Long run effects of low wage countries' growing competitiveness and exports of manufactures[#]

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Abstract

The long run effects of increasing productivity in manufactures taking place in low wage countries and the ensuing increase in exports to high wage ones are studied firstly by means of the traditional Ricardian approach; then by models developed from this approach, by removing the assumption of fixed fully employed labour supply of a model. Previous work on this problem by both neoclassical and Ricardian approaches, done by means of two country two or three good models, brought to light the possibility of a worsening of terms of trade and/or a loss in income by the high wage country. Our two country multicommodity Ricardo Mill (RM) model extends this result to the *n* good case but stresses the possibility of an offsetting income benefit, accruing to the high wage country, if the low wage country's productivity increases go beyond what is strictly necessary to bring to zero the production of a good previously produced by the high wage country. Ricardian models, however, imply that a low wage country, when new opportunities of profitable employment arise in international markets part of the labour force employed in its preexisting productions is shifted in these new directions, must reduce those productions, because of a fixed labour supply. Since this process looks scarcely plausible in our context, we explore two alternative setups, where for the low wage country the assumption of full employment of a fixed labour supply is discarded: first, a model, in which the modern (capitalist) sector can hire at a fixed wage, based on the subsistence level, any amount of labour force (infinite elasticity of labour supply model); and secondly a model, built upon the previous ones, in which the elasticity of labour supply is positive and finite. On the basis of this more realistic and general model we conclude that, if the elasticity of labour supply is sufficiently large, high wage countries, far from losing, will gain.

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1. Introduction

The large, rapid increase in exports of manufactures from low wage to high wage countries is cause for considerable concern in the latter due to job losses, particularly in labour intensive manufactures. To allay such fears the common response is to claim that this loss of jobs is a short term problem: the increased income in the former countries will provide larger markets for industries where high wage economies keep a comparative advantage. Shifting the labour force and other resources losing their employment to those industries will – in the long run – generate allocational improvements that will also benefit the high wage country and will certainly outweigh such temporary losses.

Actually, the (few) existing theoretical analyses of the problem – whether Ricardian or neoclassical - fail to support this belief: according to them, the productivity increase of low wage countries in manufactures and the ensuing growth in market shares can cause a long run real income loss in the high wage countries.

This was recently recalled by Samuelson (2004), using some two and three good two country (China America) numerical examples, built on Ricardo Mill trade theory. Moreover, an advocate of globalisation, reacting to Samuelson's paper, noted "Samuelson's analytic result […]that technical progress in China can wipe out all potential gains for America is not in dispute at all — […] it has been known to trade economists at least since 1950s when the late Harry Johnson who taught International Trade at the University of Chicago first demonstrated it." (Panagariya, 2004, p.4)[1]

In fact, in the paper published by H. Johnson (Johnson, 1955) fifty years ago the possibility that an increased productivity in an import competing industry of a given country could cause a terms of trade deterioration in the country from which those imports were coming was clearly recognized.

The analytical structure of this paper is based on a two good two country trade model, in which factors in each country are given and can move between sectors. In the case of increased

[1] However the authoritative comprehensive textbook by Bhagwati et al. (1998) does not mention it.

productivity and output expansion in an import competing (export) sector - if this output increase does not generate, via increasing income, a (more than) proportional expansion in demand for the same sector - the terms of trade move against that sector and in favour of (against) the country where productivity augmented.

Johnson's treatment of the effects on terms of trade of various aspects of economic growth was further developed and supplemented, and the subject was introduced into some advanced level textbooks of international economics (e.g. Takayama 1972).

Its implications for the problem we are discussing, however, were largely neglected. A possible explanation of this fact is that they were considered of little empirical significance[2]. Moreover most economists attach great importance to the potential dynamic gains – in terms of efficiency, of investments in technology and in new productions - that competition, spurred by free trade, could deliver and would hate the idea of supplying an argument to the protectionist tendencies, always incumbent in high wage countries, that is – as Samuelson puts it (2004, p.143) - to "[…]lobbyist induced tariffs and quotas which involve both perversion of democracy and nonsubtle deadweight distortion losses.".

However, since Johnson's argument was not so well known nor so exhaustive as asserted in the above quotation and the empirical significance of the matter is today greatly augmented, in recent years other important contributions reconsidered the issue, stressing the possible real income loss

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[2] In his comment on Samuelson quoted above, Panagariya continues as follows: "Whether the change abroad is significant enough, in terms of its net effects on excess demands and supplies of goods at existing terms of trade, and whether it makes sense to worry about sufficiently large "national monopoly power" in international trade such that large terms of trade changes may follow from modest changes in excess demands and supplies, are empirical questions. The Bhagwati, Panagariya and Srinivasan [2004] paper discounts the possibility of significant terms of trade changes following productivity changes and skill accumulation abroad." Panagariya (2004, p.8)

for high wage countries stemming from increasing productivity and exports of manufactures in low wage countries.

The first paper to be mentioned is Johnson and Stafford (1993). They use a three good two country Ricardo Mill (RM)[3] model, in which country 1 initially produces exclusively two goods (A and B) and country 2 produces exclusively the third. Then the latter country, thanks to a first productivity increase in good B becomes competitive also in this good and shares its production with country 1. In this case, *any further productivity increase* causes a loss (gain) in country 1's (2's) relative and absolute real income.

A second example of the Ricardian approach to our problem is the already mentioned paper by Samuelson (2004). In this paper, that attracted a lot of attention, two and three good two country numerical examples are discussed. Whilst the three good case is similar to Johnson and Stafford's, in the two good case technical change by simply making the low wage country's comparative cost equal to the high wage country's, wipes out the gain from trade previously enjoyed by the latter.

As for the neoclassic approach, the paper by Hymans and Stafford (1995) is to be mentioned. They prove the possibility of a real welfare loss in the high wage countries by using a suitable two country apparatus of production possibility curves and social indifference curves, which can be seen as a development of Johnson's argument. [4]

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[3] By "Ricardo Mill models" we mean Ricardian models with demand assumption similar to that of Mill, that is the expenditure on each good is a constant share of total expenditure.

[4] The main limitation of both the neoclassic and Ricardian approaches is to avoid the introduction of economies of scale, a feature that would greatly complicate the analysis. This difficult task is taken up in a remarkable book by Gomory and Baumol (2000). They are able to deal with economies of scale in general models of a multicountry multicommodity world by means of a very high number of simulations, but the focus of their work is on proving the importance of conflicting economic interests between trading nations.

In this paper we shall at first follow the traditional Ricardian approach, clarifying and extending the results of the literature. Then we shall develop it in a new direction, by removing the assumption of fixed fully employed labour supply.

In section 2, we provide a detailed presentation of the Ricardian approach by means of a two country multicommodity model. This model is based on the multivalued function that gives the relative share of world demand for any given level of relative wage. Its coupling with a "relative income function" depending on relative wage gives rise to a general equilibrium system with a unique solution for relative wage, hence also for international specialization, relative share of world demand and relative income. One advantage of this general equilibrium system is that it allows easy two dimensional representations potentially useful also for other comparative static results, outside the scope of this paper. Another distinctive advantage of our multicommodity model over other Ricardian trade models like the continuum of good and the two good models is that the range of goods can be divided into different categories, chosen for their meaning in the light of one's interpretative purposes, each of which can be treated differently. We shall choose the following three categories.

Category I: goods that low wage countries do not produce, because they are very difficult to imitate successfully;

Category II: goods produced only by low wage countries, in which they have little or no disadvantage in productivity;

Category III: goods for which they have a negative but decreasing productivity differential, so that, thanks to their low wages, they are becoming competitive.

From the above model in section 3 we shall develop simple proofs confirming for the three good case and *extending to the n good case* the possibility of a loss in the real income of the high wage country, when, thanks to increasing productivity in the low wage country, the production of one category III good is shifted to the latter. This loss takes the form of a reduction in imports of category II goods, due to a lower relative wage and the resulting worsening of the ratio between their price and income per worker.

As for the lower relative wage, this comes about because the low wage country will shift to the production of the former goods part of its labour force previously employed for the production of the latter goods. Then, since the assumptions of the RM model require that the share of each good's demand in the world income be maintained, in the presence of a change in the proportions in which they are supplied, the relative price of category II goods, hence the relative wage of the low wage country, must increase.

The model also stresses *a very important feature not found in other Ricardian analyses of the problem: if the productivity increases go beyond what is strictly necessary to reduce to zero the production of a category III good in the high wage country, for that part of the increase an income benefit accrues to the country in question*[5]*, partially or totally offsetting the aforementioned loss. This benefit takes the form of a lower ratio between the price of this good and income per worker.* However, the idea that a low wage country like China, when new opportunities of profitable employment arise in international markets, significantly reduces - as the RM model requires - its more traditional productions, due to lack of manpower, looks scarcely plausible. Therefore in section 4 we explore two alternative setups where for the low wage country the assumption of full employment of a fixed labour supply is discarded: first, a model economy, in which the modern (capitalist) sector can hire at a fixed wage, based on the subsistence level, any amount of labour force (infinite elasticity of labour supply); and secondly a model, built upon the previous ones, that we call "Intermediate", in which the elasticity of labour supply is positive and finite.

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[5] According to Gomory and Baumol (2000, p.153) this result appears already in the works of Stafford et al. We were unable to find it in their published works, in spite of an exchange of letters with Professor Stafford (who kindly sent us a copy of Johnson and Stafford (1998)). In any case our multicommodity approach gives a new dimension and an enhanced relevance to this effect, that will be very important also in the other models we shall propose.

The difference in results between the RM and the other models is remarkable. In particular we shall consider those of the Intermediate model, the more realistic and general: according to this model, if the elasticity of labour supply is sufficiently large, high wage countries, far from lose, will gain.

2. A Ricardo Mill two country multicommodity model

We consider two countries, A and B, producing *n* goods, that can be freely moved within and among countries with negligible transport costs. Labour is the only factor of production and cannot be moved among countries. Its productivity does not vary with the level of output. The labour supply L_j , $j \in \{A, B\}$, is fixed and always fully employed. Perfect competition prevails in all markets.

We define for $i \in I \equiv \{1,2, \ldots n\}$, $j \in \{A, B\}$: the wage rate of country j, w_j, the labour productivity of country j in good i, π_{ij} , the "relative productivity" for good i, $g_i \equiv \frac{\pi_{iA}}{\pi_{iB}}$,

$g_i < g_{i+1}$ *(1)*

the relative wage $w = w_A / w_B$ and the relative labour supply $L = L_A / L_B$. Wages and prices of both countries are expressed in a common unit. Let P_i be the price of good i and x_{ij} the quantity produced of good i in country j. Perfect competition implies, for all $i \in I$:

$P_i \leq \min_j (w_j / \pi_{ij})$, $j \in \{A, B\}$ x_{iA} , $x_{iB} \geq 0$ *(2a)*

$P_i = \min_j (w_j / \pi_{ij})$ if $x_{iA} + x_{iB} > 0$ *(2b)*

$x_{iA} > 0$ only if $w_A/\pi_{iA} \leq w_B/\pi_{iB}$ $\Leftrightarrow$ $w \leq g_i$ (3a)

$x_{iB} > 0$ only if $w \geq g_i$ (3b)

National income of country j, Y_j , equals the wage bill:

$Y_j = w_j L_j$, $j \in \{A, B\}$

Let D_{ij} be the amount of good i demanded in country j. In both countries

$$P_i D_{ij} = b_i Y_j, \quad b_i \text{ constant}, \quad \sum_1^n {}_i b_i = 1 \qquad (4)$$

an assumption of Millian derivation[6]. Total demand for country A's production, from eqs.(2)–(3), is given by world demand for the goods in which its relative labour productivity is higher than the relative wage

$$\sum_{i \in e(w)} {}_i b_i (w_B L_B + w_A L_A), \qquad e(w) \equiv \{i;\ i \in I;\ g_i > w\}$$

plus a share λ (to be determined) of world demand for the [unique because of assumption (1)] good, if it exists, for which relative labour productivity is equal to relative wage:

$$\lambda \theta b_r (w_B L_B + w_A L_A), \qquad \theta = 0 \text{ if } g_r \neq w, \quad \theta = 1 \text{ if } g_r = w,$$

where $r = min\{i\ ;\ i \in I;\ g_i \geq w\}$.

$\lambda \in [0,\ 1]$ when $n > r > 1$ *(5a)*

but the full employment assumption requires $x_{iA}\ ,\ x_{iB} > 0$, hence

$w \in [g_1,\ g_n]$

$\lambda < 1$ when $w = g_1$ *(5b)*

$0 < \lambda$ when $w = g_n$ *(5c)*

Income in country A equals total demand:

$$w_A L_A = \left(\sum_{i \in e(w)} {}_i b_i + \lambda \theta b_r \right) (w_B L_B + w_A L_A) =$$

$$= [1 - \left(\sum_{i \in e(w)} {}_i b_i + \lambda \theta b_r \right)]^{-1} \left(\sum_{i \in e(w)} {}_i b_i + \lambda \theta b_r \right) w_B L_B$$

Let

$$H(w) \equiv [1 - \left(\sum_{i \in e(w)} {}_i b_i + \lambda \theta b_r \right)]^{-1} \left(\sum_{i \in e(w)} {}_i b_i + \lambda \theta b_r \right)$$

As w grows, $H(w)$ decreases stepwise (See Figure 1).

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[6] Mill's original assumption (Mill, 1844) is that the value of demand for each good is constant. Cf. also Chipman (1965), p. 484.

Figure 1 approximately here

As $g_i < w < g_{i+1}$, $H(w)$ is constant. Along such horizontal stretches of the graphic of $H(w)$, no good is produced in common by both countries, whilst along a vertical stretch, that is when

$$g_i = w \qquad (6)$$

holds, λ can take on the values as in (5) and, if $\lambda \in (0, 1)$, good i is produced by both countries.

In particular $H(g_1) \in [\sum_{2}^{n} {}_i b_i / b_1, +\infty)$, $H(g_n) \in (0, \ b_n / \sum_{1}^{n-1} {}_i b_i \ ]$.

Hence $H(w)$ is a multivalued stepwise decreasing function defined for $w \in [g_1, g_n]$. We may call $H(w)$ and Lw – respectively.- "relative share of world demand function" and "relative income function". The trade balance equilibrium, if it exists, is where the two functions meet, that is when

$$H(w) = Lw \qquad (7)$$

Since it is stepwise decreasing, $H(w)$ crosses Lw once and only once and the existence and uniqueness of an equilibrium is granted.

Obvious conclusions offered by the model are the following. A general increase in country A's (B's) productivity that shifts function H to the right (left) for any value of w, will increase (decrease) its relative income per worker w, hence, given L, its relative total income. A similar effect on relative income per worker is produced by a decrease (increase) in L.

3. The effect on high wage countries' real income of low wage countries' productivity increases in "export industries" of the former.

Our focus however is not on the effect of a general increase in the low wage country's productivity - that we choose to be country B - , but on the effect on the high wage country's (country A) of an improvement in the former country's productivity taking place in an export industry.

As mentioned before, we divide the range of goods into three categories that we consider very significant for our purposes:

Category I: goods that low wage countries do not produce, because they are very difficult to imitate successfully;

Category II: goods produced only by low wage countries, in which they have little or no disadvantage in productivity;

Category III: goods for which they have a negative but decreasing productivity differential, so that, thanks to their low wages, they are becoming competitive.

The analytical advantages of this tripartition can – up to a point - be exploited in a relatively easy way by the use of a three good model, where goods 1, 2 and 3 correspond respectively to categories I, II and III. Therefore we shall base most of our analysis on a three good model of this kind.

We choose, contrary to (1), the following ordering of relative productivities:

$g_2 < g_3 < g_1$

To examine not only relative, but also absolute income changes, we introduce a utility function consistent with eq. (4): we assume that everybody and every country have a Cobb-Douglas utility function with the same parameters. Taking the case of countries, its relationship with real income can be shown as follows.

Let U_j and Q_{ij} be the utility function and the quantity of good i available in country j. Then

$$U_j = \prod_{i=1}^{n} Q_{ij}^{b_i}, \qquad \sum_{i=1}^{n} b_i = 1, \tag{8a}$$

By maximizing U_j under the budget constraint

$$\sum_{i=1}^{n} P_i Q_{ij} \leq w_j L_j \tag{8b}$$

and using Euler theorem one gets

$$\prod_{i=1}^{n} Q_{ij}^{b_i} = \sum_{i=1}^{n} P_i Q_{ij} = w_j L_j = Y_j \tag{9}$$

From eq.(4), when supply equals demand:

$Q_{ij} = b_i L_j w_j / P_i$

If good i is produced at home,

$$Q_{iA} = b_i L_A \pi_{iA} \tag{10a}$$

$$Q_{iB} = b_i L_B \pi_{iB} \tag{10b}$$

If it is imported

$Q_{iA} = b_i L_A \pi_{iB} w$ *(10c)*

$Q_{iB} = b_i L_B \pi_{iA} / w$ *(10d)*

We shall now focus on the effect on the level of national income of country A of an improvement in good 3 productivity, taking place in country B, that is in π_{3B}. We shall consider two cases, in which before the change in π_{3B}, country B's production of good 3 is nil, whilst after the change it is hundred per cent of world production in Case 1, a lesser proportion in Case 2.

Figure 2 approximately here

Let us use the graphical illustration provided by Figure 2. Note also that the properties of our model imply that $R=(b_1+b_3)/ b_2$ and $S=b_1/(b_3+b_2)$ are the only values of $H(w)$ at which its graphic is horizontal, that is, no good is produced by two countries (full specialization).

The solid stepwise line is the graphic of $H(w)$ before an increase in π_{3B}, the thick dotted lines show $H(w)$ after two different increases: g_3 moves either to g_3'' (Case 1) or to g_3' (Case 2).

The before change equilibrium is at point K where $H(w)=R$ and country B's production of good 3 is nil.

Case 1. The equilibrium point shifts from K to J. Country B's production of good 3 after the change is hundred per cent of world production. $H(w)$ is shifted from R to S. Then

$w =(b_1+b_3)/Lb_2$

$w'=b_1/L(b_3+b_2)$

(An apostrophe will always denote after change values).

The relative wage decreases:

$w'/ w= =b_1 b_2/(b_2+b_3) (b_3+b_1)<1$ *(11a)*

An economic explanation of this fact runs as follows. To maintain the full employment of its labour force, country A must expand employment in good 1, whilst country B must reduce the labour force employed in good 2 to provide sufficient employment to satisfy the demand for good 3. Then for

the share of each good's demand in the world income to be maintained, as the assumptions of the model require, in the presence of a change in the proportions in which they are supplied, the relative price of good 2, hence country B's relative wage, must increase.

These changes in relative prices and wage affect also the available quantity vectors, as determined in equilibrium by eqs. (8) (9) and (10). Let country A's available quantity of good *i, i*$\in I$, at the before change equilibrium be Q_{iA} and Q_{iA}' the corresponding after change equilibrium quantity. Then

$Q_{1A} = b_1 L_A \pi_{1A} = Q_{1A}'$

$Q_{2A} = b_2 w L_A \pi_{2B} > b_2 w' L_A \pi_{2B} = Q_{2A}'$ *(11b)*

$Q_{3A} = b_3 L_A \pi_{3A} \leq b_3 L_A w' \pi_{3B}' = Q_{3A}'$

since

$w' \geq \pi_{3A}/\pi_{3B}' = g_3'$.

The source of loss for country A then is

$Q_{2A}'/Q_{2A} - 1 = w'/w - 1$ *(11c)*

negative because of *(11 a* and *b);* whilst the possible source of offsetting gains is[7]

$Q_{3A}'/Q_{3A} - 1 = w'/g_3' - 1 \geq 0$ *(11d)*

The possible source of country A's gain arises when and to the extent that the increase in π_{3B} is larger than what is necessary and sufficient to reduce country A's production of good 3 to nil, that is when $g_3' < w' = b_1/L(b_3+b_2)$ prevails. [If $g_3' = w' = b_1/L(b_3+b_2)$ prevails, $H(w) = S$ and country A's production of good 3 is nil (the equilibrium is at a vertex of the graphic of $H(w)$)]. Then there is a gain in country A's purchasing power relative to good 3:

$P_3'/w_A' = w_B'/(\pi_{3B}' w_A') = g_3'/(w' \pi_{3A}) < 1/\pi_{3A} = P_3/w_A$

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[7] Notice that the relative size of country A's losses and gains – as shown by eqs.(*11c* and *11d*) - is fixed by the relative distance of the value of the after change equilibrium wage rate *w'* from the extremes of the interval $[g_3', w]$: $|w' - w|$ relative to $|w' - g_3''|$. (In Figure 2 by $|w_j - w_K|$ relative to $|w_j - g_3''|$).

Note that the displacement of country A's production in good 3 has *no direct adverse effect* on this country and may have a favourable effect. The negative effect, as spelled out before, comes from the worsening of the relative wage and the related increase in the price of good 2 relative to the wage rate of country A:

$w\,\pi_{2B} > w'\,\pi_{2B} \qquad \Rightarrow \qquad w_A/P_2 > w_A'/P_2'$

Case 2. The equilibrium point shifts from K to Z, both countries produce good 3 and equation

$g_3' = \pi_{3A}/\pi_{3B}' = w'$ (6 bis)

prevails. Hence the possible source of gain arising in Case 1 disappears and only a source of loss in real income remains.[8]

The three good approach, however, tends to give an impression of the possible gains that is not fully supported by an explicit introduction of many goods in each category. For if good 3 is taken to represent the whole of manufacturing goods that can be successfully imitated, it is natural to think that the process of imitation is not yet completed; hence Case 2 is the relevant one and no offsetting gains accrue to high wage countries. However, if we consider the imitated goods one by one, it seems plausible that for many goods country B's relative productivity increases, as in Case 1, exceed what is necessary and sufficient to bring country A's production of these goods to nil and offsetting gains accrue to country A[9].

The main conclusion to be drawn from the RM model is that, to the extent that low wage countries' productivity increases simply shift the production of any good away from the high wage countries without achieving further productivity gains, the effect on high wage countries' real income level is

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[8] Johnson and Stafford's (1993) analysis falls within Case 2, whilst in Samuelson's (2004, *on line file*) numerical example of Appendix 1 the after change equilibrium is at a vertex of the graphic of *H(w)*.

[9] See the Appendix, below, for a formal presentation of the multicommodity results, that are fully in line with those of the three good model.

negative. But to the extent that they exceed that level, offsetting gains accrue to them, the net effect remaining uncertain.[10]

4. Alternative assumptions on the low wage countries' labour market

As stressed above, a crucial feature for the results of the RM model is that, when country B becomes competitive in the production of category III goods, it shifts part of its labour force – which is always fixed and fully employed - from the production of category II goods to that of category III goods. But how plausible is it that a low wage country, when new opportunities of profitable employment arise on international markets, significantly reduces its more traditional productions for lack of manpower? For instance, for a very big country like China – whose manufacturing employment is double that of all the G7 countries together- it seems scarcely plausible[11]. Therefore it seems sensible to explore an alternative setup, where, in our country B, instead of the full employment of a fixed labour supply, we assume that any amount of labour demanded, within the range of the employment changes relevant to our purposes, is supplied at a fixed wage rate, based on the subsistence wage; that is at that wage there is a large, persistent excess

[10] Low wage countries, as one can easily prove, gain in any case.

[11] After a very thorough, well documented analysis of data and estimates for the Chinese labour market, Banister (2004, p.23) remarks: "[…] for the first decades of the 21st century, the PRC [People Republic of China] has for all practical purposes an unlimited supply of labor, at least of the unskilled and minimally educated variety, and perhaps also of basically literate and numerate hard working laborers who were born in the countryside." As for "Asia's developing countries" as a whole, according to Felipe and Hasan (2006, p. xiii), out of 1.7 billion workers "at least 500 million are unemployed or underemployed".

supply and infinite wage elasticity of labour supply[12]. Then, having examined these two diametrically opposed situations, we shall more easily address intermediate and more realistic cases.

4.1 Infinite wage elasticity of labour supply (IES model)

The first analytical problem to model an infinite wage elasticity of labour supply – in the sense of a large, persistent excess supply of labour at a fixed wage - is to introduce an activity that can grant the survival of the (large number) of workers not employed in the other "regular" economic activities, the former activity being such as to keep the workers ready to enter the latter activities as soon as their labour demand expands. In our setting a second analytical problem comes from the fact that workers moving from the former to the latter activities move also from subsistence consumption to expenditure patterns *à la* Mill.

We shall try to give a solution to these problems by developing a very simplified model of country B's economy with the following features. In that economy there are two very different sectors, the modern sector and the traditional one. The latter acts as a reservoir of labour, that can be hired by the former at a fixed wage. The modern sector here is the set of country B's productions we have been dealing with up to now. The traditional sector is a set of family firms that produce with constant returns technology goods that are not included in the three categories already introduced and are inferior goods. They consume entirely what they produce which is barely sufficient for their survival, so that their output per worker is the real subsistence income.

Let u be the utility for an individual worker. In view of the homogeneity properties of Cobb-Douglas functions, in the modern sector we have

$u= U_B/L_B$

where U_B – which refers to the modern sector only - fulfils (8) and (9), and

$u=w_B,$ *(12a)*

[12] As is well known, the *locus classicus* of this approach is Lewis (1954). Many of its features, however, whatever their merit, are incompatible with our present setup.

Using again the three good model, when country B is not yet competitive in good 3,

$$u=(b_1\pi_{1A}/w)^{b_1}(b_2\,\pi_{2B})^{b_2}\;(b_3\,\pi_{3A}/w)^{b_3} \qquad (12b)$$

In this particular setting, the (real) wage rate prevailing in the modern sector, $w_B°$, is equal to the lowest wage rate sufficient to attract from the traditional sector additional workers, repaying them for the displacement from the countryside and the familiar habits of life and work; we assume also that $w_B°$ is sufficient to induce them to abandon inferior goods in favour of the basket of goods prevailing in the modern sector. The real wage $w_B°$ will always remain fixed in terms utility and $u°$ is the utility associated to it: $u°= w_B°$.

As long as π_{3B} is fixed, from (12b), we get

$$w°= [(b_1\pi_{1A})^{b_1}(b_2\,\pi_{2B})^{b_2}\;(b_3\,\pi_{3A})^{b_3}/u°]^{1/(b_1+b_3)}$$

After a productivity change such that country B produces exclusively good 3, i.e.

$$\pi_{3B} <\pi_{3A}/w° <\pi_{3B}'$$

$u°$ remains fixed and $w°$ must change:

$$u° =(b_1\pi_{1A}/w°')^{b_1}(b_2\,\pi_{2B})^{b_2}\;(b_3\,\pi_{3B}')^{b_3} \qquad (12c)$$

$$=(b_1\pi_{1A}/w°)^{b_1}(b_2\,\pi_{2B})^{b_2}\;(b_3\,\pi_{3A}/w°)^{b_3}$$

then, dividing the third member by the second,

$$w°/w°' = \left(\frac{\pi_{3A}}{w°\pi_{3B}'}\right)^{b_3/b_1} <1$$

the relative wage rate moves in favour of country A.

Since w is now determined by the previous equations, the endogenous variable in eq. (7) is now L_B.

When country A produces exclusively good 3

$$L_B=w°L_A/H(w°) = w°L_A/[(b_3+b_1)/b_2]$$

After the change in π_{3B}, country A's production of good 3 is wiped out completely and

$$H(w°')= [b_1/(b_3+b_2)]$$

$$L_B'=w°'L_A/[b_1/(b_3+b_2)]> L_B$$

Along this process of dislocation of production, in the modern sector of country B employment increases, while absolute and relative wage remain constant at – respectively - w_B° and w°'.

After the increase in π_{3B}, in country A the amount of good 1 remains constant,

$Q_{1A} = b_1 L_A \pi_{1A} = Q_{1A}'$

and those of good 2 and 3 increase, the latter being produced exclusively by country B in lieu of country A:

$Q_{2A} = b_2 w^\circ L_A \pi_{2B} < Q_{2A}' = b_2 w^\circ' L_A \pi_{2B}$

$Q_{3A} = b_3 L_A \pi_{3A} < Q_{3A}' = b_3 L_A \pi_{3B}' w^\circ'$

since $w^\circ < \pi_{3A} / \pi_{3B}' < w^\circ'$.

Hence a gain in country A's real absolute income.

Country B gains as well, since the consumption basket in the modern sector is preferred by workers to the subsistence consumption and $L_B' > L_B$. Both countries share the benefits of the productivity increase. *Country B's productivity gains here go to increasing its employment in the modern sector rather than wages, while their terms of trade effect goes entirely to the advantage of country A.*

4.2 Positive and finite elasticity of labour supply (INT model)

Having examined the two diametrically opposed possibilities for the low wage countries' labour market - full employment of a fixed labour supply (zero elasticity of labour supply) and infinite wage elasticity of labour supply at a fixed wage rate - we shall now address the intermediate and more realistic case, where, in case of an increase in labour demand in country B, determined by a higher π_{3B}, both employment and wages increase. We shall express this situation by assuming

$w_B / w_B^\circ = m L_B^\gamma, \qquad \infty > \gamma > 0, \qquad m > 0$

or, by (12)

$u / u^\circ = m L_B^\gamma.$

The wage elasticity of labour supply, $1/\gamma$, is positive and finite. We shall call this third model "Intermediate" (INT).

This assumption can be explained by various reasons. In the first place, with a standard supply curve, by which labour supplied rises with real wages, an increase in employment, when comparing market equilibrium positions, can be obtained only at a higher level of wages; secondly, a rise in employment, by augmenting the bargaining power of workers, as well as the congestion of industrialized areas and the cost of urban life pushes up the wage rate. The latter explanation can mark a really important difference from the RM model if the employment increase also means the possibility of a large inflow in the modern sector from a reservoir of manpower like that described in the IES model.

Using the three-good model again, in Appendix, below, we prove the following results. If we assume a before change equilibrium at $[w^{\circ},(b_3+b_1)/b_2]$, common to the three models, for the INT model, after an increase in π_{3B} sufficient to shift completely the production of good 3 from country A to country B, the new equilibrium implies an employment level and a relative wage that are intermediate between those of the previous models. In particular we have

$$w^{\circ\prime} > w^{\circ} > w^{*} > b_1/L(b_2+b_3) > g_3' \qquad (15)$$

where w^* is the after change equilibrium value of w for the INT model (see Figure 3).

Figure 3 approximately here

Notice that eqs. (*11 a* and *11b*) can be adapted for this model to define country A's income gains and losses: the source of loss for country A is

$$Q_{2A}'/Q_{2A} - 1 = w^*/w^{\circ} - 1 \qquad (16a)$$

negative because of *(15);* whilst the source of offsetting gains is

$$Q_{3A}'/Q_{3A} - 1 = w^*/g_3' - 1 > 0 \qquad (16b)$$

the global proportional gain for country A being

$$Y_A'/Y_A - 1 = (Q_{2A}'/Q_{2A})^{b_2} \ (Q_{3A}'/Q_{3A})^{b_3} - 1$$

In Figure 3 we can see that the size of both effects depends on the distance between w* and w°, which in turn is smaller, the higher is the elasticity of labour supply. Such distance determines also

how the benefit of increasing productivity is divided: the smaller it is, the lower is country B's gain in terms of improved relative wage and the greater country A's gain in terms of Q_{3A}', the smaller its loss in terms of Q_{2A}'; but the larger is also country B's gain in terms of augmented employment[13], that, if the employment increase also means the possibility of an inflow in the modern sector from a reservoir of manpower like that described in the IES model, means an improved condition of the newly employed workers.

Then it is worth at this stage – using also the conclusions of the Appendix for the multicommodity case - giving a more detailed description of the economic processes leading – in the INT model - to country A's losses or gains. When country B becomes competitive in the production of a good of category III and shifts part of its labour force to the latter, the production of category II goods decreases, though less in the INT than in the RM model, because in the former an increase in total employment will partially offset its change of destination. Then for the share of each good in the world income to be maintained, as the assumptions of the models require, in the presence of a change in the proportions in which they are supplied, the relative price of category II goods, hence the relative wage of country B, must increase. The size of this effect, as we have seen before, depends on the wage elasticity of labour supply, $1/\gamma$: the larger it is, the lesser are – *ceteris paribus* - the reduction in the production of category II goods and the resulting increase in relative wages and prices.

The displacement of country A's production in a given good of category III – as in the RM model - has no direct adverse effect on this country and may cause a favourable effect - a gain in country A's purchasing power relative to that good - when and to the extent that the increase in country B's productivity in that good is larger than what is necessary and sufficient to reduce country A's production of that good to nil. This favourable effect – as explained for the three good case - is also dependent on (directly proportional to) the size of the wage elasticity of labour supply, $1/\gamma$.

[13] Here is we assume that the labour elasticity of supply is larger than one.

5. Concluding remarks

According to Harry Johnson (1955), in the case of a foreign country's increased productivity and output expansion in an import competing (export) sector - if this output increase does not generate, via increasing income, a (more than) proportional expansion in demand for the same sector - the terms of trade move against that sector and in favour of (against) that country. Therefore for the home country (the high wage countries in our case) productivity gains in the foreign country (the low wage countries in our case) had a completely different impact on its economy according to the sector in which they took place. The later literature focussed on the import competing case, and particularly on the loss caused to high wage countries by the increasing productivity in low wage countries' manufacturing sector. Our analysis suggests[14] that in that case also, thanks in particular to a large – on average – elasticity of labour supply, high wage countries, far from lose, will gain.

To see this, let us consider the INT model, the more realistic and general. As we have seen, in the case considered country A has a potential loss (gain) as far as goods of category II (III) are concerned. We also noticed that the size of the potential loss depends on the wage elasticity of labour supply, $1/\gamma$: the larger it is, the lesser are – *ceteris paribus* - the reduction in the production of goods of category III and the resulting change in relative wages and prices. Suppose the labour supply elasticity is very large: then high wage countries' losses from this side should be negligible. The likelihood of country A's potential gains in goods of category III is also positively affected by the size of the labour supply elasticity. In any case, we believe that when a good is successfully imitated by low wage countries, whose production replaces high wage countries', most often the productivity increases of the former go beyond what is necessary to obtain such a replacement and the potential gains are attained.

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[14] The value of these suggestions is - as always – dependent on the value of the model supporting them. In spite of the many limitations of our model, we believe that its conclusions may contribute to a fuller understanding of the problem discussed.

As for low wage countries, when the labour supply elasticity is very large, their gain is given more by employment increases – shifts from the bare subsistence sector to the modern one - than by favourable relative prices changes.

In conclusion, here we stress the importance of the labour supply elasticity and of "reservoirs of manpower" in low wage countries. In this light, the gains of these countries assume a partly different character, whilst our analysis suggests, contrary to previous theoretical works on this problem by both neoclassical and Ricardian approaches, that high wage countries, far from losing, will gain.

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Appendix

1. Comparing equilibrium wages and employment in the three models

Using the three-good model, as long as country A's output of good 3 is positive, from (8) (10) and (12b)

$w/w^{\circ} = (u/u^{\circ})^{-\delta} = mL_B^{-\delta\gamma}, \qquad \delta \equiv 1/(b_1+b_3) > 1$

so that

$L_B = m^{-1} (w^{\circ}/w)^{1/\delta} \qquad (13a)$

But after a change in π_{3B}, such that $w^{\circ} > g_3'$, from (8) (10) and (12c)

$w/w^{\circ\prime} = (u/u^{\circ})^{-\beta} = mL_B^{-\beta\gamma}, \qquad \beta \equiv 1/b_1 > 1$

so that

$L_B = m^{-1} (w^{\circ\prime}/w)^{1/\gamma\beta} \qquad (13b)$

that is, the labour supply function is shifted by the change in π_{3B}, hence in the relative price of a wage good.

We shall assume for the INT and RM models a common before change equilibrium which is – as point K in Figure 3 - at $(w^\circ, (b_3+b_1)/b_2)$, where country A produces exclusively good 3 and the relative wage is equal to that of the IES model; moreover that g_3' is less than $[b_1/L(b_3+b_2)]$, the equilibrium relative wage in the RM model when country B produces exclusively good 3 (see point Q in Figure 3).

When $w=w^\circ$ we have

$L_B = m^{-1}$

i.e., in the INT model m^{-1} is the supply of labor when $w=w^\circ$.

Without loss of generality, m^{-1} can also be taken as the (exogenously given) value of L_B in the RM model, so that $L= mL_A$.

The after change equilibrium equation now takes the form:

$$G(w)w = b_1/(b_3+b_2) \qquad (A4)$$

where

$G(w)\equiv L\,(w/w^\circ)^{1/\gamma\beta}$

$G(w)w$ is in the INT model the relative income function (taking the place held by Lw in the RM model). Now we shall show that the graph of $G(w)w$ must lie between the ray Lw and the vertical line at w°', as in Figure 3. Notice that

$G(w^\circ')= L$

$G(w^\circ')w^\circ'=L\,w^\circ'$

and $(w^\circ', L\,w^\circ')$ is point T in Figure 3.

$G'(w)= (\gamma\beta w)^{-1}G(w)$

$$\frac{d[G(w)w]}{dw} = G(w) + w\,G'(w) = [1 + (\gamma\beta)^{-1}]\,G(w) > 0$$

$$\frac{d^2[G(w)w]}{d^2w} = [1 + (\gamma\beta)^{-1}]\;G'(w) > 0$$

At $(w^\circ', L\,w^\circ)$:

$$\frac{d[G(w)w]}{dw} = (1 + 1/\gamma\beta)\, L > L$$

Moreover for any positive $w < w^{\circ\prime}$

$L\,w - G(w)w = L\,w[1-(w/w^{\circ\prime})^{1/\gamma\beta}] > 0$

Hence the two lines $G(w)w$ and Lw cannot cross for $w \in (0, w^{\circ\prime})$ but cross at the origin and at $w^{\circ\prime}$; moreover for $w>0$ $G(w)w$ is positive and increasing. Then the graph of $G(w)w$ must lie between the ray Lw and the vertical line at $w^{\circ\prime}$, as in Figure 3 and a (unique) value of the relative wage, say w^*, exists that fulfils both (A4) and

$w^{\circ\prime} > w^* > b_1/L(b_2+b_3)$

The after change equilibrium relative wage in the INT model is intermediate between those of the two previously examined models. The same is true of the after change equilibrium employment L_B, which in all three models must fulfil

$L_B' = w' L_A [b_1/(b_3+b_2)]^{-1}$

where w' is given by $w^{\circ\prime}$, w^* and $[b_1/L(b_2+b_3)]$ for, respectively, the IES , INT and RM model. Then we can summarize the above results as follows. If we assume a before change equilibrium at $[w^{\circ}, (b_3+b_1)/b_2]$, common to the three models, for the INT model, after an increase in π_{3B} sufficient to shift completely the production of good 3 from country A to country B, the new equilibrium implies a relative wage of country A and an employment level of country B that are intermediate between those of the previous models. Moreover, as γ tends to ∞, $G(w)$ tends to L, whilst as γ tends to 0, $G(w)w$ tends to coincide with the vertical line at $w^{\circ\prime}$, as long as w is not too small, since in any case as w tends to 0 $G(w)w$ tends to the origin.

2. Country A's losses and gains in a multicommodity setting for RM and INT models.

Let N_r be the set of goods in category r, $r \in \{I, II, III\}$, w_E the before change equilibrium wage rate. If country B becomes competitive in good $s \in N_{III}$ and produces a share of its world output, the relative demand function $H(w)$ is shifted and a new equilibrium wage rate w_E' prevails such that:

$g_s' \leq w_E' < w_E < g_s$ (A1)

Then

$Q_{iA}' = b_i L_A \pi_{IA} = Q_{IA}$ all $i \in N_I$

$Q_{iA}' / Q_{iA} - 1 = w_E' / w_E - 1 < 0$ all $i \in N_{II}$ (A2)

$Q_{sA}' / Q_{sA} - 1 = w_E' / g_s' - 1 \geq 0$ (A3a)

Or suppose that all category III goods undergo a productivity increase in country B, such that their production, that before the change was entirely in country A, is shifted to the former:

$g_i' < w_E'$ all $i \in N_{III}$

Then the loss for country A is given by eq. (A2), whilst the offsetting gains are

$Q_{iA}' / Q_{iA} - 1 = w_E' / g_i' - 1 > 0$ all $i \in N_{III}$ (A3b)

These formulae confirm the results of the three good case for both RM and INT models: country B country B' s productivity increases in goods of category III fulfilling (A1) generate a source of loss for country A since the quantities available of category II goods decrease [eq.(A2)], though to a lesser extent in the INT model, since the shift of employment toward goods of category III is partly counterbalanced by labour supply increases; this loss can be offset by a gain to the extent that those productivity increases exceed the level required to bring to zero country A's production of those goods [eq.(A3) fulfilled as inequality].

The relative size of country A's losses and gains – as shown by eqs.(A2 and A3) - is fixed by the relative distance of the value of the after change equilibrium wage rate w_E' from the extremes of the interval $[g_s', w_E]$. The difference between the RM and INT models becomes relevant for the after change equilibrium: we recall that the "relative income function" is Lw in the former, $G(w)w$ in the latter, with the derivative of $G(w)w$ positive and increasing as in Figure 3. Actually the shift from the before change and the after change equilibrium could be represented by modifying $H(w)$ in Figure 2 and 3 so as to express the presence of many goods. Then we can repeat with small adaptations what has been said about the three good INT model: the distance between w_E' and w_E is smaller, the higher is the elasticity of labour supply. Such distance determines also how the benefit of increasing productivity is divided: the smaller it is, the lower is country B's gain in terms of

improved relative wage, the smaller country A's corresponding loss and the greater its gain in terms of category III goods; but the larger is also country B's gain in terms of augmented employment.

Figure 1: equilibrium in the Ricardo Mill two country multicommodity model.

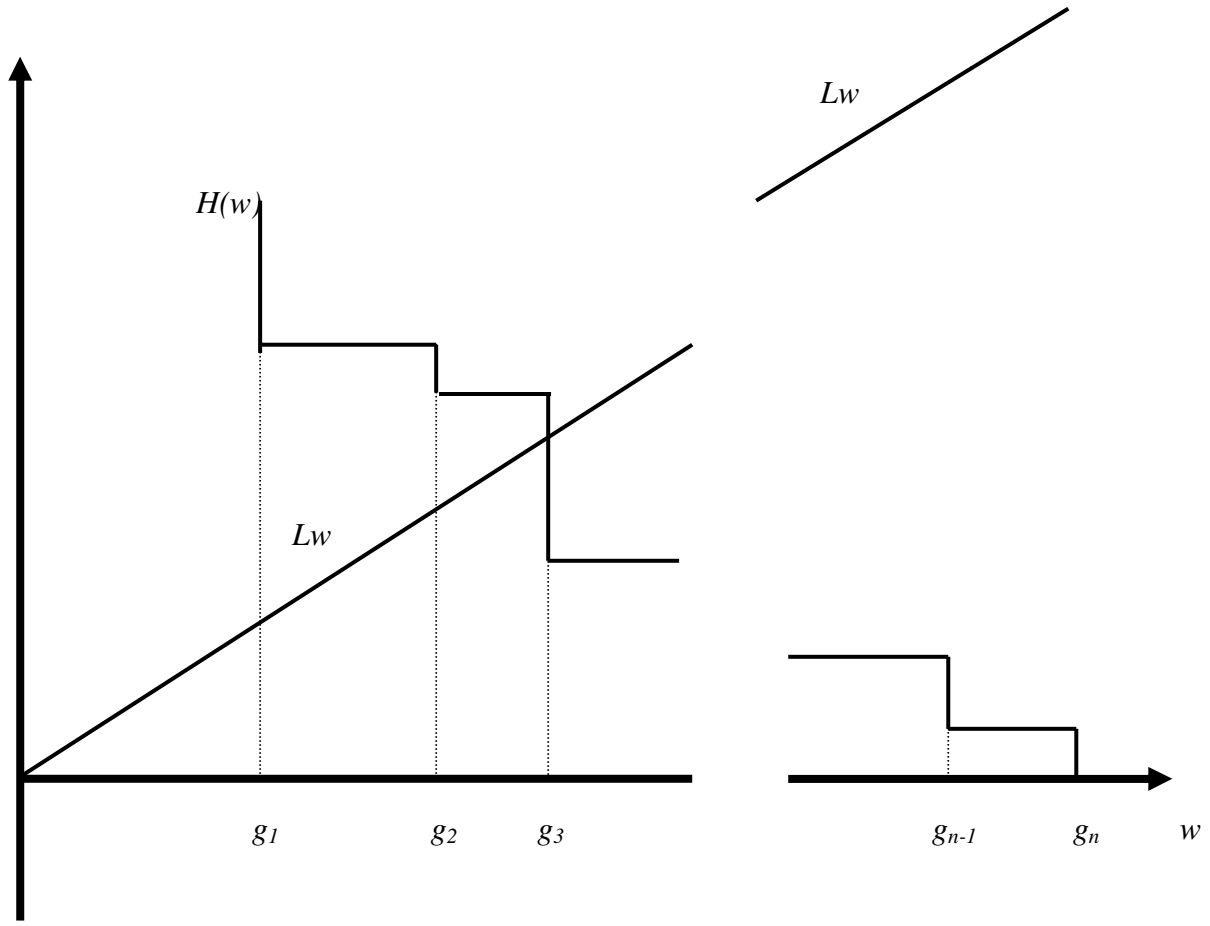


Figure 2: Changes in equilibrium positions in the Ricardo Mill three good model

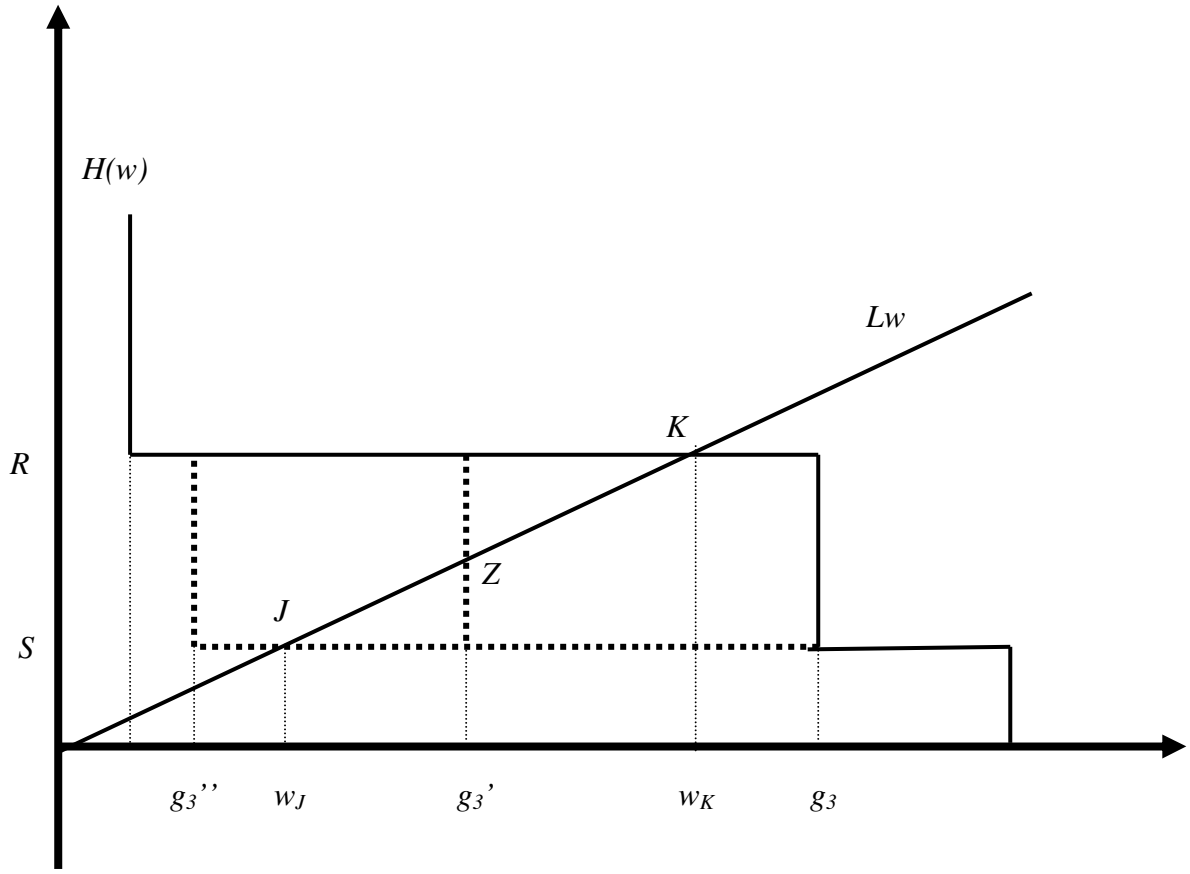
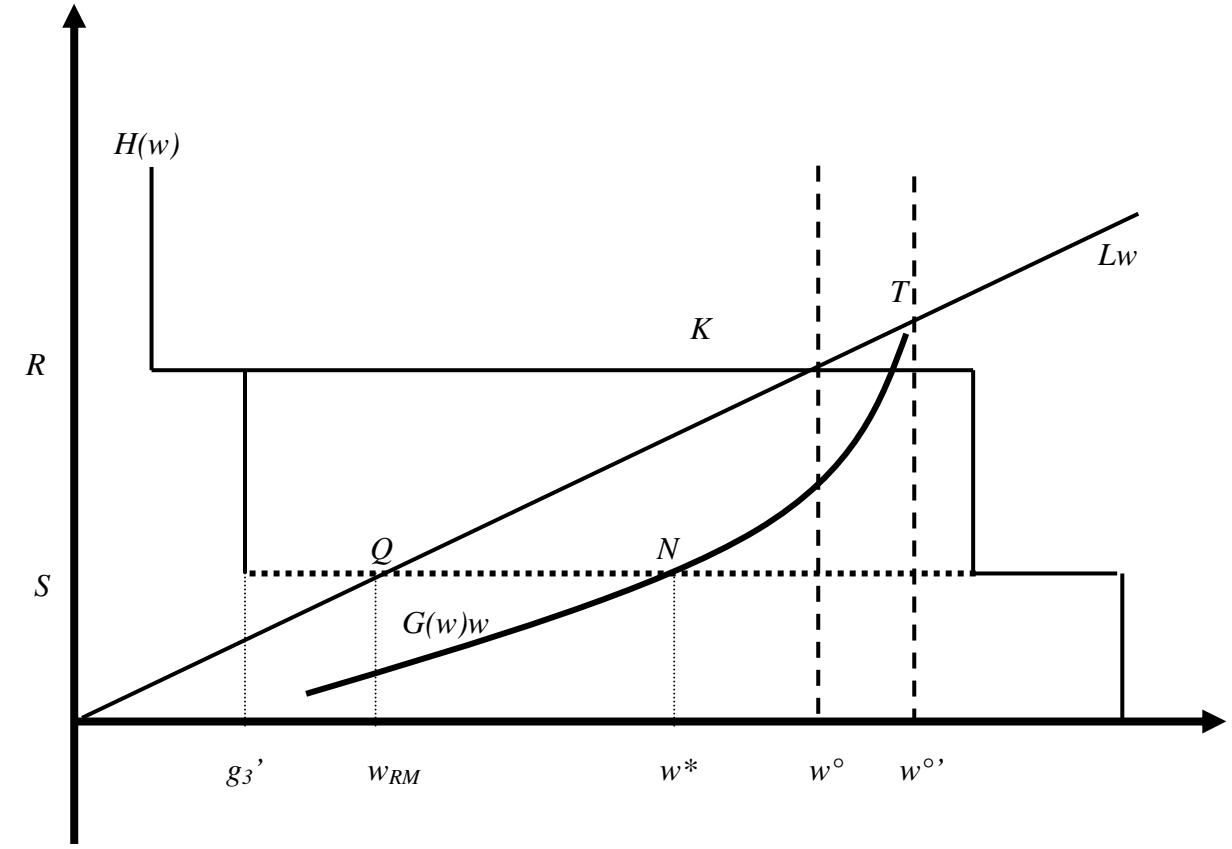


Figure 3: Changes in equilibrium positions in the Intermediate model



$w_{RM} \equiv [b_1/L(b_3+b_2)]$