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TERMS OF TRADE AND DOMESTIC DISTRIBUTION

Export-Led Growth with Abundant Labour

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A general equilibrium macro model is constructed to explore effects of export-led growth policies on the terms of trade and the domestic distribution of a developing region with abundant labour. This region, the South, trades with another, the North; they have different technologies and supplies of factors. It is shown that under certain conditions of dualism in the production of goods and of abundant labour supply in the South, an increase in the volume of exports from the South may bring about a sustained worsening of the South's terms of trade with the North even if this increase in exports is due to a positive shift in demand from the North. This change in the terms of trade is accompanied by a sustained loss of purchasing power of wages within the South. These results take place in a Walrasian stable market. When technologies are more homogeneous and labour less abundant, the results are reversed: increased exports will take place together with improvements in terms of trade and a tendency to equalise factor prices between the regions. The results argue for coordination of domestic and international policies with special attention to technologies and labour markets.

1. Introduction

The objective of this paper is to study relationships between domestic distribution and terms of trade in the context of export-led growth policies. The model compares successive general equilibria of a two-region, i.e., North–South, economy in which the volume of exports from the South increases.

Each economy consumes and produces basic consumption goods and luxury or investment goods, using two factors of production, labour and

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capital. Both goods are traded. The South exports basic goods, and the North luxury/investment goods.

The economy of the South is characterized by abundant labour, (i.e., supply of labour is very responsive to the real wage)[1] and duality in production. Due to this characterisation, it is proven that the reaction curve of the South, relating the price and the volume of exports of basic goods across equilibria, is negatively sloped.[2] With more homogeneous technologies or less responsive supply of labour, this price/quantity relation is, instead, positive. These two cases are shown to yield contrasting implications for the changes in terms of trade and factor prices that take place with export-led policies.

The behaviour of the economy of the South that is summarised in the downward sloping price/quantity relation across equilibria has rather striking implications for export policies. An increase in exports will in this case necessarily worsen the terms of trade of the South and reduce its domestic employment and consumption, and increase the inequality of the factor prices across the regions. These effects are accentuated with increases in the volume of exports of the South, even if the rise in exports is produced by a positive shift in demand from the North. Increases in investment demand within the South also reinforce these negative outcomes.

The worsening of terms of trade as export volumes increase, is derived from the negative slope of the price/quantity reaction function of the South across equilibria. The effects on wages and employment are responses of the domestic equilibria of the South as the international equilibrium prices change. This particular behaviour of the reaction function of the South with duality and abundant labour can be explained as follows.

An increase in the price of basic goods in a new equilibrium is consistent with increases of domestic output of this good. However, with a dual technology and abundant labour this price increase is also shown to increase domestic demand relatively more, due to the income effects of increased output and employment. Hence excess demand for the basic good rises as the price increases. Thus if the level of exports of the basic goods has increased at the new equilibrium, the new relative price of these goods must necessarily decrease. Furthermore, in the new equilibrium, employment and

[1]Due, for instance, to rural–urban migration or population growth. While our assumption is clearly related to that of A. Lewis in his model of development with unlimited labour supply, our model differs from Lewis's in a number of ways, which are discussed later in the paper.

[2]The curve relating prices and quantities of exportables in this model is a general equilibrium response of the economy of the South; it is not a supply curve as studied in partial equilibrium analysis production theory. The fact that this equilibrium curve of the South is negatively sloped does not imply that the model is Walrasian unstable; this is discussed in the appendix. Broome (1978) also studied in the general equilibrium context how an increase in the demand for a product may cause a decrease in its price even under conditions of perfect competition and constant returns to scale; his result is given in a different model, and it is due to different causes than ours.

domestic wages will decrease, and wages will also decrease in relation to the price of the basic good in the South, thus reducing their purchasing power.

These results are reversed when the price/quantity reaction curve of exports of the South is upward sloping. In this latter case at a new equilibrium with increased exports, the price of the basic goods is higher, and so are real wages and employment. However, when labour is abundant and the production structure dualistic, this latter case is not likely to arise; it will be replaced by the downward sloping price/quantity relation. Therefore, for some parameter values this model encompasses the neoclassical results on welfare gains and factor price equalising effects of trade; for others, it yields results running counter to these. The study of the range of parameters under which one or the other case arises, is obviously relevant for policy.

Sections 2 and 3 study the workings of the effects of export-led policies both in a dual economy with abundant labour and in a more homogeneous economy where labour is less abundant. Section 4 discusses the relationship of the results to previous development and trade literature. Section 5 presents the conclusions. The appendix has a numerical example of the model with exemplifies the results using stylised data based on Brazil and the U.K., and discusses the stability properties of the model and the local uniqueness of solutions.

2. Specification of the macro model

The model presented in this paper is a two-good, two-factor, two-region general equilibrium model with special features, in which markets for goods and factors interact and are cleared in equilibrium, and Walras Law is satisfied.

The two goods represent basic consumption goods, denoted B, and luxury/capital goods, denoted I; the factors of productions are capital (K) and labour (L). The two regions represent the North and the South.

In each region we assume the technology has fixed coefficients production functions for both goods:

$$B = \min (L^B/a_1, K^B/c_1), \tag{1}$$

$$I = \min (L^I/a_2, K^I/c_2). \tag{2}$$

The technical coefficients will in general be different in each region; however, in both regions they satisfy $a_1c_2 - a_2c_1 > 0$, indicating that basic goods are always more labour intensive than luxury/investment goods.

This particular form of the production functions is not crucial to the results, but it simplifies the computations; the results obtained require only a relatively low elasticity of substitution between factors.

The North is assumed to have factor proportions that are consistent with a more homogeneous economy. In the South, however, the capital–labour ratios in the two sectors are rather different. This property of the production technology in the South is here called *dualism*; it is formalised by a significantly larger value of the determinant of the matrix of technical coefficients ($D=a_1c_2-a_2c_1$) in the South than in the North. Each region produces and consumes both goods; the specifications of the technical coefficients, together with factor supply conditions, imply that in this model the South is a net exporter of basic goods, and the North of luxury/investment goods [see Clark, Cole and Lucas (1979)]. Greater labour intensity shows up consistently in exports of the South according to recent work by Krueger (1978).

Because of the above specification, there are four prices in this model: the price of the basic good, denoted p_B, the price of the luxury/investment good, denoted p_I, the rate of profit, or, more precisely, the quasi-rent on capital, r, and the wage, w.

In contrast to most two-good, two-factor trade models, here factor supplies are not fixed; they are instead increasing functions of factor rewards. For instance, labour supply is here an increasing function of the real wage which is represented for simplicity by the linear equation[3]

$$L=\alpha\frac{w}{p_B}+\bar{L}. \tag{3}$$

The high responsiveness of labour supply in the South is formalised by the specification that α is a large positive scalar. This responsiveness of labour supply to prices is an important determinant of the results, as will be seen in the next section.[4] The welfare and distributional properties of the most general class of general equilibrium models with variable endowments is reported in a later paper by Chichilnisky and Heal (1979) which confirms the results given here, and shows that they do not depend on the simplifying

[3]This linear labour supply function is used to simplify computations. The results also obtain if a supply function with a large elasticity of supply in the South is used instead and factor substitution is allowed. In (3) the constant $\bar{L}$ can be shown to be negative under certain conditions. For instance, if w/p_B is a minimum subsistence wage,

$$0=\alpha\left(\frac{\bar{w}}{p_B}\right)+\bar{L}, \qquad \bar{L}=-\alpha\left(\frac{\bar{w}}{p_B}\right)<0.$$

[4]While the condition that α be large is obviously not independent of the units of measurement of labour, in a two-country model the condition that one country's α is larger than the other's is, and this is all that is required. The same applies to the assumption of duality of technology, requiring that the determinant D of the matrix of technical coefficients be large. In the next section assumption (C.1) uses these two requirements on α and D to prove the main results. Since assumption (C.1) is shown to be independent of units of measurement, the results presented here are, too.

assumptions made here on technologies, number of goods and factors, and structure of demand.[5]

The supply of capital is given similarly by the equation

$$K=\frac{\beta r}{p_I}+\bar{K}. \tag{4}$$

In the South, K is in relatively more inelastic supply, and hence β is relatively small.

From the production functions (1) and (2), because of constant returns to scale, and fixed factor proportions we have the following associated price equations in each region, assuming that factors are efficiently used:

$$p_B=a_1 w+c_1 r p_I, \tag{5}$$

$$p_I=a_2 w+c_2 r p_I. \tag{6}$$

From (5) and (6) we therefore obtain a wage/price relationship

$$w=\frac{p_B c_2-c_1 p_I}{D}. \tag{7}$$

The corresponding relationship between the rate of profit and prices is

$$r=\frac{p_I a_1-p_B a_2}{D p_I}. \tag{8}$$

Since the technical coefficients in both regions are different, even in a world equilibrium (when the prices of both commodities traded are equalised) the equilibrium factor prices within the North and the South will remain different, as they are given by (7) and (8).

It follows that one cannot expect factor price equalisation in this model. However, one can study the relative movements of factor prices in each region as the volume of trade changes, and find out whether they have a tendency to equalise, or whether they diverge further.[6] For a given output of

[5]Trade models with one price responsive endowment have been studied by Pearce (1970), by Kemp (1964), and Kemp and Jones (1962).

[6]For instance, it can be shown that in a Heckscher–Ohlin model with different technologies in each region (and $D>0$ in each region) a move from isolation towards the trade equilibrium will in general increase the wage/profit ratio in the labour rich region and decrease it in the capital rich region, thus tending to equalise factor prices, even though it will never fully equalise them. The results given here will show that in this model under certain conditions a move towards equilibria with higher volumes of exports will unequalise factor prices between the two regions further. It should be noted, however, that here we do not study a move from isolation to equilibrium, but rather a move from one equilibrium to another.

goods B^S and I^S, from (1) and (2) one derives equations for the demand for labour and capital when factors are used efficiently,

$$L = L^B + L^I = B^S a_1 + I^S a_2, \tag{9}$$

$$K = K^B + K^I$$

$$= B^S c_1 + I^S c_2. \tag{10}$$

From eqs. (9) and (10) the following relationships between outputs of goods, and employment of factors obtain at the equilibria:

$$B^S = (c_2 L - a_2 K)/D, \tag{11}$$

$$I^S = (a_1 K - c_1 L)/D. \tag{12}$$

In contrast with other two good two factor two region models, here it is assumed that in each region the demand for the investment/luxury good I^D is exogenously given. As in the following I will be used as a numeraire ($p_I = 1$), this implies that in effect this demand is fixed in nominal terms; in real terms I^D is then a negatively sloped function of its price p_I. While this assumption is rather useful to simplify the computations, it is not essential to prove the main results; more general downward sloping demand curves for I can be postulated without changing the main features of the model.

A (temporary) general equilibrium of each economy in isolation is specified by a set of prices, wages, a quasi rent on capital and a corresponding level of outputs of goods and employment of factors, that equalise supply and demand in all markets for goods and factors of production. In equilibrium, when supply equals demand in both goods and factor markets, the budget balance (or Walras' Law) condition that total value of demand equals income is automatically satisfied:[7]

$$p_B B + p_I I = wL + rp_I K. \tag{13}$$

It can be seen that when a value of the parameter $\bar{I}^D$ is given, the equilibrium is completely specified for each economy in isolation.[8] In general there will

[7]The following shows that, at the equilibrium, Walras' Law (13) is always satisfied in this model:

$$\begin{aligned}\text{Total value of output} &= p_B B + p_I I = [\text{from eqs. (5) and (6)}]\\ &= (a_1 w + c_1 r p_I) B + (a_2 w + c_2 r p_I) I\\ &= w(a_1 B + a_2 I) + r p_I (c_1 B + c_2 I),\end{aligned}$$

which, from eqs. (9) and (10), in equilibrium $= wL + rp_I K$.

[8]From (12), (3), (4), (7) and (8) one obtains I as a function of the relative price of B only; this yields an equilibrium value for the relative price of B (see also the appendix). From this relative price one obtains w and r from (7) and (8), employment of factors from (3) and (4) and output levels from (11) and (12).

be two equilibria for each region for each value of $\bar{I}^D$, because the solutions describe a polynomial equation of degree two. This is discussed in the appendix.

Having completed the specification of the model for each region in isolation, we now specify the complete model, when both regions trade and reach a world market equilibrium.

In this case, all the above equations for the economy of each region hold except those defining the equilibrium. For instance, the clearance of markets must now include the traded values of B and I. In the South, at the trade equilibrium the supply of B must equal domestic demand plus net trade (exports) denoted X_B^S, i.e.,

$$B^D + X_B^S = B^S.$$

Similarly, for the market of I

$$I^D + X_I^S = I^S.$$

In a trade equilibrium

$$X_B^S = -X_B^N,$$

and

$$X_I^S = -X_I^N,$$

where X_B^N and X_I^N denote net trades by the North. Therefore, the new clearance of markets conditions in each region imply that world total demand equals world total supply in each market.

Walras Law (13) must now also be reinterpreted to take into account proceeds from exports and the income spent on imports, as follows.

Assume the prices p_B and p_I are international equilibrium prices. Then the revenues from exports of basic goods B, $p_B X_B^S$, must be added to income in the right-hand side of (13). The total use of luxury/investment goods in the left-hand side must now contain imports. Therefore eq. (13) now reads

$$p_B B + p_I(I + X_I^N) = wL + rp_I K + p_B X_B^S. \tag{14}$$

Since in a world equilibrium there must be a balance of payments $p_I X_I^N = p_B X_B^S$, (14) is actually identical to (13) in equilibrium.

Finally, note that at the international market equilibrium the balance of payments condition

$$p_B X_B^S = p_I X_I^N \tag{15}$$

always holds when in each region the corresponding budget equation

$$p_B B + p_I I = wL + rp_I K \tag{16}$$

is satisfied.[9]

As discussed above, the equilibrium of each closed economy is determined once the values of the investment demand $\bar{I}^D$ are known. We shall now see that the equilibrium of the North–South model is determined when both values of investment demand, in the North and in the South, are known. When studying the equilibrium of the North and the South trading with each other one adds both more freedom and more constraints to each economy. More freedom is added because supply and demand in each traded commodity need not match any longer with trade. The equations

$$X_B^S = B^S - B^D,$$

and

$$X_I^S = I^S - I^D$$

replace the equilibrium conditions in isolation $B^D = B^S$ and $I^D = I^S$. We have therefore two more degrees of freedom as X_B^S and X_I^S may vary. On the other hand, two more constraints are added, as international payments must balance, i.e.,

$$\frac{p_B}{p_I} X_B^S = X_I^S,$$

[9]When Walras' Law is satisfied in both economies, receipts for exports equals payment of imports. This can be seen as follows: from value of consumption equals income in the South, we have in equilibrium

$$p_B B + p_I I = wL + rp_I K,$$

substituting (5) and (6) in the left-hand side, and on the right-hand side substituting equations

$$L = (B + X_B^S)a_1 + (I + X_I^S)a_2,$$

and

$$K = (B + X_B^S)c_1 + (I + X_I^S)c_2,$$

we obtain

$$a_1 w X_B^S + rp_I c_I X_B^S + a_2 w X_I^S + rp_I c_2 X_I^S = 0.$$

i.e., $p_B X_B^S + p_I X_I^S = 0$, and thus

$$p_B X_B^S = p_I X_I^N$$

in equilibrium. Therefore, as $p_B X_B^S$ increases, when the budget eq. (16) is satisfied at the world equilibrium prices $p_I X_I^N$ automatically adjusts and balances the North–South trade bill.

and in addition (relative) prices in both regions must be equal

$$\left(\frac{p_B}{p_I}\right)^S = \left(\frac{p_B}{p_I}\right)^N.$$

Therefore, the world equilibrium is determined under the conditions that determine the equilibria of both economies in isolation, i.e., when exogenous demand in each region $(\bar{I}^D)^N$ and $(\bar{I}^D)^S$ are given. In particular, the volumes of trade in equilibrium X_B^S and X_I^S are then known.

It can be seen that the equilibria of this model are in general (locally) unique, since they solve a polynomial equation (see the appendix). Therefore, as $(\bar{I}^D)^N$ and $(\bar{I}^D)^S$ vary, the world equilibria of this model will describe (locally) a 2-dimensional surface, along which we shall perform our comparative statics exercise.

In the following section we shall explore the implications of export-led policies, i.e., policies that shift one trade equilibrium to another with a higher volume of exports from the South. In order to obtain different equilibria, we must allow for shifts of at least one of the parameters $(\bar{I}^D)^N$ or $(\bar{I}^D)^S$; if the volume of exports of B, X_B^S is to be a control variable, then obviously either $(\bar{I}^D)^N$ or $(\bar{I}^D)^S$ must be determined endogenously.

A possible institutional setting for the formation of equilibria in the market for basic goods is now described; this will illustrate the results that are proven formally in the section. The process discussed now is a quantity adjustment. A price adjustment process can also be specified instead. However, since the model has linear technologies and hence constant returns to scale at each given price, the standard specification of supply by profit maximisation behaviour of producers does not yield a unique output unless aggregate demand for this output is also known (i.e., at the equilibrium). Therefore a price adjustment process requires further specification in this model. This is done in section A.2 of the appendix, where the Walrasian stability of the results with respect to this price adjustment is also discussed.

It should be noted that the results of this paper are obtained at the equilibria of the model. Therefore, they are independent of the adjustment process followed to attain equilibrium.

Let us focus on the economy of the South first. Assume that domestic producers are competitive, both as buyers of factors and as sellers of commodities. Given a level of (short-run disequilibrium) prices in the South p_B^S, each producer has a (temporary) output target both for the domestic market and for exports. When added up over all producers this yields a total export target E_B, which will be modified until an equilibrium in the international market is attained. As a function of such output targets, producers employ factors. All domestic markets (for goods and factors) adjust, and new levels of employment of factors and of factor prices, emerge.

These, in turn, produce new levels of aggregate domestic demand and supply of goods in the South. The excess domestic supply of B should equal E_B if the initial prices were equilibrium prices for the domestic economy. Changes in the initial prices will change the volume of B that the South offers (in the short run). Unless this volume of exports matches the North's demand, the international market is in disequilibrium.

In a similar fashion, the short-run demand for basic goods from the North is determined. If at the South's going prices p_B^S, the demand from the North exceeds the export target E_B, obviously producers in the South will increase their output since, being price takers, each foresees an opportunity to increase profits. If, instead, the demand from the North falls short of the target E_B, this will be revised downwards. The process will continue until a price equilibrium in the international market is attained, in which demand for imports from the North equals supply of exports from the South (in real terms) and both domestic economies are also at an equilibrium. Fig. 1 illustrates this case. Note that in fig. 1 as the (short-run) export target E_B increases, the (short-run) relative price of B increases, domestic output of B increases, and domestic demand of B decreases.

Fig. 1 also illustrates a tendency for factor prices to equalise across regions when exports increase in a world trade equilibrium due to a positive shift in demand from the North. This is because the wage profit ratio w/r and the relative price of B are positively related since B is the more labour intensive good [from (7) and (8)]. As the price of B increases with increased exports, so will w and w/r in the South. Therefore, increases in the volume of exports of the labour rich region increase the relative price of labour, and thus tend to equalise factor prices between the North and the South.

Fig. 2 illustrates how the outcomes illustrated in fig. 1 may be reversed when there is duality in production and abundant labour. With abundant labour and duality, an increase in the price of exports p_B implies an increase of the domestic demand for basic goods in the new equilibrium due to income effects (fig. 2a). This demand increase is sufficiently strong that it dominates the increase in supply. Therefore, across domestic equilibria of the South the price/quantity relation for exports of the South is downward sloping (fig. 2b). This price/quantity behaviour across equilibria has the effect of reversing the previously discussed impact of an increase in exports, both on terms of trade and on factor prices.

Fig. 2b shows a case where in a new world equilibrium there is an increase in exports due to a positive shift in demand by the North. The new relative price of B decreases, and thus terms of trade worsen for the South. Since, as seen above, p_B and w/r are positively related, it follows that the relative price of labour in the South *decreases* with an export expansion. Therefore, factor prices in the two regions tend to diverge further with increased exports. In addition, employment and consumption in the South decrease also.

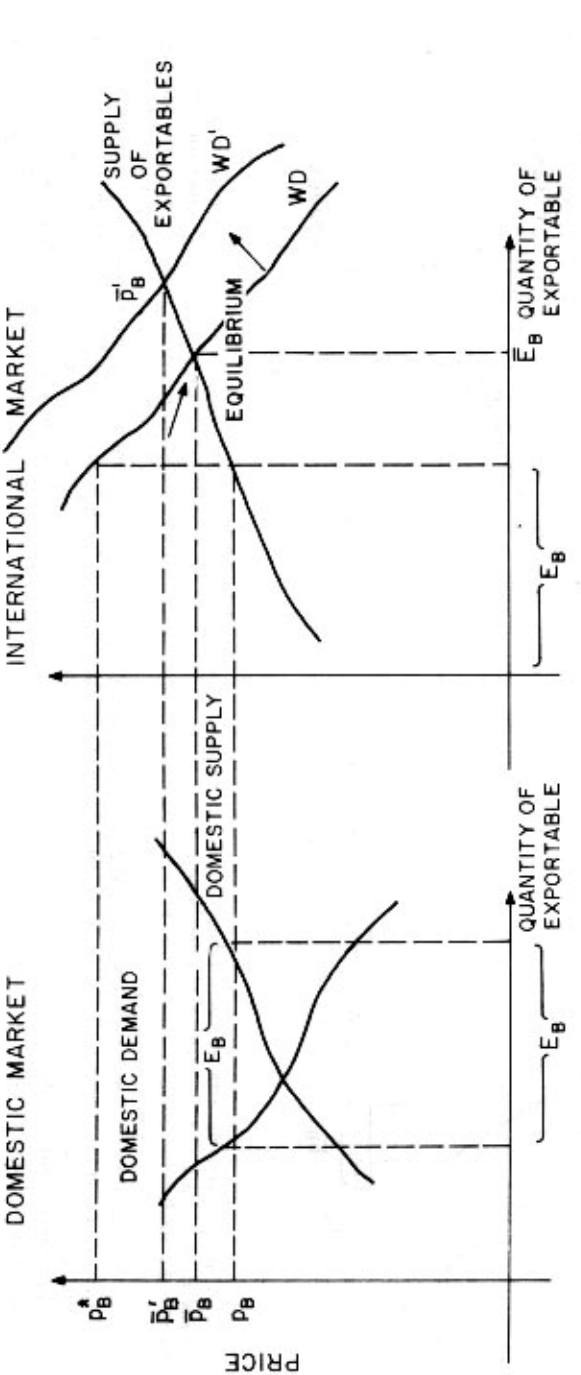

Fig. 1. *The neoclassical case: The model with homogeneous production sectors and relatively inelastic labour supply.* Fig. 1a depicts the domestic market supply and demand functions for basic goods. E_B is the fixed short-run level of exports. Together with domestic demand this determines short-run domestic price p_B. In fig. 1b the short-run export level E_B together with the world demand (WD) curve determine the short-run international price p_B^*. If the short-run domestic price p_B is lower than international (demand) price p_B^*, there is an incentive for producers to increase exports until an equilibrium E_B is reached. Total domestic supply at equilibrium (E_B) is higher and domestic demand is lower than at E_B. Note that with an upward shift of world demand (to WD') exports increase, and the price of the exportable increases also (to $\bar{p}'_B$). Since $\bar{p}'_B$ is larger than $\bar{p}_B$ this implies also higher real wages in the model. Total employment increases also. These results obtain in a general equilibrium of our model under certain parameter conditions, which are discussed in Proposition 2 of the next section. In this case there are gains from trade, and also factor price equalising effects of trade.

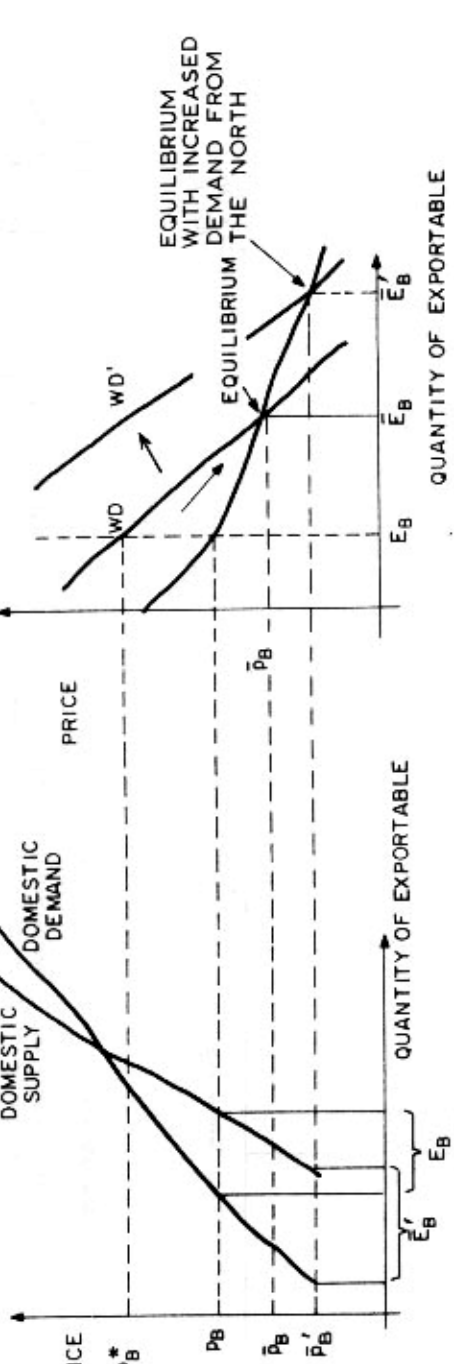

Fig. 2. *The dual economy with abundant labour.* Fig. 2a illustrates domestic market supply and demand functions for basic goods where demand is an upward sloping function of prices across equilibria. In fig. 2a E_B is the fixed short-run level of exports together with domestic demand, E_D determines domestic equilibrium price p_B. At the short-run level of exports E_B, world demand WD determines short-run international prices p_B^*, which are higher than domestic prices: there is therefore an incentive for producers to increase exports. At E_D an equilibrium is reached and domestic and international prices are equalised at the world equilibrium price $\bar{p}_B$. Note that with an upward shift of world demand (to WD'), at the corresponding new equilibrium price $\bar{p}_B'$, total exports E_D' increase, domestic output is lower, and domestic consumption of B is also lower than at $\bar{p}_B$. Increases in world demand worsen the terms of trade of the South. Together with the terms of trade, real wages, employment and domestic consumption of basic goods in the South can all be shown to decrease. The results sketched here are proven in a general equilibrium context in Proposition 1 of section 3 when the parameters of the model correspond to a dual economy with abundant labour.

3. Duality and abundant labour: Terms of trade and domestic distribution with export-led policies

In this section we shall analyse the effects of export-led policies, formalised as movements towards world equilibria with higher levels of exports from the South. Different levels of consumption, employment of factors and returns to factors will emerge at the new equilibria. We shall then be able to ascertain the effects of export-led policies in the domestic economy of the South.

We shall proceed to study first the equilibrium reaction function of the South, i.e., the quantity of exports X_B^S that it offers at various prices, under the assumption that these are general equilibrium prices in which all markets (domestic and international) clear. We shall then study changes in the initial parameters of the model that shift the equilibrium prices and examine the corresponding changes in exports X_B^S at the new equilibrium.[10]

The equilibrium reaction function of the South is computed as follows. Given a relative price p_B/p_I, the supply and demand of the South for basic goods is computed, assuming that factor markets are at equilibrium at the factor prices corresponding to p_B/p_I, and that Walras Law is satisfied. Here the international market is always assumed to be equilibrated, in particular, the level of exports (excess supply) generated is assumed to balance international payments. At the end of this section this assumption is relaxed and we analyse the case when the level of exports must correspond to the domestic equilibrium of both regions simultaneously in order to reach a new international equilibrium.

From eq. (11) relating supply of B to capital and labour use in equilibrium, and the supply functions for capital and labour as a function of wages, profit rate and prices (3) and (4) we obtain

$$B^S = \left(c_2 \left(\alpha \frac{w}{p_B} + \bar{L} \right) - a_2 \left(\frac{\beta r}{p_I} + \bar{K} \right) \right) \Big/ D. \tag{17}$$

From the equations that relate in equilibrium wages and rate of profit to prices and technical coefficients (7) and (8), we obtain B^S as a function of prices only. Taking I as a numeraire ($p_I = 1$) we obtain

$$B^S = \frac{\alpha c_2}{D^2} \left[c_2 - \frac{c_1}{p_B} \right] + \frac{c_2 \bar{L}}{D} - \frac{\beta a_2}{D^2} [a_1 - p_B a_2] - \frac{a_2 \bar{K}}{D}. \tag{18}$$

A linear approximation to the effect of a change of price p_B on the supply B^S

[10]Note that X_B^S does not yield information about the behaviour of supply of exportables and their prices in disequilibrium as required for stability analysis. This represents, instead, a comparative statics exercise across equilibria; see the appendix for a discussion of stability.

is thus given by the derivate $\partial B^S/\partial p_B$. From (18) we obtain

$$\frac{\partial B^S}{\partial p_B} = \frac{c_1 c_2 \alpha}{D^2 p_B^2} + \frac{a_2^2 \beta}{D^2} \tag{19}$$

which is always positive. This shows that across equilibria *the supply of B in the South always responds positively to increases in the relative price* p_B.

Next we compute the demand for B, B^D, using the balanced budget condition. In order to provide a more general setting, we shall allow here for tariffs, i.e., cases where domestic and international prices may differ. This includes, as a particular case, the case when they are equal, i.e., free trade. The relevant budget equation for the South becomes

$$p_B B + \bar{I} = wL + rK + (\bar{p}_B - p_B) X_B^S,$$

where $\bar{p}_B$ are international prices, from which one obtains

$$B^D = \frac{1}{p_B} \{wL + rK - I^D + (\bar{p}_B - p_B) X_B^S\}. \tag{20}$$

From (18) and (20) we can ascertain the relationship of the price of B and the level of exports X_B^S across equilibria. When labour supply is very responsive to real wages, i.e., when α is sufficiently large, we can assume that the terms in α dominate the other terms of (18) and (20) and determine the sign of these expressions, and therefore we concentrate on these terms.

Since

$$L = \alpha \frac{w}{p_B} + \bar{L},$$

from (18) and (20) it follows that, when $\bar{p}_B = p_B + \Delta$, $\Delta \lesseqgtr 0$ and sufficiently small,

$$\frac{\partial}{\partial p_B}(B^S - B^D) = \frac{\alpha}{D^2 p_B^2}\left[\frac{2c_1^2}{p_B} - c_1 c_2\right] - \frac{c_1 \bar{L} - \bar{K} a_1}{p_B^2 D} - \frac{I^D}{p_B^2}. \tag{21a}$$

For α sufficiently large, since $X_B^S = B^S - B^D$:

$$\frac{\bar{p}_B}{p_B} X_B^S \cong \alpha\left[\frac{c_2}{D}\frac{w}{p_B} - \left(\frac{w}{p_B}\right)^2\right]. \tag{21b}$$

Therefore, for instance, if the international price is close to the domestic price of B,

$$X_B^S \sim \alpha\left(\frac{c_2}{D}\frac{w}{p_B} - \left(\frac{w}{p_B}\right)^2\right). \tag{22}$$

Now, since by (7) $w = (p_B c_2 - c_1)/D$, then

$$\frac{w}{p_B} = \frac{c_2}{D} - \frac{c_1}{D p_B},$$

and therefore

$$\frac{\partial(w/p_B)}{\partial p_B} > 0. \tag{23}$$

Since by (23), changes in the price p_B are accompanied by changes in the real wage w/p_B in the same direction, to compute the response of the price p_B to an increase in exports X_B^S it suffices to compute the sign of $\partial X_B^S/\partial(w/p_B)$. From (21b) one can approximate $\partial(X_B^S)/\partial(w/p_B)$ (when Δ is sufficiently small and $p_B \cong \bar{p}_B$) by

$$\alpha\left[\frac{c_2}{D} - \frac{2w}{p_B}\right]. \tag{24}$$

Therefore, if $c_2/D < 2w/p_B$, p_B decreases when exports increase and *therefore the reaction curve of the South relating prices and quantities of exports across equilibria is downward sloping*. By (23), real wages also decrease when the supply of exportables increases in a new equilibrium.

We now study the condition

$$\text{(C.1)} \qquad \frac{c_2}{D} < \frac{2w}{p_B}.$$

Since (C.1) is equivalent to the condition that $2(c_1/p_B) < c_2/p_I$, it is independent of the units of measurement. (C.1) can be interpreted as follows. By inverting the supply of labour eq. (3) one derives a wage function

$$\frac{w}{p_B} = a + \frac{1}{\alpha}L$$

[where the $\bar{L}$ in (3) is $-a\alpha$]. When α is sufficiently large the real wage w/p_B

approximates (and is larger than) the parameter a. Therefore a can be thought of as a minimum real wage; it can in some cases be approximated by $1/a_1$, the inverse of the labour output ratio in sector B. In that case, inequality (C.1) becomes

$$\frac{c_2}{D} < 2a. \tag{25}$$

Condition (C.1) will then be satisfied, for instance, when D is a very large positive number so that c_2/D is exceeded by $2a$, i.e., when there is a strong duality in the production of the basic and investment goods.

Therefore, with abundant labour and duality in production, increased exports of the basic good are accompanied by a lower price of the basic good. From (7), at the new equilibrium with increased exports wages will decrease and, from (23), the purchasing power of wages will also decrease. The stability of this result is analysed in the appendix.

Eq. (21a), shows that with higher values of investment demand in the South, the negative effect of an increase in exports on the price of B and on the purchasing power of wages are even more pronounced. We have therefore obtained:

Proposition 1. For a given level of investment demand $\bar{I}^D$, consider a move towards equilibria with higher levels of exports of the basic consumption good B.[11] *When labour supply is highly responsive to real wages and the production structure for basic and investment goods is dualistic (C.1), at the new equilibrium the price of the exportable good will decrease with respect to that of the importable good, and the purchasing power of wages will also decrease. This takes place within a Walrasian stable economy. The effects are accentuated with increases in domestic investment demand $\bar{I}^D$.*

The rationale for this result can be briefly summarised as follows. The high responsiveness of labour supply to wages and the differences in labour and capital intensities between sectors in the South give income effects an important role. Since the exported good B is labour intensive, it is necessary to consider the effects of increased employment and the accompanying increased demand for B by the local population as the equilibria moves towards higher export levels. If increased output and employment in B

[11]Note that we are envisaging a movement across equilibria along the South's curve of exportables, and *not* a shift in this curve. It is obvious that if the demand curve of the North remains fixed, and the South's supply curve shifts, in an attempt to increase exports at each price, the new equilibrium market prices will decrease. This is not the case depicted here. Our case reflects, instead, shifts in the demand of the North, that increase the demand for the exportable at each price. This would under traditional assumptions increase the price of the exportable. In our case, just the opposite effect takes place.

brings about a significant increase in the domestic demand for B, the surplus available for export in a new equilibrium may actually decrease with price increases. We showed above that at higher equilibrium prices domestic supply of B respond 'normally' by increasing. This, however, is accompanied by a proportionally higher increase in domestic demand for B, due to income effects. Therefore it is only curtailing domestic demand that the exportable supply can be increased in a new equilibrium. If at the new market equilibrium exports increase, the relative price of these export goods will be lower than at the previous equilibrium. Finally, since wages and the prices of B are positively related (because B is more labour intensive than I), as the relative price of the basic good B has decreased, so do wages. In addition, the purchasing power of wages in terms of the basic good is also shown to decrease.

Since $\bar{I}^D$ is exogenously given in nominal terms and α is large, the changes in domestic demand due to the increased exports (represented by those terms containing α in the equation for X_B^S) occur mostly in the basic goods sector. This implies that a determining factor in the price/quantity relation of the exportable surplus is the demand by wage earners for basic goods. Significantly more employment in the sector B means more output, but this, in turn, implies even more domestic demand for B. Which of these two tendencies, increase in output or increase in demand, dominates, will determine the availability of exportable surplus. This suggests that a similar result to that of Theorem 1 could be obtained without the condition of abundant labour, provided the demand in the South were specified so that most wage income was spent on the basic good B, which would then be more appropriately called the 'wage-good'. This is equivalent to a 'classical savings function' condition, in which investment is only derived from rental income. In Chichilnisky and Cole (1978) this case is studied; the same condition (C.1) given here is shown to reproduce in that context the negative slope of the price/quantity relations of basic goods in the international market across equilibria even if labour is not abundant.

Note, however, that if condition (C.1) is not satisfied, we have, instead,

$$\text{(C.2)} \qquad \frac{c_2}{D} > \frac{2w}{p_B}.$$

The results of Proposition 1 are now reversed, and become consistent with more standard views on the effects of export-led policies:

Proposition 2. If subsistence real wages are sufficiently low, or else the technology is sufficiently homogeneous so that (C.2) is satisfied, then a move towards an equilibrium with higher volume of exports will increase the relative price of the basic good B, increases wages and also the purchasing power of

wages. However, if a higher rate of growth is desired, which translates into a higher investment demand, $\bar{I}^D$ these positive effects on prices and wages may be reversed as exports increase.

To prove this proposition one notes that in the proof of Proposition 1 (C.2) implies

$$\frac{\partial X_B^S}{\partial p_B} > 0, \quad \text{unless } \bar{I}^D \text{ dominates the expression (20).}$$

We now discuss the results in the context of an increase in the growth of the North that produces a positive shift in its demand for basic goods. In Proposition 3 we assume that an equilibrium is reached when prices and the trade levels correspond to domestic equilibria of both the North and the South; thus, the hypothesis of Propositions 1 and 2 that the international market is always equilibrated for each level of exports of the South is now relaxed.

As in the case of the South one obtains a reaction curve of the North X_B^N relating price and quantities demanded of B across different equilibria (21a). As the (exogenous) demand for investment goods $(\bar{I}^D)^N$ is increased within the North, eq. (21a) implies a positive shift in its demand for B, X_B^N, at each price level.

Fig. 1 of section 2 corresponds to the case of Proposition 2, when (A.2) is satisfied. In this case $\partial X_B^S/\partial p_B$ across equilibrium is positive. The intersection of both reactions curves, X_B^N and X_B^S, is the world equilibrium. In this case a positive shift in X_B^N brings about an improvement in the terms of trade for the South, and there is a corresponding equalising effect on factor prices brought about by larger volumes of trade.

However, the results of Proposition 1 show that when there is duality and labour is abundant, (C.1) is satisfied instead. In this latter case the consequences of larger trade volumes are those illustrated in fig. 2. This is because as the economy of the North is specified analogously to that of the South, but labour is relatively unresponsive to wages (α small), eq. (21a) implies that in the North the excess demand curve for B across equilibria is downward sloping. When α is rather small, X_B^N is rather price inelastic as well. Therefore X_B^N will cross X_S^N from above, i.e., its graph will have a non-empty intersection with the set

$$\{p_B : p_B \geqq p_B(X_B^S)\}.$$

It follows that a positive shift in the North's demand will necessarily worsen terms of trade for the South. This effect will be more pronounced if

investment demand increases further in the North, as shown in eq. (21a). The stability of this result is studied in the appendix.

We therefore have obtained

Proposition 3. Assume that labour in the North is relatively price inelastic (α small) and that the economy of the South has the characteristics described in Proposition 1. If a new world equilibrium with an increased volume of exports by the South is attained due to a positive shift in demand for basic goods by the North (e.g., higher growth rate of the North), then the terms of trade will worsen for the South and the purchasing power of wages within the South will also decrease.[12] *This takes place within a Walrasian stable world economy.*

4. Relationship with previous literature

The fact that income effects can make supply curves slope the wrong way has been studied for some time in the literature, mostly within partial equilibrium frameworks; see Johnson (1959), Diaz-Alejandro (1965), and the references in Taylor (1974).[13] Kempt (1964), Kemp and Jones (1962) and Pearce (1970) studied trade models with variable endowments; the possibly unusual effects of variable endowments on the supply of exportables were pointed out in the first two works. However, two points have apparently gone unnoticed in the literature. One is that related price/quantity relations across the equilibria of the international market may arise due to two rather realistic assumptions on a developing economy: the combination of labour abundance and dualism in production studied here. The second point is that a consequence of this market behaviour across equilibria is to produce a

[12]Note that the lower prices at the new equilibrium with increased exports by the South does not correspond to the typical case where the exports are increased by a subsidy policy. In our case, as X_B^S is downward sloping with such a subsidy the result will be *less exports at higher prices*. If, instead, one had an upward sloping X_B^S then as the supply curve shifts outwards, the result would be the opposite, i.e., more exports at lower prices.

[13]Johnson showed that when there is more than one consuming group in the economy Walrasian stability may be foiled by income effects; this is studied in detail in his offer curve analysis in Johnson (1959). Here, however, the focus is not on lack of stability (indeed, the market may be stable in our case) but on the distributional and terms of trade implications of export-led policies. Diaz-Alejandro (1965) discusses also related supply of exportables conditions [see discussion in Taylor (1974)]. His analysis is different from ours in several ways: in our model both goods are traded, the supply of exports does not depend on producers' behaviour or on the elasticity of substitution in the home (non-traded) sector being high (these are actually not considered in our model), but rather on a form of competition across equilibria for the consumption of the exportable good between domestic and international markets, which arises due to the duality in production and the abundance of labour supply. The paper of Taylor (1974) discusses, and gives references to other works on negatively sloped curves but does not work on that case himself. The model of Taylor (1974) is quite different from ours and the results are also of a different nature. They rely crucially on elasticity of substitution assumptions, and the money wage is an important variable of the analysis. The duality and abundance of labour assumptions in our model are also not considered by Taylor.

sustained deterioration of both terms of trade and domestic distribution when the South pursues an export-led growth policy.

Our results also differ both in assumptions and in policy conclusions from others in the existing formalised trade and growth literature on the immiserising effects of growth [cf. Bhagwati (1968, 1972), Mundell (1968)]. In those works the results emerge from assumptions on international markets such as, for instance, different international elasticities of demand for the goods in which the North and the South specialise: the exports of the South are assumed to have inelastic demand internationally while the exports of the North have more elastic demands. Therefore, as the South attempts to grow more than the North, the prices of the exports of the South fall significantly, thus undermining its growth efforts.

Here we stress, instead, the *internal* structure of each region. Rather than assuming a given international demand structure we prove that technological dualism and abundance of labour in the South have certain effects on the structure of international markets, such as the behaviour of the reaction curve of exportables across equilibria discussed above. The results obtained here clearly depend on the structure of the domestic markets for factors, domestic techniques of production, and the derived internal terms of trade.[14]

In this sense, and because of the assumed elastic supply of labour, they obviously relate to results previously studied in a less formal way by Prebisch (1962) and especially by Lewis (1954) in his celebrated model of development with unlimited labour supply, while differing from them in other aspects. For example, here labour is abundant but not in infinitely elastic supply as in Lewis. As a consequence, real wages do change here across equilibria (while in Lewis they are pegged at the subsistence level) thus allowing us to measure the impact of trade policies on factor rewards. Prebisch's early work, in particular his thesis of secular deterioration of terms of trade of the South, was based on the assumption that the income elasticity of demand for the South's exports is lower than that for the North's

[14]The results in this paper have a dual character with respect to those of Bhagwati (1968, 1972), since ours depend more on the behaviour of supply of factors of production rather than on the elasticity of demand for goods. Other more recent works with related concerns are Bacha (1978), Bruno (n.d.), and Findlay (1978). Bacha's model is a partial equilibrium one, while ours is of a general equilibrium nature. Bruno studies also technology effects on a development economy. In his model the developing region is a small economy, and therefore does not have an effect on international prices. In our case, we consider a trade model of a two-region economy, where each region may have an effect on the international market equilibrium prices. Therefore for instance, the effects of internal policies within the South (such as export led policies) on international terms of trade can be studied in our framework. Findlay's (1978) model differs from ours in several ways. Both the North and South produce one good in Findlay (1978); in ours each region produces two goods. In Findlay (1978) labour is perfectly elastic and receives a fixed real wage in terms of primary products; in ours labour is very abundant, but not infinitely elastic, and wages are an endogenously determined variable. Findlay's model is dynamic. It also considers investment as being constantly equal to a fraction of output, and full employment; these conditions are not required in our model.

exports. If we could formalize his thesis in a general equilibrium framework, and reinterpret the condition on elasticity of demand for the South's goods as the fact that across equilibria basic goods are inferior goods, then our results would become consistent with his when $\hat{\partial} X_B^S / \hat{\partial} p_B < 0$ is interpreted as B being an inferior good (its demand rises with its price). However, the import substitution policies implied by Prebisch will not in general be applicable here. This is because in our general equilibrium framework it is not only the substitution on the supply side but also what could be called demand substitution, that must be achieved in order to obtain positive outcomes from export-led policies.

Our results differ more strikingly from those of the immiserising growth literature with respect to their possible implications for the relationship between the growth of the South and the growth of the North. In the immiserising growth results, the worsening in terms of trade for the South tends to occur and to accentuate as the South attempts to grow more than the North. They could be prevented if the North were to grow more than the South instead. In that sense, the immiserising growth results would imply that the growth of the North may be a pre-condition for the growth of the South, when reliance is put on trade. According to those models, if the North grows sufficiently rapidly relative to the South, the worsening of the terms of trade for the South may not occur. Actually, the terms of trade may *improve* in this latter case for the South, rather than worsen in those models.

In our model, instead, the above relationships between the growth of the North and of the South are reversed. Under the conditions of duality and abundant labour studied here, more growth of the North worsens further, rather than improves, the terms of trade for the South. It also tends to increase the North–South wealth gap as well as reinforce inequalities within the South if the South follows export-led policies. Therefore under the conditions considered here, more growth of the North may not be a necessary, or even a favourable condition, for more growth of the South, or for better distributions. These results are consistent with some of Lewis' (1978) conclusions as well.

5. Conclusions

The results are obtained here under simplified assumptions, and further work seems indicated. However this stylized framework suggests certain relationships between internal and international terms of trade, domestic distribution, and techniques of production that seem worth pointing out. They signal a need for careful coordination of domestic and international policies, a prescription many times emphasised yet often overlooked in the standard models of the development literature. The results could also be interpreted as indicating broad technological conditions and labour market

structures which would have to obtain if the equalisation of wealth between the North and the South through the mediation of international markets were a goal.

The model suggests several implications, some pertaining to the development of trade between the North and the South, and others to more immediate trade policy.

A plausible time evolution of trade between the North and the South is suggested as follows. Consider a developing economy in isolation, reasonably homogeneous and with a low level of wages (as compared with those of the North). As trade opens, the initial effects of trade will be, as predicted by neoclassical theory, positive [because (C.2) holds]. The price of the export good will increase and bring about some equalisation of factor prices across the trading regions (Proposition 2). However, as export levels increase further real wages may become sufficiently large, or the technology sufficiently dual (due to the exposure to that of the North) that (C.2) is no longer valid, and (C.1) holds instead. This brings about a reversal of the initial positive effects of export-led policies. As export volumes increase, the terms of the South now worsen and real wages become more unequal across the two trading regions. These characteristics of the development of trade among unequal regions may help explain within the same model both the existence of trade, and also the existence of persistent misgivings about export-led policies.

It should be noted that the Heckscher–Ohlin theory explains why trade takes place by comparing welfare in isolation and after an international trade equilibrium is reached. Here, instead, we have compared welfare across equilibria in which the volume of trade increases. Therefore, the two sets of results are not strictly comparable, as the state of isolation is in general not an international market equilibrium, because the prices of different regions differ in isolation. However, if the values of the initial parameters were such that there is an international equilibrium in (near) isolation for the regions and (C.2) holds, then Proposition 2 implies that export-led policies will improve terms of trade and wages, thus obtaining a result which is not inconsistent with Heckscher–Ohlin theory.[15]

With respect to more immediate trade policies, the results suggest that the success of export-led growth (if measured in terms of equalizing factor prices

[15]It can be argued therefore that the negative effects of trade increases proven in Proposition 1 are not inconsistent with Heckscher–Ohlin theory, as they apply to different circumstances: this latter theory does not examine variations across equilibria but rather compares two economies in isolation and in equilibrium. In effect, a Heckscher–Ohlin model will only yield as a solution one vector of trade (or at most finitely many). Thus the changes in the parameter X_B^S studied here, which are possible due to the particular specifications specifications of our model, are not meaningful in a Heckscher–Ohlin model, at least not without modifications. Thus in principle Heckscher–Ohlin theory is not appropriate for the comparative statics exercises given here, even though by implication the trade and development literature has assumed that its predictions on gains from trade and factor price equalization apply to export-led policies.

across regions and/or better terms of trade) depends on whether in the process more homogeneous production structures can be achieved by the South, and whether the abundance of labour supply can be overcome.[16]

In fact, homogeneity in production may be associated to less abundant labour as both cases are consistent with a better integration of different segments of the economy. For instance, an economy in which most people are involved in the production and exchange of most goods, which in turn are consumed by most people, would probably have more homogeneous technologies, and less abundant labour.

The opposite is the case of duality, where a segment of the population mostly produce and consume at subsistence levels, and another is more related to consumption, exchange and production of luxury or investment goods. One link between these two sectors is the labour market. The development literature on migration and employment explains the role of the subsistence economy, and of the level of real wages, in generating abundant labour supply. Dual technologies may be more likely to arise with abundant labour. Also, a rise in productivity and consumption of basic goods may have positive effects in decreasing both labour abundance and duality.

But there is another, less positive, way to bring about the conditions needed for positive effects of export-led policies. Even with duality and abundant labour, if real wages are lowered sufficiently, then condition (C.2) will still be satisfied. This, one fears, may be the reason why one observes a persistent, even increasing wage repression in many export-led economies in the South. An orthodox prescription of income concentration, therefore, appears to yield a solution to the problem, *provided* that wages are not required to decrease beyond their strict subsistence minimum. If they are, it may be found that such policies are simply unfeasible. Even if they were feasible, however, they seem unnecessarily harsh, as similar results can be obtained without the obvious negative effects of wage repression. A better policy prescription here would be to seek a more appropriate production structure, and alleviate the causes of labour abundance. However, one may expect at least in the short run a reluctance among export-linked groups within the South to such policies, especially if they can arrange to benefit from export proceeds even while the terms of trade of the South worsen as a whole.

It may seem paradoxical that what is in general considered the relative advantage of the South, its abundant labour and labour intensive exports, may be a handicap in export policies, bringing about a worsening of its terms of trade, and reinforcing North–South factor price inequality. It follows that relative advantages based on inequalities, are not necessarily self-

[16]This discussion suggests the need to set in a dynamic framework the model studied here, and to endogenize some of its parameters, such as labour response (α), and technology coefficients.

destructing: in some cases they may actually be self-perpetuating. The opposite of the conventional wisdom on this matter seems closer to the truth, in the sense that a strong domestic market structure (with the associated high productivity and wages) is a better basis for a long-term success in export policies than the cheap and abundant labour provided by widespread poverty.[17]

Appendix

This appendix reports on results of runs solving the model and reproducing numerically the comparative statics results of Propositions 1 and 3, and studies also uniqueness of equilibria and the stability properties of the model.

A.1. Numerical simulation

The following runs were based on work by John Clark and Sam Cole. They satisfy the specifications of the models of the North and the South given in sections 2 and 3, and reproduce plausible behaviour of the developed (North) and a developing (South) region, trading with each other. In the basic run, and the run with increased investment of the North, assumption (C.1) is satisfied (see table A.1). Similarly, for the South, see table A.2. In the basic run, investment demand in the North was set to be 1.5 and investment demand in the South was 0.75. The solution values are shown in tables A.3 and A.4.

Table A.1

Initial data for the North.

Technical coefficients		Supply of labour	Capital stock
$a_1 = 0.00471$	$a_2 = 0.009$	$\alpha = 0.015$	$K = 125$
$c_1 = 0.189$	$c_2 = 10.4$	$L = 0$	$\beta = 0$

Table A.2

Initial data for the South.

Technical coefficients		Supply of labour	Capital stock
$a_1 = 0.04$	$a_2 = 0.24$	$\alpha = 1$	$K = 35$
$c_1 = 0.05$	$c_2 = 10$	$\bar{L} = 0$	$\beta = 0$

[17] The disparate examples of Japan and Germany in the 70's come to mind here. Within the South, Korea had a relatively homogeneous technology and better distribution of income in their successful export-led growth years. In this case, (C.2) is likely to be applicable, and thus the results of Proposition 2. Lewis' work has shown, in particular, that terms of trade between two regions are related to productivity and real wages in agriculture [Lewis (1978)], and that in order to improve North–South terms of trade these have to be improved as well.

Table A.3
Equilibrium values of the basic run in the North.

Wages (w)	Rates of profit (r)	Employment (L)	Domestic consumption of basic goods
16.88	0.08154	2.668	566
Total output of basic goods	Total output of investment goods	Excess supply of basic goods	Excess supply of investment goods
563	1.788	−3.034	0.2881

World equilibrium price of basic goods in the basic run:

$$p_B = 0.0949.$$

Table A.4
Equilibrium values of the basic run in the South.

Wages (w)	Rates of profit (r)	Employment (L)	Domestic consumption of basic goods
2.31	0.04437	24.42	604.6
Total output of basic goods	Total output of investment goods	Excess supply of basic goods	Excess supply of investment goods
607.6	0.4619	3.035	−0.2881

We next report the results of a comparative static run, where the parameter of investment demand is increased in the North from 1.5 to 2. Equilibrium value of exports of basic goods by the South increase and their price p_B decreases:

World equilibrium price in the run with increased equilibrium value of exports:

$$p_B = 0.0801.$$

Table A.5
Equilibrium values for the North in the run with increased exports of basic goods by the South.

Wages (w)	Rates of profit (r)	Employment (L)	Domestic consumption of basic goods
13.62	0.08437	2.551	540.4
Total output of basic goods	Total output of investment goods	Excess supply of basic goods	Excess supply of investment goods
537.3	2.256	−3.19	0.2557

Table A.6

Equilibrium values for the South in the run with increased exports of basic goods by the North.

Wages (w)	Rates of profit (r)	Employment (L)	Domestic consumption of basic goods
1.936	0.05354	24.16	598.0
Total output of basic goods	Total output of investment goods	Excess supply of basic goods	Excess supply of investment goods
601.1	0.4943	3.193	−0.2557

Notice that the expression $(c_2/D)-(2w/p_B)$ in the South has a negative value at equilibrium (-23.06) which satisfies the conditions of Proposition 1, assumption (C.1). In the North, since α is relatively very small, this term does not have much effect on the $\partial X_B^N/\partial p_B$. Actually, by fully computing $\partial X_B^N/\partial p_B$ it follows that

$$\frac{\partial X_B^N}{\partial p_B}=\frac{\alpha}{D^2 p_B^2}\left[\frac{2c_1^2}{p_B}-c_1c_2\right]-\frac{c_1L}{D}+\frac{\bar{K}a_1}{D}-\bar{I}^D D^2. \tag{A.1}$$

At the equilibria of the North $\partial X_B^N/\partial p_B$ is positive due to the fact that initial capital stock $\bar{K}$ is quite large and D quite small in the North. Therefore, as exports of the North decrease the price of basic goods p_B decreases in the North. Since, as exports of the South increase, their price p_B also decreases in the South, in the new world market equilibrium prices of the basic goods decrease with more exports from the South, and less exports from the North.

A.2. Local uniqueness and stability properties of the solutions

From eq. (12) we obtain for each region in isolation

$$\bar{I}^D=\frac{1}{D^2 p_B}[a_1\beta(p_Ba_1-p_B^2a_2)+\alpha(c_1-p_Bc_2)]+\frac{1}{D}(a_1\bar{K}-c_1L), \tag{A.2}$$

which is a quadratic function on p_B. For each fixed value of $\bar{I}$ we therefore obtain at most two solutions in the relative price B, p_B. As pointed out in footnote 8, the equilibrium relative price p_B completely determines the equilibrium of all other variables of the model. It follows that the model of each region has at most two equilibria for each $\bar{I}^D$. In the particular case

when $\beta=0$, i.e., the initial capital stock is not responsive to prices, then (A.2) becomes

$$\bar{I}^D=\frac{1}{D^2 p_B}[\alpha c_1(c_1-p_B c_2)]+\frac{1}{D}(a_1\bar{K}-c_1\bar{L}), \tag{A.3}$$

and there is a unique solution p_B for each value of $\bar{I}^D$.

Therefore, as $\bar{I}$ varies, in general the equilibria of each region describes (locally) a one-dimensional surface, i.e., a curve.

When the two regions are considered, as discussed in section 2, the equilibrium of the model is determined if both $(\bar{I})^N$ and $(\bar{I})^S$ are known. As these two parameters vary we obtain (locally) a two-dimensional surface of equilibria. If in order to allow specified variations of export levels X_B^S in the two region model, only one of the parameters $(\bar{I})^N$ or $(\bar{I})^S$ needs to vary; we thus obtain (locally) a one-dimensional surface, along with the comparative exercises of section 3 are performed.

We now discuss stability of the model.

It should be noted that the Walrasian stability of the solutions to this model (say in the market for B) cannot be studied from the reaction curve across equilibria (X_B^S and X_B^N) precisely because these represent relationships *across domestic equilibria.* They do not represent, as required for Walrasian stability analysis, the independent responses of supply and demand to given prices, obtained by aggregating across regions the outputs of profit maximising producers, and utility maximising consumers (and ignoring other parts of the market). Such independent producer and consumer responses, in effect, cannot be obtained in this model in a standard fashion, because technologies here are linear. As is well known, with a linear production technology profit maximising producers cannot determine a unique output level at given prices, because there are constant returns to scale. The output is determined in such models only at a general equilibrium, i.e., when supply equals demand. For a discussion of this point in general linear models see, e.g., Arrow and Hahn (1971, ch. 11, p. 317). In order to investigate stability one must therefore specify an adjustment process for demand and supply out of equilibrium.

We assume an adjustment process analogous to that discussed in Arrow and Hahn (1971) for linear models: within factor markets supply and demand always equilibrate at the given prices, so that the burden of adjustment is on commodity markets only. In this case, from eq. (11) we obtain in each region a supply function for B in terms of (equilibrium) employment levels,

$$B^S=(c_2L-a_2K)/D.$$

Assuming that the supply of factors is always in equilibrium

$$B^S = \left(c_2 \left(\alpha \frac{w}{p_B} + \bar{L} \right) - a_2(\beta r + \bar{K}) \right) / D.$$

Therefore the independent reaction of the supply of B to changes in its relative price p_B, assuming that factor markets are always equilibrated as p_B changes [so that, e.g. $L^D = \alpha(w/p_B) + \bar{L} = L^S$ without further adjustments of w], is

$$\frac{\partial B^S}{\partial p_B} = -\frac{c_2}{D} \alpha \frac{w}{p_B^2}.$$

From (20) in each region (when $p_B = \overline{p_B}$)

$$B^D = \alpha \left(\frac{w}{p_B} \right)^2 + \bar{L} \frac{w}{p_B} + rK - \bar{I}^D.$$

Therefore the independent reaction of B^D to prices is

$$\frac{\partial B^D}{\partial p_B} = 2\alpha \frac{w^2}{p_B^2} - \bar{L} \frac{w}{p_B^2},$$

which is always negative. It follows that

$$\frac{\partial}{\partial p_B} (B^D - B^S) = -\frac{w}{p_B^2} \alpha \left(\frac{2w}{p_B} + \bar{L} - \frac{c_2}{D} \right).$$

Therefore when condition (C.1) of Proposition 1 is satisfied, i.e., $(c_2/D) - (2w/p_B) < 0$, the market for B in the South is Walrasian stable, as its excess demand decreases with its price.[18]

Since the South is a net exporter of basic goods, when the North has a downward sloping excess demand for B (i.e., a Walrasian stable market for B) the world market for B will necessarily be Walrasian stable. The North's market for basic goods is Walrasian stable because α and β are assumed to be relatively small, so that the supply of B_S [from eq. (17)] is nearly inelastic. As $\partial B^D / \partial p_B = 2\alpha(w^2/p_B^3) - \bar{L}(w/p_B^2)$ is always negative, $(\partial/\partial p_B)(B^D - B^S) < 0$ in the North.

[18]Note that even when (C.2) of Proposition 2 is satisfied $(c_2/D - 2w/p_B > 0)$ the model could be Walrasian stable in B if $\bar{L}$ was positive and sufficiently large. Since a natural interpretation for $\bar{L}$ makes it (as shown in footnote 3) a negative number, the positive results of export-led policies (of Proposition 2) will in general obtain in a Walrasian unstable domestic market for B. The results of Proposition 1 obtain, instead, in Walrasian stable domestic markets for B.

Therefore the world market for B is Walrasian stable under the conditions of Proposition 1.

The Walrasian stability of the market for I is checked similarly. From (12) $I^S = (a_1 K - c_1 L)/D$. Taking now p_B as the numeraire for simplicity,

$$I^S = \left(a_1 \left(\beta \frac{r}{p_I} + \bar{K} \right) - c_1 (\alpha w + \bar{L}) \right) \Big/ D,$$

therefore

$$\frac{\partial I^S}{\partial p_I} = -a_1 \frac{\beta r}{p_I^2}.$$

Since $p_I I^D = \bar{I}$ (a constant),

$$\frac{\partial I^D}{\partial p_I} = -\frac{\bar{I}}{p_I^2}.$$

Therefore, if capital supply is sufficiently inelastic, i.e., β close to zero,

$$\frac{\partial}{\partial p_I} (I^D - I^S) = \frac{1}{p_I^2} (a_1 \beta r - \bar{I}) < 0.$$

Therefore each domestic market of I is Walrasian stable, and thus the world market for I is too. This completes the stability analysis.

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