.41
2	PsubsN/PS (%)	40.09	-4.23	-1.11	+0.89	+0.24
3	PluxS/PS (%)	45.31	-1.48	+2.32	-1.40	+0.16
4	Npartners	2.30	-8.66	+1.86	+9.86	+0.76
5	profitsNbas	0.24	-33.28	+11.04	+14.47	+1.25
6	profitsNlux	0.30	+1.59	+0.83	+3.19	+8.32
7	profitsNtot	0.54	-14.05	+5.41	+8.25	+5.15
8	profitsNbas/ profitsNtot (%)	44.85	-10.035	+2.40	+2.58	-1.66
9	profitsNtot/ fdispincN (%)	34.84	-3.45	+0.96	+0.80	-0.43
10	fdispincN/ fdispincS	4.14	-26.61	+2.59	-12.54	+6.45
11	ToT (pN/pS)	1.35	+0.46	+1.08	+4.53	-2.59
12	UN	2.14-2.76	-4.86	+1.91	+3.03	+8.22
13	US	0.52-0.68	+29.63	-0.66	+17.81	+1.66
14	UN/US	4.14	-26.61	+2.59	-12.54	+6.45
15	A	5.00-11.79	0.00	0.00	0.00	0.00
16	(A-B)/A (%)	80.00	0.00	0.00	0.00	0.00

Table 4. Outcomes by Experiment: % Differences between Steady States

[12] Plots are shown from left to right continuing on the next line of plots.

Results Base Run

The base run results indicate that, for the base run parameterization, subsistence goods production is an important source of profits for the North. In addition, it is an important source of employment for the South. It should be noted that there are 2.3 partners in this case, which is actually larger than the total population of the South. This is because the average population size of a country equals 0.5, since we have assumed that the density of Southern countries in each point within the dotted rectangle in Figure 2 equals 1. Hence, the number of Southern countries is necessarily larger than the Southern population. Because the North produces a much wider spectrum of luxuries than the South, its free disposable income is much larger than in the South, also because profits amount to about one third of free disposable income in the North. The terms of trade are very favorable for the North, and so is the distribution of utility between the North and the South. Note that in the 10 'year' simulation period, the total number of luxury goods more than doubles. However, the share of Northern luxury goods in total luxury goods remains constant at 80 percent.

Results Experiment 1: a 10% productivity rise in local subsistence goods productivity

Such a productivity rise lowers Southern prices for subsistence goods q, and therefore also lowers prices for the basic goods produced by the North. The marginal Southern countries now yield lower profit, turning them in fact extra-marginal. Consequently the number of Southern partner countries is reduced by almost 9 percent. This forces those Southern countries to move their subsistence production labor from Northern subsistence production technologies into local subsistence technologies, which leads therefore to a fall in subsistence labour productivity on that account (Northern technology still outperforms the improved Southern subsistence technology). However, as the local subsistence technology itself has increased in productivity, the overall productivity effect is positive, leading to more Southern labor resources being available for luxury goods production, and hence to a (slight) fall in the terms of trade for the South. Nonetheless, the overall effect on Southern utility is very positive, because free disposable income for the South rises significantly.[13]

[13] It should be noted that because we have aggregated over partner countries, some of the differential country results go unnoticed. For example, if an extra-marginal Southern country would become a partner country, the real income effect of such a change would be much bigger for a small country than

Results Experiment 2: a 10% productivity rise in Northern subsistence goods productivity

The results for this experiment. experiment, except for the change in employment in Northern subsistence technologies. Even though the number of partner countries increases (because the productivity increase of the Northern technology raises profits on Northern subsistence goods production, *ceteris paribus*, turning some of the previously non-partner countries into partners), the 10 % productivity increase reduces the overall labor requirements in Northern subsistence goods production. With more partner countries and higher Northern subsistence goods productivity, there is now 'spare' Southern labor that can be used to increase the production of luxury goods. This however, leads to a deterioration of the terms of trade for the South to such an extent that total utility actually falls for the South, albeit only slightly. For the North, the effects are all positive.

Results Experiment 3: a 10 % increase in the rate of innovation in the North

The results of this experiment are shown in Figures 4.A and 4.B below. The results are very much as expected, as they closely resemble the ones obtained by Krugman: a higher rate of innovation increases the relative scarcity of Northern luxury goods per variety, and hence raises the terms of trade, and also Northern wages. This reduces the number of Southern partner countries, and forces the South to move labor into local subsistence production. The effect is a lower supply of Southern luxury goods, which limits the rise in the terms of trade for the North to some extent. Free disposable income for the South falls, but utility for the South – perhaps somewhat surprisingly – does not. The reason is that utility per dollar spent has risen through the love of variety effect (further called the 'LOV-effect'), which is associated with an expansion of the total number of luxury goods. In this case the LOV-effect is so strong that it more than compensates the negative effects on utility of the drop in free disposable income. The conclusion that the overall utility effect is positive both for the North and the South therefore crucially hinges on the relative strength of the LOV-effect.

for a large country, as in the latter case part of subsistence production still uses old, relatively labour intensive, local production technology.

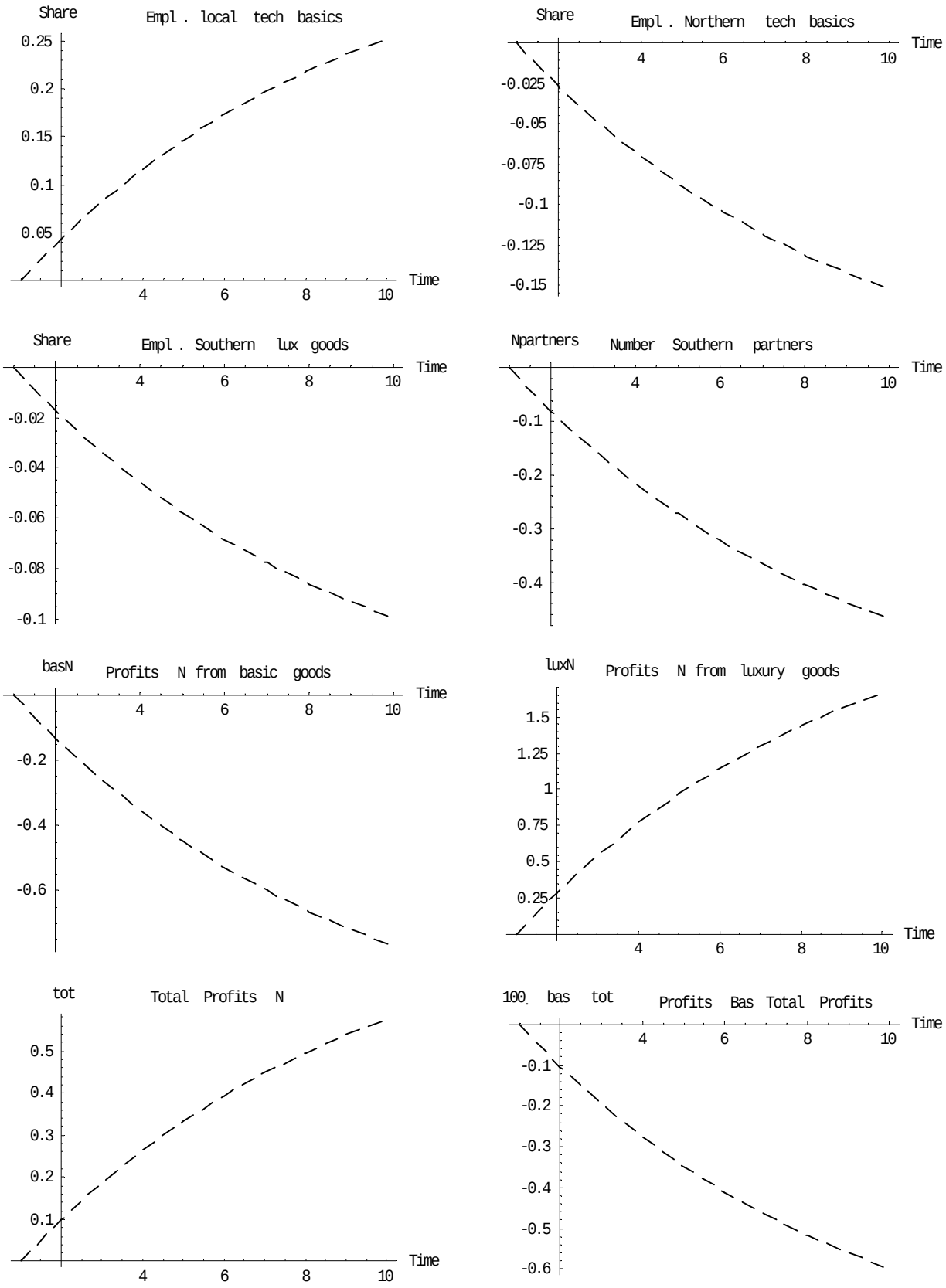


Figure 4.A Experiment 3: Rate of Innovation + 10 %, Plots I-VIII

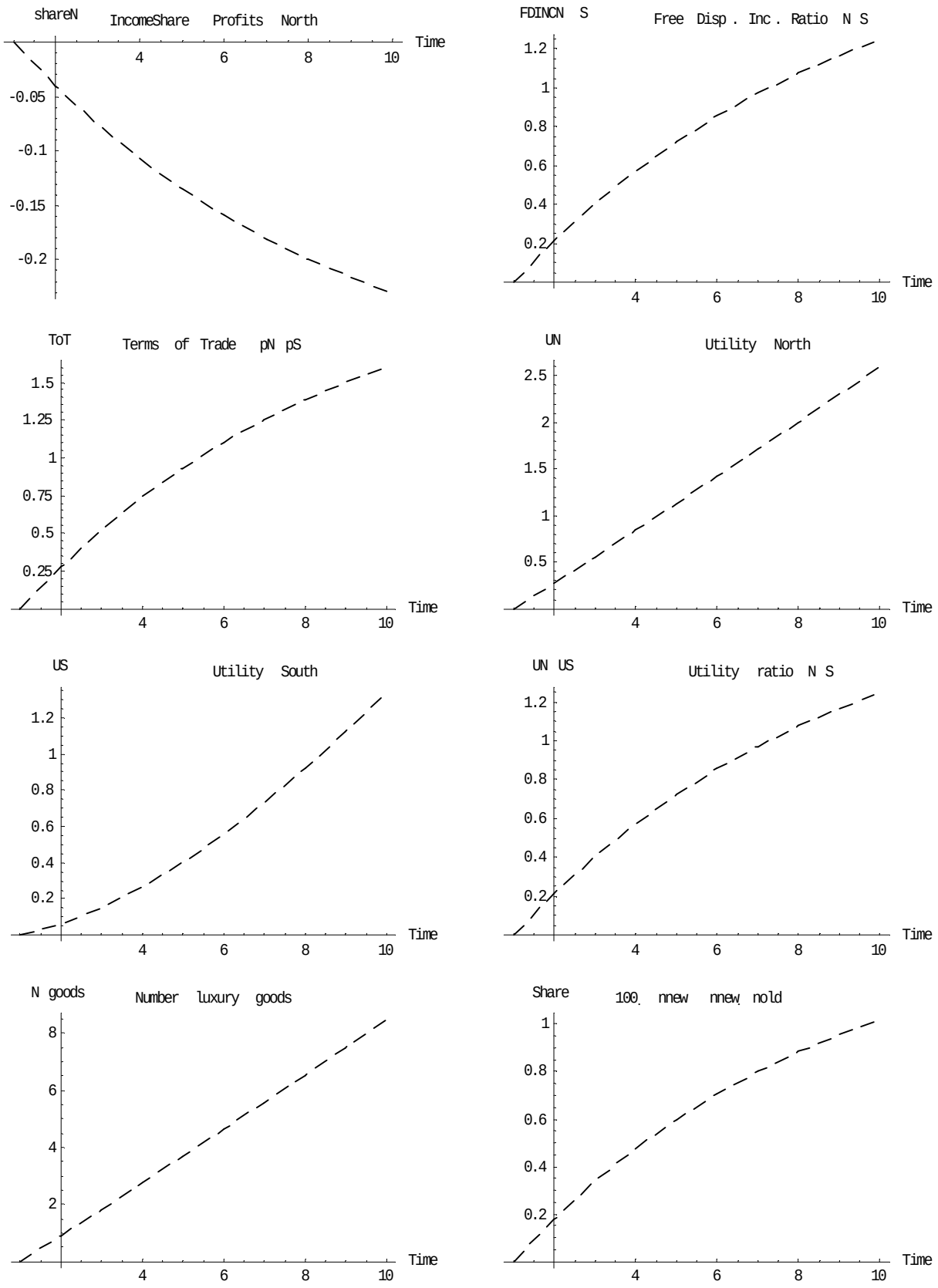


Figure 4.B Experiment 3: Rate of Innovation + 10 %, Plots IX-XVI

Results Experiment 4: a 10% increase in the rate of imitation in the South

Like the increase in the rate of Northern innovation, an increase in the rate with which the South imitates Northern luxury good varieties leads to out-of-steady state dynamics, which drive the evolution of all variables.

Compared with the base run, the share of luxury goods produced in the South rises somewhat over time. As the share of luxury goods produced in the South rises, the volume produced of each of these goods falls. This, in turn, raises the relative price of old luxury goods, which represents a terms of trade benefit for the South. With the relative price (and therefore the profitability) of Northern varieties thus diminished, Northern labor moves from the production of luxury goods in the North into subsistence goods production in the South. Utility in the South therefore rises not only because of the initial change in the terms-of-trade, but also due to an income effect associated with a more intensive use of the more efficient Northern technology in subsistence good production.

This experiment offers a theoretical explanation for the empirically observed move of multinationals into subsistence goods in recent years. According to the current experiment, this move could be the endogenous response of Northern firms to increasing imitation by Southern firms. Hence, greater involvement of the North in Southern subsistence goods production does not necessarily arise because the benefits from entering Southern markets have become greater over time, but because the opportunity costs in terms of luxury good production foregone have dwindled.

Finally, it should be noted that this development is a net benefit for both North and South. That is, the North gains despite the loss of some monopolies and the associated rents and its terms of trade loss. The reason is the higher total volume of old luxury goods produced, enabled by the more efficient production of subsistence goods, releases labor from inefficient local production in the South. Because the labor thus released is used in old luxury goods production, the negative terms of trade effects of increased imitation for the North are mitigated to such an extent, that both the North and the South may actually gain in utility terms, albeit only very slightly for the North and in a much more outspoken manner for the South.

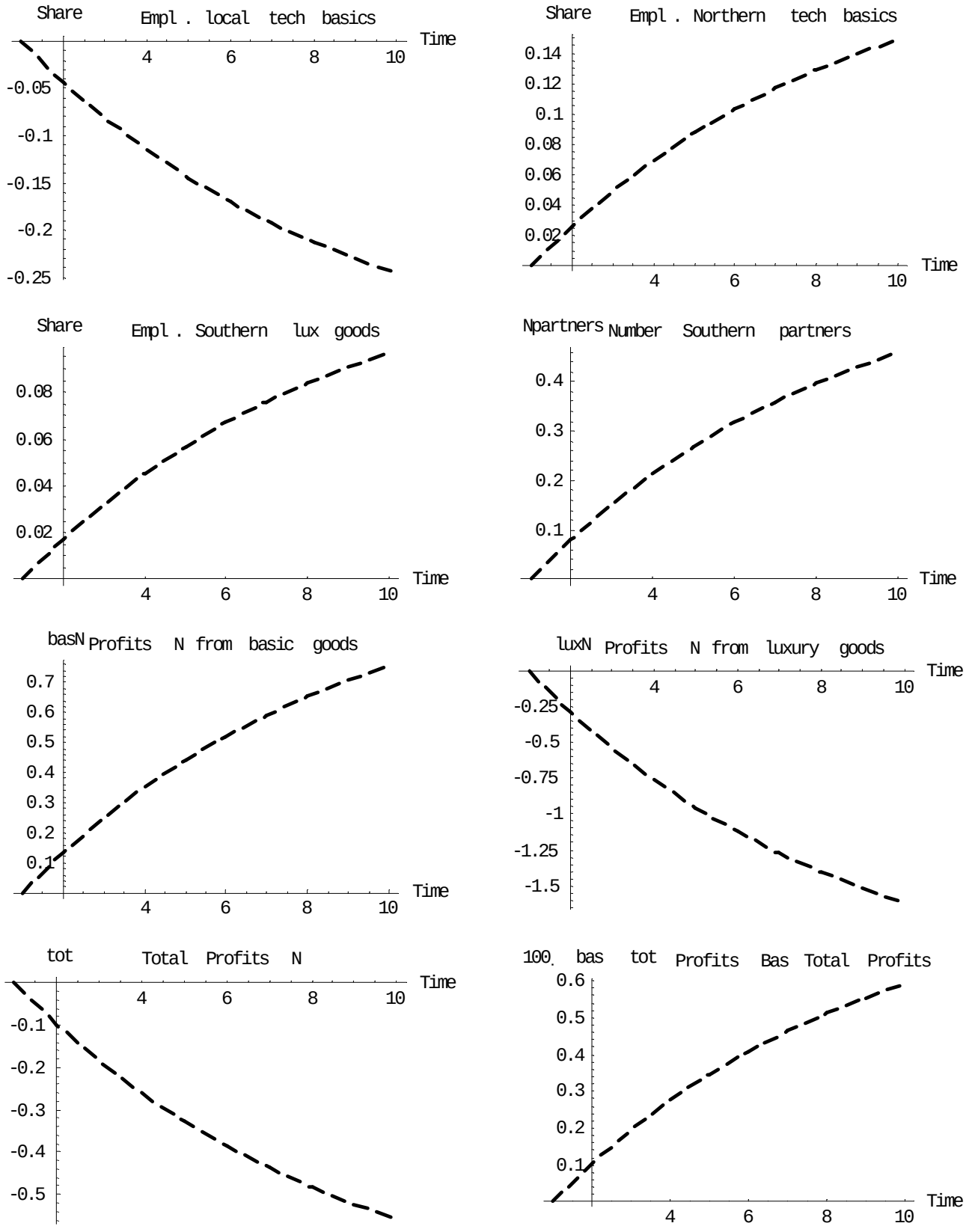


Figure 5.A Experiment 4: Rate of Imitation + 10 %, Plots I-VIII

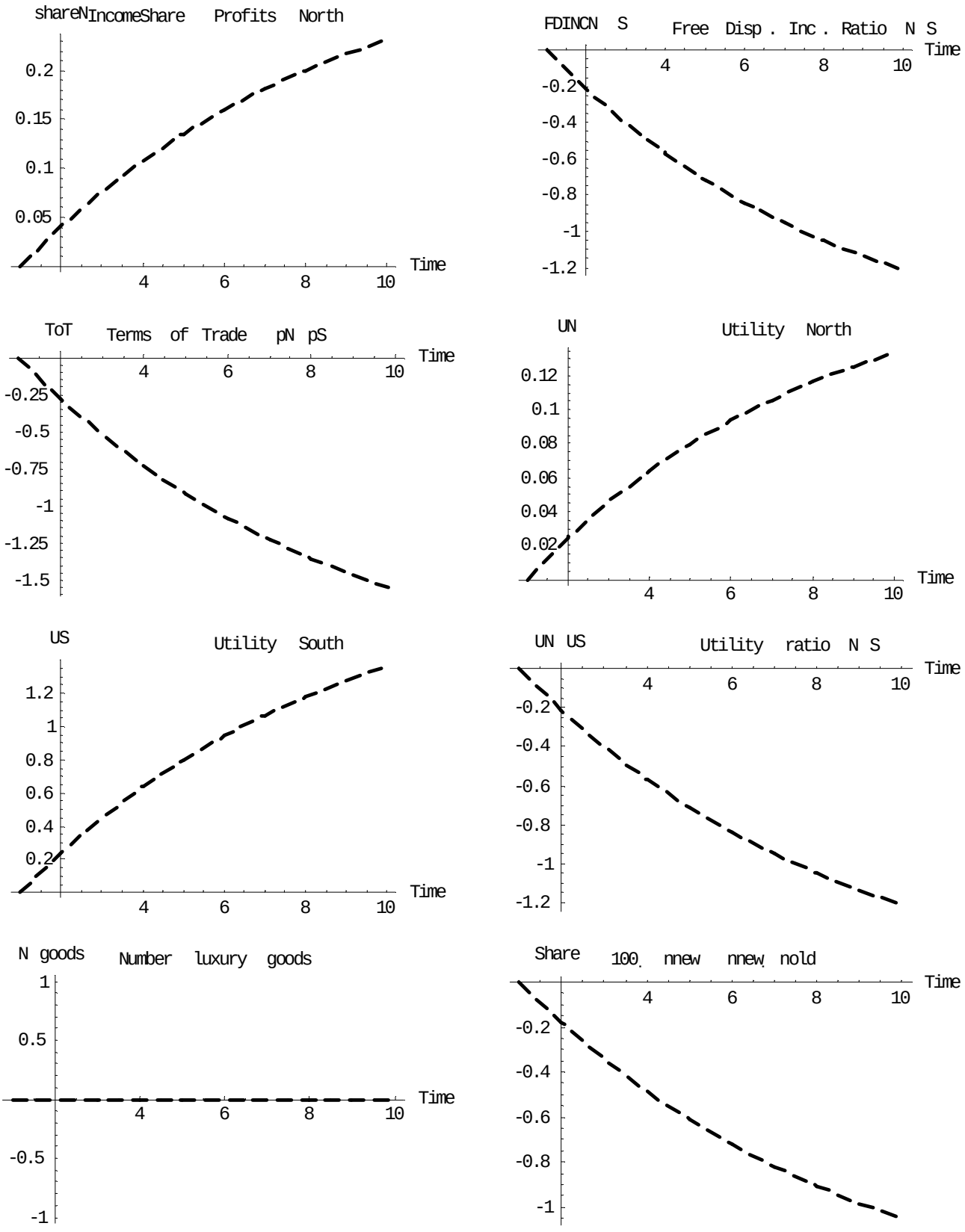


Figure 5.B Experiment 4: Rate of Imitation + 10 %, Plots IX-XVI

Results Experiment 5: a 10 % increase of the population in the South

Contrary to expectations perhaps, this has a positive effect on utility both in the North and in the South, and more so in the South. Utility per head in the South rises by almost 8 percent (17.8 percent rise in total utility less 10 percent rise in the number of heads), even though the terms of trade go against the South, as expected. The reason is that the number of Southern partner countries increases by almost 10 percent. Total profits from Northern subsistence goods production increase considerably, but the North now earns less in actual Northern luxury goods production, leading to a fall in the free disposable income ratio for the North and the South. However, for both the North and the South, total utility rises relative to the base run, which is indicative of a rise in free disposable income in the North and the South, because in this experiment there is no additional LOV-effect to take into account, as the rates of imitation and innovation are unaffected. We conclude that an increase in the size of the population in the South, invokes partnerships reactions by the North that increases average labor productivity in the South, that in this case outweigh the negative terms of trade effects for the South.

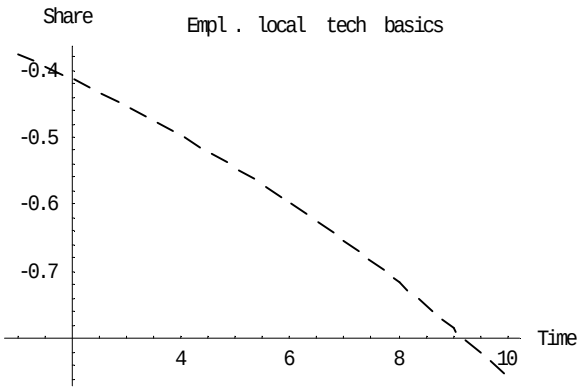
Results Experiment 6: a 10 % increase of the population in the North

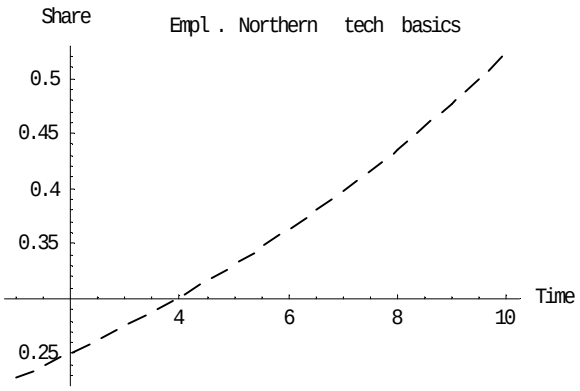
A 10 percent increase in the size of the workforce in the North has negative terms of trade effects for the North, and decreases Northern wages in the process. This creates an incentive to move into Southern subsistence goods production and to increase the number of partners in the South. Total profits for the North increase, but free disposable income for the North increases by more than that, since the share of profits in free disposable income slightly falls. In the North, utility per head falls slightly. In the South utility per head rises roughly by as much as utility per head in the North falls. This is due to the positive terms of trade effect for the South, but also because average labor productivity in the South has risen somewhat due to an increased activity of the North in Southern subsistence goods production.

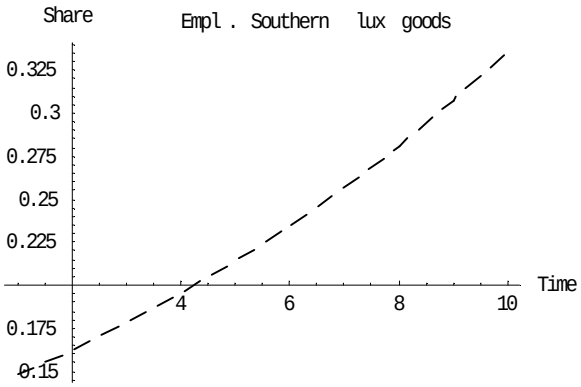
Results Experiment 7: Decreasing Returns to Variety

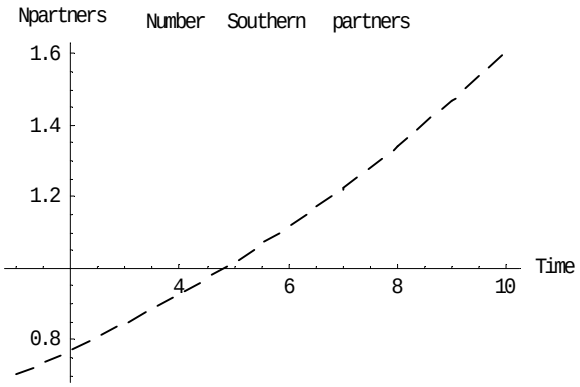
In this experiment we make the weight of the marginal variety in the utility function decay with rate γ as the number of varieties increases due to innovation. Since the North produces the latest luxury goods varieties, one can interpret this as demand becoming ever more biased in the direction of Southern varieties, because the newest Northern varieties contribute less and less to utility. Contrary to the other (non-innovation) experiments, one sees that the deviations from the base-run have a tendency to grow bigger over time in absolute terms, except for the innovation and imitation related variables, that exogenously evolve over time. The reason is that we now have a variable, i.e. the marginal contribution to utility of the newest luxury good, hat falls continuously over time. This will reduce the weight of the entire spectrum of Northern luxury goods in total utility, and hence will continuously reduce the demand for Northern varieties over time.

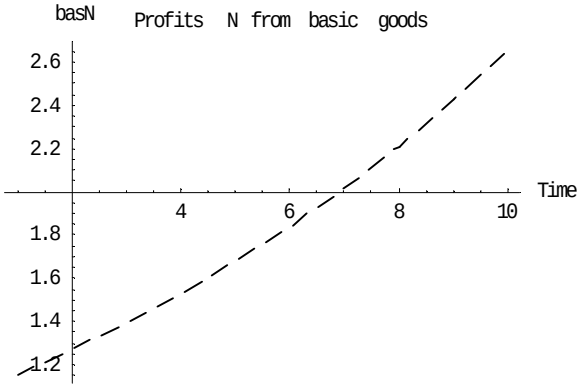
Comparing the Figures of experiments 3 and 7, one can immediately see that they present qualitatively opposite results: positive deviations relative to the base run in experiment 3 correspond with negative deviations in experiment 7, and the other way around. This is only natural, as in experiment 3 Northern relative supply conditions per variety became tighter due to the increase in the size of the Northern luxury goods spectrum, whereas in experiment 7, demand per variety of the Northern goods spectrum now falls. Consequently, Northern wages fall, and there is an incentive for the North to engage ever more intensively in Southern subsistence goods production. Both for the North and the South, the decreasing returns to variety results in lower utility but more so for the North as the ratio of Northern and Southern utility falls.


Share
Empl . local tech basics
-0.4
-0.5
-0.6
-0.7
Time
4
6
8
10

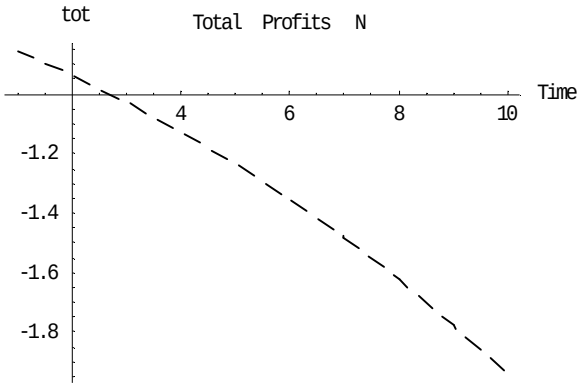

Share
Empl . Northern tech basics
0.5
0.45
0.4
0.35
0.25
Time
4
6
8
10


Share
Empl . Southern lux goods
0.325
0.3
0.275
0.25
0.225
0.175
0.15
Time
4
6
8
10


Npartners
Number Southern partners
1.6
1.4
1.2
0.8
Time
4
6
8
10


basN
Profits N from basic goods
2.6
2.4
2.2
1.8
1.6
1.4
1.2
Time
4
6
8
10


luxN
Profits N from luxury goods
-2.5
-3
-3.5
-4
-4.5
-5.5
Time
4
6
8
10


tot
Total Profits N
Time
4
6
8
10
-1.2
-1.4
-1.6
-1.8

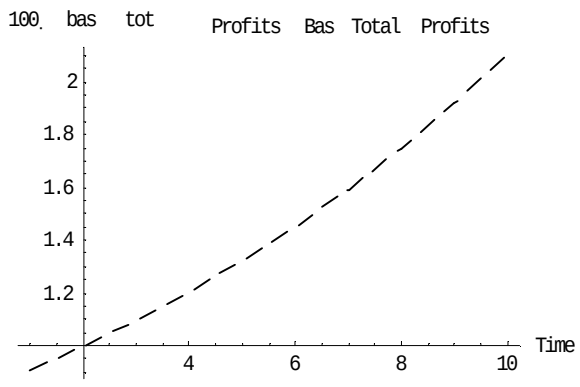

100. bas tot
Profits Bas Total Profits
2
1.8
1.6
1.4
1.2
Time
4
6
8
10

Figure 6.A Experiment 7: Decreasing Returns to Variety, Plots I-VIII

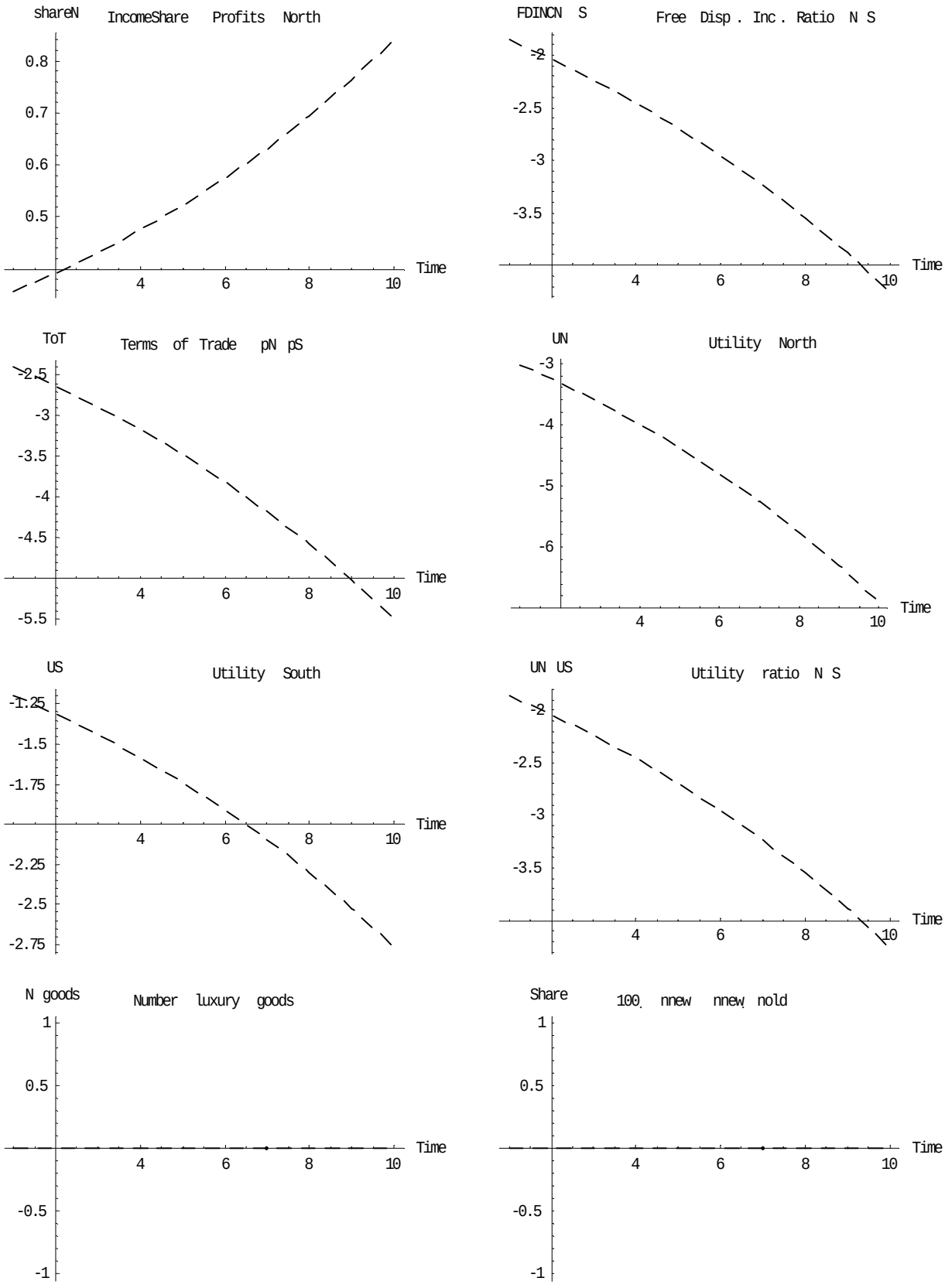


Figure 6.B Experiment 7: Decreasing Returns to Variety, Plots IX-XVI

4. Concluding Remarks

In this paper we have presented an extension of Krugman's (1979) North-South model by including subsistence goods production in the South next to matured luxury goods production in the South and 'new' luxury goods production in the North. Subsistence goods can be produced in the South using either a relatively efficient Northern technology that requires a fixed amount of Northern high-skilled management input, or using less efficient Southern local technologies. The North therefore produces subsistence goods under increasing returns to scale. We assume that the profitability of the North in subsistence goods production depends non-linearly on the cost of reaching the local market. We also assume that Southern countries differ with respect to both the size of their population and the internal connectedness of their markets. Under these circumstances, we are able to determine which set of Southern countries would be profitable partners for the North to engage in subsistence good production. We distinguish between small partner countries and large partner countries. Small countries are so small that their entire population is smaller than the size of the population that would be targeted by a profit maximizing Northern subsistence goods supplier. Hence, in small countries marginal profit opportunities are left unused. In large countries, all positive marginal profit opportunities are exhausted at a level of the targeted population that is below the actual population size of the country. This implies that it is profitable for a Northern firm to leave part of the local population un-serviced.

We have assumed that the North repatriates the rents arising from those subsistence goods production activities from the South to the North. For the Southern partners, however, there is a productivity effect that they can benefit from, in the sense that using the more efficient Northern subsistence goods production techniques instead of the less efficient local techniques, frees labor resources that can now be used to produce the tradable 'old' luxury goods. Thus the South has more to trade on the world-market, but suffers a negative terms of trade effect in the process, in combination with a positive real income effect. Whether the overall effect on utility is positive, depends on the specific situation on hand, as we show in a number of parameter sensitivity experiments.

Based on these experiments, we can draw a number of conclusions. The first one is that the reactions of the model to changes in the rate of innovation work in qualitatively the same way as in the Krugman (1979) model. A wider spectrum of Northern luxury goods, in

combination with the existence of latent demand for these goods, increases the scarcity of each individual Northern variety, and presents a negative terms of trade effect for the South. However, in this case the situation is even worse for the South, because the rise in Northern wages that this entails, makes it less worthwhile for the North to engage in subsistence goods production in the marginal Southern partner countries (the Southern countries currently yielding zero profits). Thus, the marginal Southern partners become extra-marginal (i.e. non-partners effectively), and are forced to redirect part of their labour resources into relatively inefficient subsistence goods production again. This reduces their ability to supply old tradable luxury goods to the world-market, which represents a real negative (free disposable) income effect. There is also a countervailing terms of trade effect, that is positive from the point of view of the South, but the effect is not strong enough so to compensate the negative income effect.

The second conclusion is that changes in the productivity of the North and of the South in subsistence goods production work out favorably for the region that owns the technology whose productivity has increased, but unfavorably for the other region. This suggests that Northern productivity increases in subsistence goods production may not be the best way to improve utility in the South. Obviously, if the North and the South would engage in rent-sharing, the situation might change in favor of Northern productivity increases, but at this stage we haven't looked more closely into this matter yet.

The third conclusion is that increases in the rate of innovation unambiguously raise utility for both parties. However, the number of partner countries for the North decreases, leading to a fall in average productivity for the South, and hence to lower real free disposable income, also because there is a negative terms of trade effect from the point of view of the South. Nonetheless, utility for the South rises absolutely, due to the LOV-effect. This result, even though implied by the model structure, seems somewhat hard to believe. As free disposable income in the South is far lower than in the North, one would expect the LOV-effect there to be potentially less important than in the North, suggesting a further extension of the decreasing returns to variety model, by making the marginal contribution coefficient of each variety in the utility function dependent on free disposable income per head *and* the variety index, rather than on the variety index alone. Stated differently, one could imagine that for countries with a low free disposable income per head, the contribution to utility of

the newest varieties are lower than for countries with a higher value of income per head. At this stage, we must leave this for future research, however.

The fourth conclusion is that the move of Western companies into Southern subsistence goods market may actually be regarded as a natural by-product of the successful imitation efforts by the South. Our experiment with an increase in the rate of imitation shows that this reduces the terms of trade for the North and consequently lowers the opportunity cost of Northern high-skilled workers in terms of the profits on Northern luxury goods production foregone. In these circumstances, entering Southern subsistence markets becomes a more profitable business opportunity for the North.

The fifth conclusion is that changes in population sizes in both the North and in the South provide an incentive for the North to intensify its subsistence goods production in the South by seeking more Southern subsistence goods production partners. In terms of utility per head, the South would actually benefit from having a higher population, as that raises the incentive for the North to increase the number of subsistence production partners in the South and raise aggregate Southern productivity in the process. By contrast, a rise in the Northern population leads to a slightly lower rise in Northern utility, and hence to a slight fall in utility per head. Conversely, a fall in the size of the Northern population would raise utility per head.

The sixth conclusion is that the satiation of demand for the newest luxury goods, as we have modeled in experiment 6, leads to a continuously falling terms of trade for the North, and an increasing incentive for the North to move into Southern subsistence goods production. This has positive real productivity effects for the South, which, furthermore, is accompanied by a positive terms of trade effects for the South.

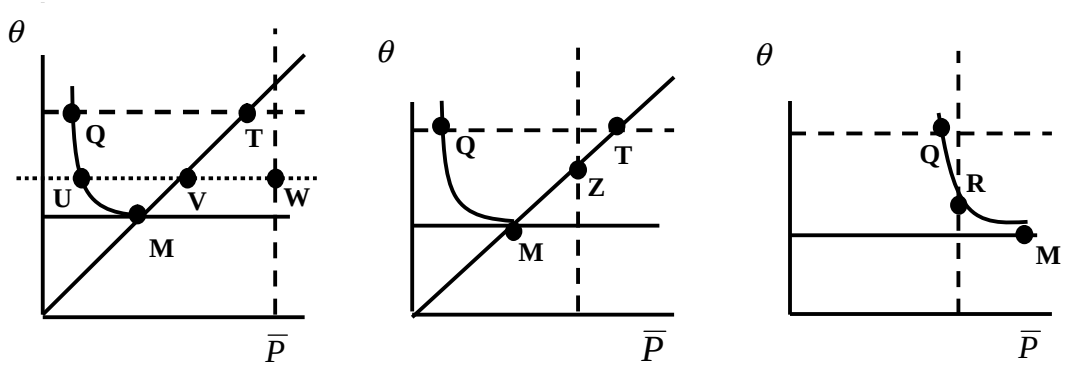
Appendix A. Aggregation over Southern Countries

This appendix describes the outcomes of various aggregations over groups of Southern countries. These aggregations are necessary in order to be able to determine:

1. the total demand for high-skilled labor associated with subsistence goods production in Southern countries;
2. the demand for low-skilled labor associated with subsistence goods production in Southern countries;
3. the profit flows associated with subsistence goods production in Southern countries.

In order to be able to do this, the distinction between large and small countries is important again. For small countries, the population size determines the size of the profitable subsistence market for Northern firms, whereas this is not the case for large countries. The same applies therefore to the demand for labor in as far as it is associated with subsistence goods production. This holds both for high-skilled management labor, as well as low-skilled production labor. Finally, the net operating surplus depends on the combination of characteristics of a country. Hence, aggregation over all profits earned by Northern firms in Southern subsistence markets allows us to obtain the income flows as they arise out of subsistence goods production.

In order to be able to perform the aggregations mentioned above, it is helpful to present the three situations that can arise in the model for which the set of partner countries is non-empty again (see Figure 3 in the main text):



Situation II Situation III Situation IV

We summarize the requirements for each situation in the table below:

	P(Q)	P(M)	P(T)
Situation II	$P(Q) < \overline{P}^{\max}$	$\overline{P}(M) < \overline{P}^{\max}$	$\overline{P}(T) < \overline{P}$
Situation III	$P(Q) < \overline{P}^{\max}$	$\overline{P}(M) < \overline{P}^{\max}$	
Situation IV	$P(Q) < \overline{P}^{\max}$	$\overline{P}(M) \geq \overline{P}^{\max}$	

Recalling that the vertical dotted line and the horizontal dotted line are defined by $\overline{P} = \overline{P}^{\max}$ and $\theta = \theta^{\max}$, respectively, the number of Southern countries in which Northern firms are engaged in subsistence production can be obtained as follows. For situation 2, draw a horizontal line somewhere between points Q and M. This line will intersect with the convex curve connecting points Q and M at a point further called U, as well as the straight line connecting points M and T at a point further called V but also the vertical dotted line at a point further called W. Obviously, the length of the line-segment connecting points U and V, further called UV, depends on the vertical position of that line-segment, i.e. on θ. Hence, the area associated with the small partner countries is the integral over all line-segments UV with a θ in the interval $\theta(M)..\theta(Q)$. Thus, for the number of small Southern partner countries in situation II, we would find that:

$$P^S = \int_{\theta(M)}^{\theta(Q)} \int_{\overline{P}(U(\theta))}^{\overline{P}(V(\theta))} 1 \, d\overline{P} \, d\theta \qquad \text{(A.1)}$$

where 1 is the frequency of Southern countries in each point of the area enclosed by the vertical and horizontal dotted lines, as before. For the number of large partner countries, we would find analogously:

$$P^L = \int_{\theta(M)}^{\theta(Q)} \int_{\overline{P}(V(\theta))}^{\overline{P}(W(\theta))} 1 \, d\overline{P} \, d\theta \qquad \text{(A.2)}$$

Note that for situations III and IV, a similar procedure can be followed, but the integration boundaries need to be adjusted somewhat. This is straightforward and therefore not shown here.

As regards the supply of labour available for matured luxury goods production, we need to distinguish again between large and small countries. For a small country, for example, and using the assumption that $v^S<1$, we must have that the total amount of low-skilled labour not used in subsistence goods production is equal to:

$$\overline{P}^{NS} = \overline{P} - v^N \cdot P^* - v^S \cdot (\overline{P} - P^*) = \overline{P} \cdot (1 - v^S) + (v^S - v^N) \cdot P^* \qquad \text{(A.3)}$$

Equation (A.3) has several interesting features. First, if $v^S>v^N$ as we assume, then Northern subsistence goods production in a Southern country does indeed free resources that become available for matured luxury goods production. Secondly, the larger the Northern subsistence goods market P^*, the more resources will be freed. Finally, lowering v^S will help free resources only in case the Southern country is big, since for small countries we have that $P^* = \overline{P}$ if $v^S < 1$, as we have assumed it to be the case and (A.3) reduces to:

$$\overline{P}^{NS} = \overline{P} \cdot (1 - v^N) \qquad \text{(A.4)}$$

Equation (A.4) reflects the notion that all subsistence goods production in a small Southern country is taken over by Northern producers, by the definition of a small country. Hence, in situation 2, we would find that the total supply of low-skilled labour in small Southern countries, i.e. L^S, that is available for matured luxury good production must in that case be given by:

$$L^S = \int_{\theta(M)}^{\theta(Q)} \int_{\overline{P}(U(\theta))}^{\overline{P}(V(\theta))} \overline{P} \cdot (1 - v^N)\, d\overline{P} d\theta \qquad \text{(A.5)}$$

For a large country, (A.4) does not hold. Instead, we would have to substitute the definition of S* from Table 1 into (A.3) , in which case we would find for low-skilled labour supply in large Southern countries, i.e. L^L , that:

$$L^L = \int_{\theta(M)}^{\theta(Q)} \int_{\overline{P}(V(\theta))}^{\overline{P}(W(\theta))} \{\overline{P} \cdot (1 - v^S) + (v^S - v^N) \cdot \theta \cdot \phi\} \, d\overline{P} d\theta \qquad \text{(A.6)}$$

Finally, total profits from subsistence goods production can be obtained as follows. The net operating surplus per active firm in each country will be given by equation (8), where one should realize that the net operating surplus, i.e. $\overline{g}$, is a function of θ for large countries and of θ and $\overline{P}$ for small countries, as apparent from Table 1. Thus we get for total profits obtained from subsistence goods production in small Southern countries, i.e. Π^S:

$$\Pi^S = \int_{\theta(M)}^{\theta(Q)} \int_{\overline{P}(U(\theta))}^{\overline{P}(V(\theta))} \{\overline{P} \cdot w \cdot \phi - \frac{\overline{P}^2 \cdot w}{2 \cdot \theta} - w^N \cdot \overline{h}\} \, d\overline{P} d\theta \qquad \text{(A.7)}$$

For large Southern countries we obtain, by analogy:

$$\Pi^L = \int_{\theta(M)}^{\theta(Q)} \int_{\overline{P}(V(\theta))}^{\overline{P}(W(\theta))} \{\frac{1}{2} \cdot w \cdot \phi^2 \cdot \theta - w^N \cdot \overline{h}\} \, d\overline{P} d\theta \qquad \text{(A.8)}$$

Using the principles outlined above, we first have to obtain the expressions for the points U,V and W, before we can actually evaluate all the integrals. Since these expressions are relatively complicated for the small country case, the integrals themselves become relatively unintelligible. Hence we do not report them here. For the simulations we have performed, we have evaluated these integrals numerically as part of the numerical simulation of the entire model, using the Mathematica programming package.

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