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Trade, Migration and Inequality in a World without Factor Price Equalisation

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ABSTRACT

The behaviour of trading economies in the absence of factor price equalization is not well understood, although empirical evidence against factor price equalisation is overwhelming. This paper maps regions of diversification and specialization for competitive world economies with different factor endowment partitions, and considers goods and factor price responses as economies move within and across different regions. The analysis is applied to migration in a non-factor-price-equalisation world, especially the impact of endogenous migration flows (such as US-Mexico) on inequality. It also sheds light on the impact of the entry of a large unskilled labour intensive economy (such as China) on factor prices and factor flows.

1) Introduction

There have been many advances in the theory of international trade in recent years (surveyed for instance in Grossman and Rogoff (1995)), but most trade modelling and policy analysis still operates with fully diversified economies where factor price equalisation holds. This emphasis is problematic as empirical studies such as Davis and Weinstein (2001) and Schott (2003) and Debaere and Demiroglu (2003) suggest incomplete diversification and failure of factor price equalisation is the norm.

We know surprisingly little about the behaviour of trading economies in the absence of factor price equalisation, even for the simplest competitive models. Krugman (1995) in his survey comments that determining what happens outside the factor price equalisation region is a "fairly nasty business"(p1247), Dixit and Norman (1980 p113) that it is "very complicated", and Deardorff (2001 p143) that we are "surprisingly ignorant". Standard graduate texts such as Dixit and Norman (1980) and Bhagwati, Srinivasan and Panagariya (1998) err in their discussions of non-factor price equalisation cases. The recent text of Feenstra (2004 p22-5) offers brief comments on the complications involved.

Some recent work considers specialised economies such as Wood (1994), Leamer (1995), Davis (1996) or Oslington (2002) but imposes a particular pattern of specialisation rather than linking it to underlying endowment, technology, taste, and other parameters. An important paper which takes up the challenge of linking patterns of specialisation to underlying parameters is Leamer (1987) who considered a three-factor n-good model, showing how the range of products produced in different countries depends on their endowment ratios. While an extremely rich paper it's usefulness for the problem considered here is limited by Leamer's fixed production coefficients technology, ruling out the changes in factor intensity that flow from the factor price changes which occur outside the factor price equalisation region. Another stand of the literature that addresses the issue is inframarginal economics, for instance Cheng, Sachs and Yang (2000), or Tombazos, Yang and Zhang (2005). These authors show how interactions between technology, economies of scale and transaction costs generate different patterns of specialisation.

The first aim of the paper is to map the regions of specialisation as for the standard competitive trade model trade model, as no satisfactory accounts exists in the literature. To make the problem tractable we will use Cobb-Douglas tastes and technology to explore numerically the shapes regions of specialisation for possible trading worlds, and relationships between endowments, factor prices and goods prices in the different regions. The second aim is to apply the model to clarify relationships between trade, endogenous migration and inequality outside the factor price region. This application relies on interpreting the factors as skilled and unskilled labour. Thirdly we will consider the impact of the growth of the unskilled workforce on inequality and migration flows.

The paper is structured as follows. The first aim occupies sections 2 and 3, a major part of which are a series of (we think) beautiful diagrams. Applications and the second aim begin in section 4 with the definition of inequality and then we consider migration pressure in a non factor price equalisation world is described in section 5, and the migration trade and inequality relationships in section 6, 7 and 8. Section 9 considers the consequences of adding unskilled labour to the world economy for inequality and migration flows. Some possible extensions are briefly discussed in section 10.

2) Integrated Equilibrium Analysis

Our mapping of regions of specialisation builds on the technique of integrated equilibrium analysis developed by Dixit and Norman (1980 pp100-125), who took up Samuelson's (1949 pp194-195) parable of an angel splitting the world factor endowment between countries in different ways[1]. Integrated equilibrium analysis allowed Dixit and Norman to cut through the previous debate on factor price equalisation by reframing it as a question of what joint restrictions on technology, preferences and factor endowments supported factor price equalisation[2]. It has been fruitful in other ways: Deardorff (1994) further clarified the conditions for factor price equalisation; Helpman and

[1] Some of the following discussion draws on an unpublished paper on integrated equilibrium analysis Oslington and Towers (manuscript).

[2] A common approach in the trade literature is to construct cones of diversification, following Mckenzie (1955) and argue that economies with endowment combinations inside the cones will be diversified, while those outside the cone will specialise. This is sometimes useful, but will be misleading to the extent that goods prices change (as they will in a global economy when endowments or other parameters change), altering the position of the cones

Krugman (1985) and Kreickemeier and Nelson (2006) have extended it to consider trading worlds with imperfect competition; Davis (1998) called it "a truly global approach" when deriving some startling results about the consequences for different countries factor markets of factor accumulation in different parts of the world.

The simplest and most widely used model with two countries, two factors and two goods will be used, along with standard assumptions of perfect competition, concave constant returns to scale technology that is the same across the world, and identical homothetic preferences. It will be assumed that equilibrium factor proportions are unique, and degenerate combinations of technology, endowments and tastes which mean a good is produced nowhere in the world will be ruled out.

An equilibrium for a world not divided into countries (or equivalently with free movement of goods and factors between countries) is shown in figure 1[3]. The dimensions of the box are the world endowment of the factors, unskilled labour L and skilled labour K[4]. Equilibrium factor usage vectors for the two products X and Y are shown. X is relatively unskilled labour intensive.

Now consider splitting the world endowment of the factors between countries A and B in the proportions represented by V in figure 2. Since V is within the shaded parallelogram (the area enclosed by the factor usage vectors from figure 1) both countries produce both goods using the same factor proportions as the undivided world. Factor prices and goods prices will be identical to the undivided world. Since preferences are identical and homothetic individuals in the countries will consume the products in the same proportions as the undivided world, so the factor content of consumption in the two countries will be a point on the diagonal of the box such as C. The factor content of trade will thus be the vector VC. This is the factor price equalisation case.

For splits of the endowment outside the shaded parallelogram in figure 2 such replication of the integrated equilibrium is not possible and factor price equalisation breaks down. This has been widely noted in the literature, but there is considerable uncertainty about what exactly happens. Dixit and Norman comment "In order to be able to say what happens outside the factor price

[3] Equilibrium conditions are given in the appendix

[4] Capital can be thought of an intersectorally and internationally mobile third factor.

equalization region, we need more information concerning technology and demand functions" (p113) and that this can "make matters very complicated" (p113).

None of the discussions in the literature of what happens outside the factor price equalisation region are completely accurate. Dixit and Norman's textbook, an excellent and widely used reference, errs in suggesting that there are four regions of specialisation outside the factor price equalisation region[5] (see Dixit and Norman (1980) pp113-114 and especially figure 4.4). As will be shown below there are in fact six regions - they miss the possibility that both countries specialise completely in different goods. Bhagwati, Srinivasan and Panagariya (1998 87-90) repeat the error that there are four regions and miss the regions where both countries specialise. There seems to be no satisfactory account in the literature of what happens outside the factor price equalisation region.

3) What Happens Outside the Factor Price Equalisation Region?

As suggested by Dixit and Norman (1980 p113) the analysis outside the factor price equalisation region is "very complicated" and we will follow their approach of numerical simulation with a particular production technology to map the regions. The case illustrated has Cobb-Douglas production and utility functions, production share of K in X $\alpha = .45$, share of K in Y $\beta = .55$, and consumption share $\sigma^Y = .5$, but we have experimented with a range of parameter values[6].

The six regions of specialisation and diversification are shown in Figure 3[7]. The regions are best explained by tracing how a trading world switches between equilibria as endowments change. Begin with an endowment split in the diversification and factor price equalisation region. For purposes of illustration make the starting point above the Western apex of the factor price equalisation region.

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[5] In correspondence on this issue Avinash Dixit mentioned that his colleague Gene Grossman independently realised the error in the Dixit and Norman text (see Grossman (1990), and Grossman and Helpman (1991) p190), as well as a related error in the earlier Helpman and Krugman book. My letter to Avinash Dixit contained an error about the shape of one the regions and I thank him and Gene Grossman for pointing this out. Deardorff (1994 p169) includes a diagram that divides the area outside the factor price equalisation region into six regions, but draws linear boundaries for the special case of fixed production coefficients.

[6] The figures have been generated using *Matlab*, after some initial experimentation with *Mathematica*.

[7] Equilibrium conditions for the different regions are given in the appendix.

Give country B more skill and country A correspondingly less. In country B, factor and goods prices do not change and the output of the labour intensive good X will fall, and Y rise following the Rybczynski Theorem. The reverse effects will occur in A but since A is the smaller country the endowment change will have a proportionately smaller impact on A. Eventually the output of X in country B will fall to zero at the boundary of the diversification and specialization regions. Further increases in the endowment of skill in country B will make it impossible for B to fully employ its endowment of both factors producing both products at the integrated equilibrium factor proportions. There is not enough labour to absorb all country B's skill, and to maintain full employment in B production of the labour intensive good X must cease and Y alone be produced in B.

Now the world economy is in the specialization region in figure 3. Continue taking skill from country A and giving it to country B. Responses are now more complex because factor prices and proportions change outside the factor price equalisation region. There will be a Rybczynski-like response at constant factor prices in country A, reducing output of the skill intensive good Y and increasing output of X in country A. However factor prices are not constant, and in country A the return to skill will rise and skill intensity of both goods fall. In country B the output response is straightforward as the additional skill will increase output of the only good produced Y, the return to skill will fall and production become more skill intensive. In A the return to skill rises. The relative supply of good Y falls and the relative world price of good Y rises. This reduces relative demand for good Y, tending to push it out of production. Eventually the combined effects will close down the Y industry in country A.

The world economy is now in the extreme specialisation region where county A produces only X and country B only Y. Continuing to take skill from country A and giving it to B increases output of X in A and increases Y in B. The return to skill rises in A and falls in B. These changes drive down the world price of good Y until eventually it becomes so low that it is profitable to recommence production of X in country B, taking the economy to a specialisation region analogous to the one previously considered.

The extreme specialisation region (the region missed in some previous discussions) region has the convex lens shape shown in figure 3[8]. If the production technology was fixed coefficient then the boundaries of the extreme specialisation region would be straight line extensions of the factor usage vectors which enclose the diversification region, as illustrated by Deardorff (1994 p169). However in our more general case where factor price changes induce factor intensity changes which delay the switch to extreme specialisation described above.

We can map goods prices p^Y and factor prices w^A , w^B, r^A , r^B for all possible endowment splits, as shown in figures 4-8. These fully characterise the responses to endowment changes for the standard model, encompassing the local comparative static responses within regions and responses as we switch between regions[9].

Some responses reverse well known properties of factor price equalisation economies, for instance the correspondence between relative goods price and factor price movements. As we have seen in the specialisation region, reallocating capital from A to B causes the relative world price of the capital intensive good Y to rise and the relative return capital to rise in A and fall in B. In the extreme specialisation region same reallocation of capital causes the price of good Y to fall, and the relative return capital to rise in A and fall in B. Thus reverse results can emerge, and the reversals reverses as we switch between regions.

Stolper –Samuelson "reversals" like this were previously noted by Cheng, Sachs and Yang (2000). It is perhaps unreasonable to describe these as reversals of the Stolper –Samuelson relationship because country B produces a single good so the usual resource reallocation mechanisms are not operating, and also because the goods and factor price changes are induced by endowment changes.

[8] An explicit expression for the boundary of the extreme specialisation region has been derived for the general Cobb-Douglas case, but is extremely complex.

[9] Comparative static responses to endowment changes within each region can be obtained by manipulation of the equilibrium conditions (10)-(17) for the specialisation region and (18)-(24) for the extreme specialisation region.

4) Inequality

We now move to the second aim of the paper and consider some current controversies in a non-factor price equalisation world. To consider controversies involving inequality we will interpret the factors as unskilled and skilled labour, and the ratio of skilled to unskilled wages r/w will be our measure of inequality[10]. In a society of two individuals with given endowments where one owned all the unskilled labour and the other the skill, this measure would correspond to the ratio of the incomes of the two individuals, and would also be proportional to the Gini coefficient. This simple measure of inequality ties into recent debates over trade and wage inequality.

Using the factor price solutions from the previous simulations we can find values of inequality for the two countries for different partitions of the world factor endowment. These values are shown in figure 9. The inequality surface for country A labelled r^A/w^A runs from the top left (or West[11]) of figure 9 to the bottom right, and for B from the top right to bottom left. The flat central region that is part of both surfaces indicates the level of inequality in the countries when factor returns are equalised across countries, which is the level of inequality that would prevail in a borderless world.[12] In the West part of figure 9 where country A is relatively well endowed with unskilled labour country A has greater inequality than country B. In the East where country A is relatively well endowed with skilled labour it has less inequality. These differences in inequality come entirely from differences in factor abundance between countries.

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[10] This interpretation suggests $w \leq r$, and appropriate choice of units for labour and skill can ensure this. An alternative, not explored in this paper would be a production technology that allowed skilled workers to be substituted for unskilled, but not visa versa, so the skilled wage can never fall below the unskilled.

[11] Directions West and East here and elsewhere in the paper are relative to North at O^B and South at O^A.

[12] In the simulations r/w=1 for the flat region since K=L and the technologies are symmetric Cobb-Douglas.

5) Migration Pressure

To consider controversies involving migration we need to specify what drives migration flows[13]. We will take migration pressure to come entirely from factor price differentials which reflect differences in factor endowments between countries, although we recognise that migration decisions in reality are more complex. Others influences include technological differences[14], networks created by previous migrants, ease of remittances, risk, and locational preferences as discussed by Massey (1990) and the specialist literature on migration.

For our simplified world the sign and magnitude of migration pressure for different between different countries can be read off the inequality surfaces in figure 9. In the factor price equalisation region there is no pressure for labour to move between countries. Outside the factor price equalisation region, in the West of figure 9 where $r^A/w^A > r^B/w^B$ unskilled labour will flow from A to B and skilled labour will flow from B to A, and in the East of figure 9 the reverse.

[13] We are assuming the individual migrates, so endowment partition changes and the income is spent in the destination country.

[14] Technology and endowments are alternative (and sometimes equivalent) analytical boxes. It can be argued that technology differences are omitted factors. If we allow technology differences between countries this undermines the logic of integrated equilibrium analysis. It also makes the analysis of migration messier because both technological and endowment differences contribute to the factor price differentials that drive migration flows. However we could still consider the effects of migration and trade on inequality in a world with technological differences. Technology of receiving country applies when factors migrate.

6) Migration and Inequality

This is an extremely contentious issue, and one which has been with us for a very long time, as discussed by Lindert and Williamson (2003), Hatton and Williamson (2005) and many others.

Consider an endowment point in the West of figure 10 where country A is relatively well endowed with unskilled labour. Opening up migration of unskilled labour induces migration flows from A to B, pushing B up its inequality surface so inequality rises in B, and pulling A down its inequality surface so inequality falls in A. Opening up migration of skilled labour induces the opposite flows, skilled labour moves from B to A, but inequality moves in the same direction, inequality rises in B and falls in A.

These movements are indicated by the arrows in figure 10, and will continue until counties are on the edge of the fpe plane. If one facto only is mobile we can predict exactly where, but with two a range of possible points on the edge of the fpe plane are possible.

Proposition 1

Opening up migration of either factor pushes countries towards the factor price equalisation plane, i.e. level of inequality that would prevail in an integrated world economy

Proposition 2

Opening up migration of either factor reduces inequality in the most unequal country (the labour abundant country) and increases inequality in the other country (the skill abundant country).

So if the US is relatively well endowed with skilled labour, this suggests relaxing barriers to migration will reduce inequality in Mexico, and increase inequality in the US.

These results are consistent with previously derived comparative static effects of exogenous endowment changes (e.g. Woodland 1982, Falvey and Kreickemeier (2005)) for a single country. However they are more general in endogenising the endowment changes, endogenising world goods prices, and considering effects on different parts of the world simultaneously.

7) Trade and Inequality

Relationships between trade and inequality have been one of the most contentious issues in international and labour economics over the last 20 years (for example Wood (1994) or Bhagwati (2004)). Comparing the free trade inequality surface in figure 9 with an inequality surface for autarky gives the effect of opening up trade on inequality in both countries.

To obtain an autarky inequality surface first consider inequality endowment partitions on the diagonal of the box. ##Need to add autarky picture### Each country has the same relative endowments which are the same as the borderless world, so factor prices and inequality on the diagonal of the box must be the same as the borderless world. Now moving away from the diagonal, if free trade goods price ratios lie between the two countries autarky price ratios, then the autarky surfaces for the relative price of good Y must rise and fall away from the diagonal in the same directions as the free trade inequality surfaces rise or fall away from the factor price equalisation plane. If autarky factor price ratios move in the same direction as autarky goods price ratios then autarky inequality surfaces will rise and fall away from the diagonal in the same directions as the free trade inequality surfaces do, only be steeper. This means the free trade inequality surface lies between the two countries autarky inequality surfaces.

Proposition 3

Opening up goods trade reduces inequality in the most unequal country (the labour abundant country) and increases inequality in the other country (the skill abundant country).

8) Trade and Migration and Substitutes

The model nicely illustrates relationships between trade and migration flows. Trade and migration are substitutes in the sense of Mundell (1957 p321) or Wong (1995 p170-1), but only for certain endowment partitions. For world economies with endowment partitions inside the factor price equalisation region opening up either trade or migration equalises factor prices. Outside the factor price equalisation region free trade is insufficient, but migration will equalise factor prices.

It also suggests another sense in which trade and migration are substitutes outside the factor price equalisation region. Opening up either trade or migration of either factor has the same effects on inequality (Comparing Propositions 2 and 3), reducing inequality in the most unequal country and increasing inequality in the more equal country.

9) Unskilled Labour Growth

Another application of the model is to the impact of adding a large pool of unskilled labour to the world economy. An example would the growth of China's unskilled labour endowment, either from demographic forces or from unskilled workers moving into the market economy.

A rise in country A's unskilled labour endowment can be represented by stretching the world economy box away from the country A origin from O^A to $O^{A'}$ as shown in figure 11[15]. This stretching of the box will alter the boundaries of the regions, perhaps leaving the endowment point in it in a different region. For example V in figure 11 was a diversified factor price equalisation equilibrium but is now specialised, and U was previously a specialised equilibrium now diversified.

The additional unskilled labour causes the inequality surfaces to be raised and stretched south, and the new inequality surface is shown lighter hatched in figure 12, over the darker old surface. The surface is raised because an integrated world with more unskilled labour will have a higher r/w and level of inequality. In the Western part of figure 11 the new A and B inequality surfaces lie wholly above the old surfaces. In the Eastern part the new A surface is wholly above the old, but the new B surface cuts the old. This means that unskilled labour growth increases inequality in all countries, except in the case where the unskilled growth occurs in the skill abundant country, where inequality may fall. An example might be growth of skill abundant America's unskilled workforce reducing inequality in the rest of the world.

Proposition 4

With free trade but no migration, inequality rises in a country which brings more unskilled labour to the world economy, and inequality may rise or fall in rest of the world.

We can also consider the effects of unskilled growth with completely open borders. With free

[15] Since A gets the extra labour, the endowment split can't be south of O^A.

migration countries will always be on the factor price equalisation plane. Inequality is the same everywhere and depends on world endowments. Increasing the world endowments of unskilled labour increases world inequality, so:

Proposition 5

With free migration, growth of the unskilled labour endowment in any country increases inequality in all countries.

Unskilled labour growth generates migration pressure, modifying the migration flows that would occur if we begin in a world of free trade but closed borders, then opened up migration. We need to isolate migration induced by the additional unskilled labour from migration that would have otherwise have occurred. To do this begin at V in figure 12 where there was no migration before growth, after growth the endowment point is pushed up onto western slope, inducing unskilled labour flows from A to B, and skill flows from B to A. If we begin at U – before growth unskilled labour would have moved from B to A, and skill A to B, but after growth there is no migration. Putting these together yields:

Proposition 6

Growth of a country's unskilled labour endowment creates migration pressure for the country to shed unskilled labour and attract skilled labour.

10) Extensions

(a) Higher dimensions.

Increasing the number of goods introduces the shape of the factor price equalisation region and introduces indeterminacy into the pattern of production and trade, as discussed by Dixit and Norman (1980 p114-21) and Feenstra (2004 p83-8). For three goods and two factors there will be regions of extreme specialisation where each country produces one product, specialisation regions where countries produce a good in common, and a hexagonal factor price equalisation region where the pattern of production is indeterminate and countries produce up to three goods.

Increasing the number of factors, so we have to three factors and two goods means we have a three dimensional factor quantity box as illustrated by Dixit and Norman (1980 p122-5). The three dimensional factor price space is not spanned by the factor usage vectors of the two goods, and factor price equalisation will only occur in fluke cases.

(b) Unemployment.

The analysis generalises to situations of minimum wage unemployment, provided the minimum wage is common to both counties[16]. The factor price equalisation region for a world economy with unemployment is derived in Oslington (2006) and compared to a similar world economy with full employment, but regions of specialisation are not considered. Unemployment of one of the factors introduces indeterminacies into the pattern of production and trade similar to the cases where there are more goods than factors. Some comparative statics of specialised economies with unemployment are derived in Oslington (2002) and compared with Davis's (1998) results for diversified factor price equalisation economies. Kreickemeier and Nelson (2006) is an interesting recent reconsideration of Davis's results where factor price equalisation breaks down because different preferences for fairness parameters in an efficiency wage model, but with no consideration of specialised unemployment equilibria.

(c) Nontraded Goods.

[16] If the minimum wage were not common specifying the proportion of the world endowment to which the minimum wage applies would preclude variations of the endowment split which is the essence of integrated equilibrium analysis.

11) Conclusions

The main contributions of the paper has been to provide a full mapping from endowments partitions to patterns of production, goods and factor prices for the competitive trade model. This fills an important gap in the literature, not least because the few existing discussions err.

This mapping of the regions of diversification and specialisation has opened the way to consider some important issues for non-factor price equalisation economies. Our two moves of interpreting the factors as skilled and unskilled labour, and assuming migration to be driven by factor price differentials allowed us to generalise existing results about connections between trade, migration and inequality beyond the much analysed factor price equalisation case. Some sharp results were derived – especially the result that opening up either trade or migration reduces inequality in the most unequal country and increases inequality the other country. The mapping also allowed us to consider the inequality and migration impacts of adding unskilled labour to a competitive world economy.

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Appendix – Equilibrium Conditions in Regions

For the factor price equalisation region, equilibrium conditions are:

Zero profit for each product produced in each country[17] (X is the numeraire)

$$(1)\quad 1 = c^X(r^A, w^A)$$

$$(2)\quad 1 = c^X(r^B, w^B)$$

$$(3)\quad p^Y = c^Y(r^A, w^A)$$

$$(4)\quad p^Y = c^Y(r^B, w^B)$$

Full employment of each factor in each country ($\overline{L}$ and $\overline{K}$ are world endowments)

$$(5)\quad c(r^A, w^A)\, X^A + c(r^A, w^A)\, Y^A = L^A$$

$$(6)\quad c(r^A, w^A)\, X^A + c(r^A, w^A)\, Y^A = K^A$$

$$(7)\quad c(r^B, w^B)\, X^B + c(r^B, w^B)\, Y^B = L - L^A$$

$$(8)\quad c(r^B, w^B)\, X^B + c(r^B, w^B)\, Y^B = K - K^A$$

Demand

$$(9)\quad \frac{X^A + X^B}{p^Y Y^A + p^Y Y^B} = \frac{1-\sigma^Y}{\sigma^Y}$$

These conditions yield equilibrium values of p^Y, w^A, w^B, r^A, r^B, X^A, Y^A, X^B and Y^B.

In the region marked specialisation in figure 3, product X is not produced by country B, so that the equilibrium conditions are:

Zero profit for each product produced in each country:

$$(10)\quad 1 = c^X(r^A, w^A)$$

$$(11)\quad p^Y = c^Y(r^A, w^A)$$

$$(12)\quad p^Y = c^Y(r^B, w^B)$$

Full employment of each factor in each country:

$$(13)\quad c(r^A, w^A)\, X^A + c(r^A, w^A)\, Y^A = L^A$$

$$(14)\quad c(r^A, w^A)\, X^A + c(r^A, w^A)\, Y^A = K^A$$

[17] These equilibrium conditions are expressed in terms of minimum unit cost functions c(w,r), whose derivatives with respect to the factor prices $c_w(w,r)$ and $c_r(w,r)$ are input-output coefficients - see Woodland (1982).

(15) $c\,(r^B, w^B)\, Y^B = L - L^A$

(16) $c\,(r^B, w^B)\, Y^B = K - K^A$

Demand

(17) $$\frac{X^A}{p^Y Y^A + p^Y Y^B} = \frac{1-\sigma^Y}{\sigma^Y}$$

These conditions yield equilibrium values of p^Y, w^A, w^B, r^A, r^B, X^A, Y^A and Y^B.

Equilibrium conditions in the extreme specialisation region are[18]:

Zero profit for each product produced in each country:

(18) $1 = c^X(r^A, w^A)$

(19) $p^Y = c^Y(r^B, w^B)$

Full employment of each factor in each country:

(20) $c\,(r^A, w^A)\, X^A = L^A$

(21) $c\,(r^A, w^A)\, X^A = K^A$

(22) $c\,(r^B, w^B)\, Y^B = L - L^A$

(23) $c\,(r^B, w^B)\, Y^B = - K^A$

Demand

(24) $$\frac{X^A}{p^Y Y^B} = \frac{1-\sigma^Y}{\sigma^Y}$$

These conditions yield equilibrium values of p^Y, w^A,w^B, r^A,r^B, X^A and Y^B.

[18] The boundary of the specialisation and extreme specialisation regions is the locus of LA KA obtained from solving (10)-(17) when setting YA=0 in (13) and (14). Needless to say it is ugly even for these simple functional forms.

Figure 2 – Integrated Equilibrium

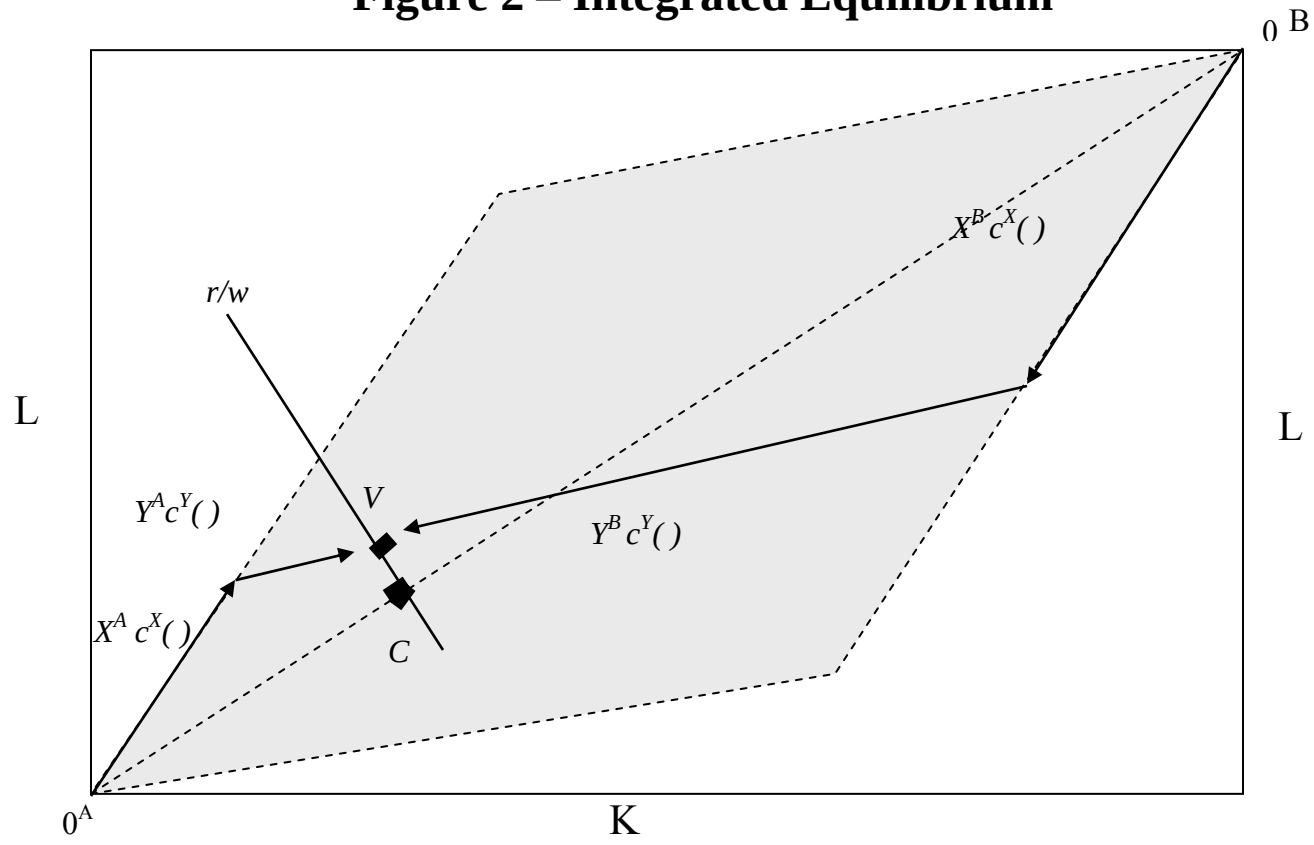

Figure 1 – Borderless World

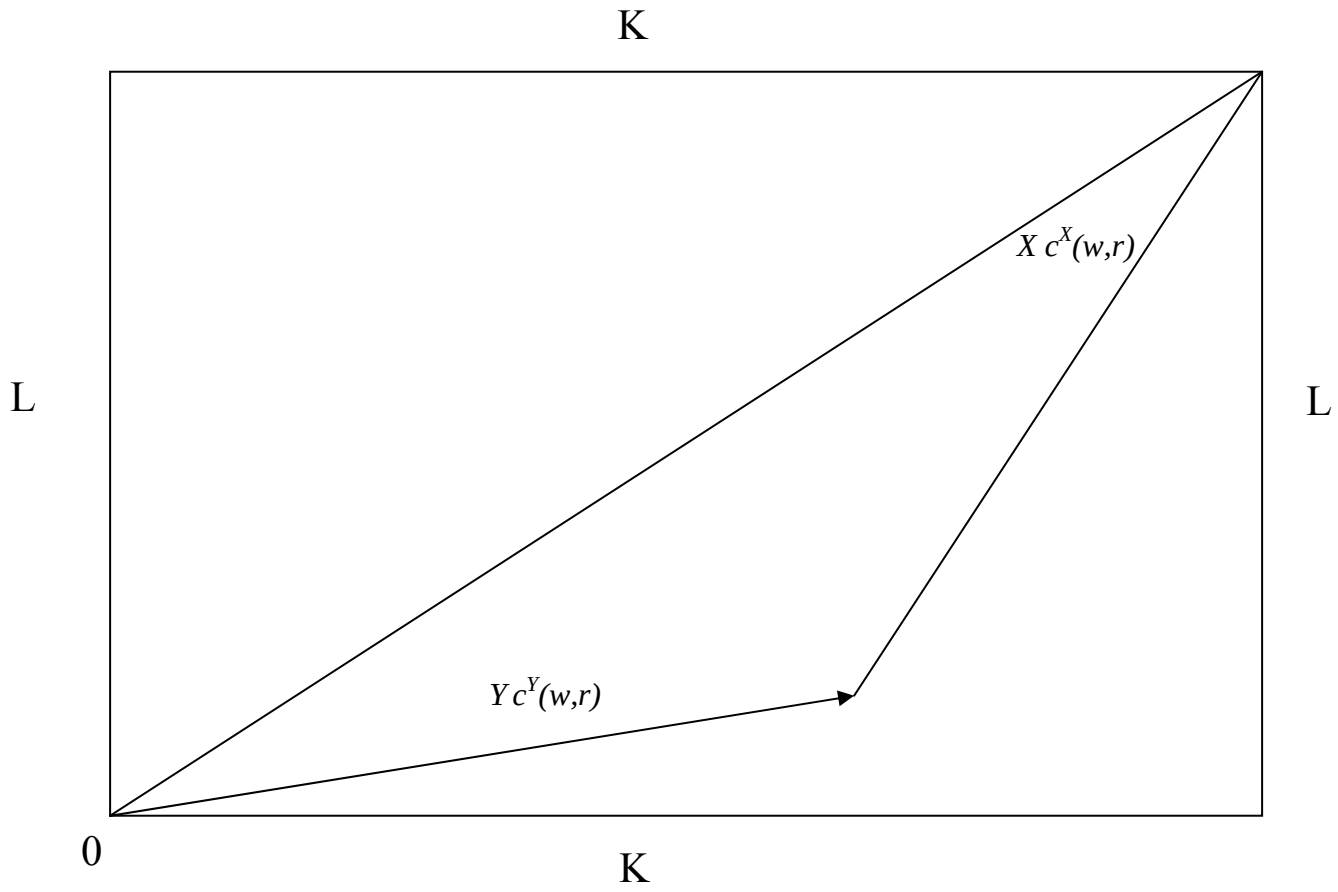

Figure 3 – Regions of Specialisation and Diversification

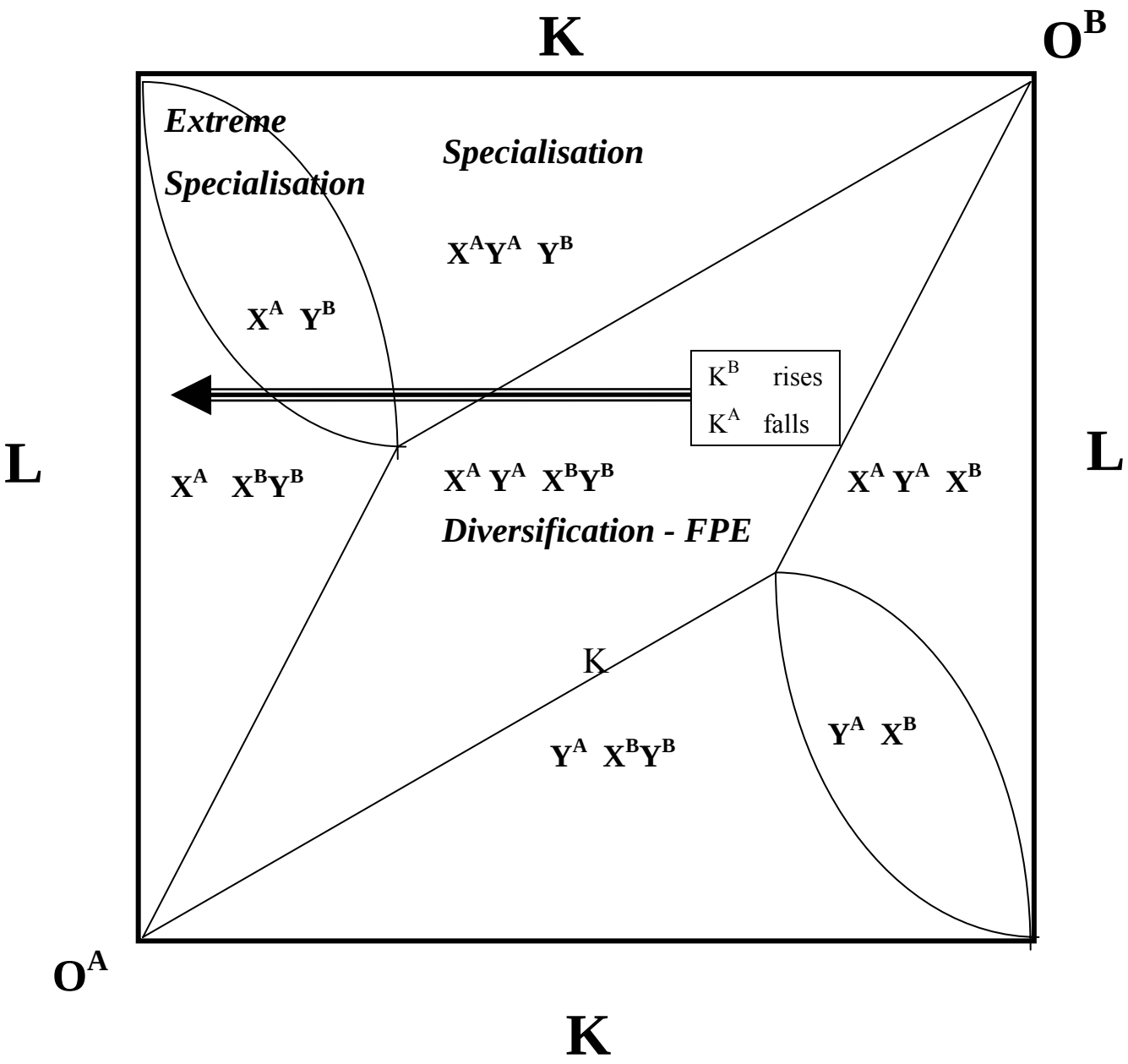

Figure 4

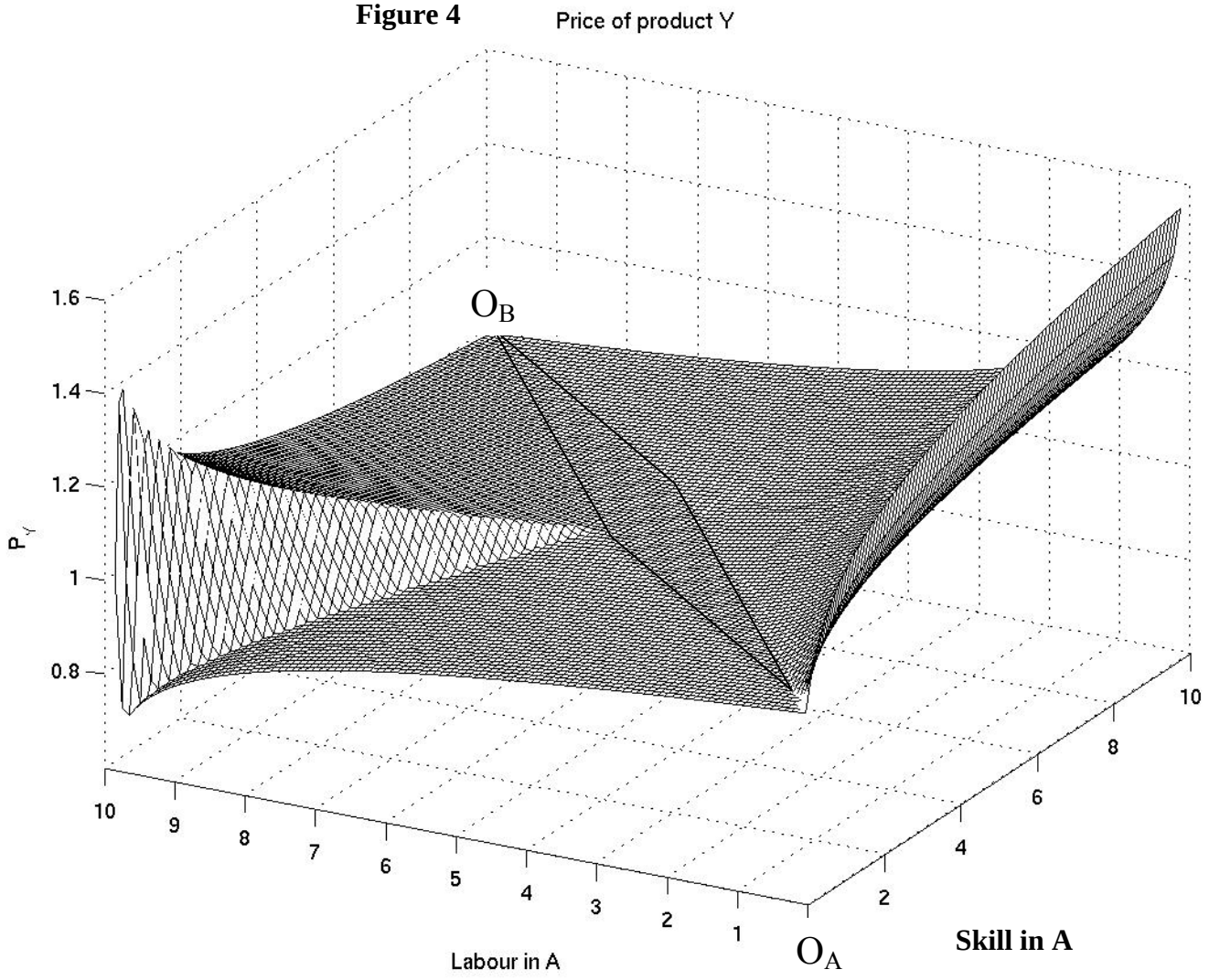
Price of product Y
O_B
1.6
1.4
1.2
1
0.8
P_Y
10
9
8
7
6
5
4
3
2
1
Labour in A
O_A
2
4
6
8
10
Skill in A

Figure 5

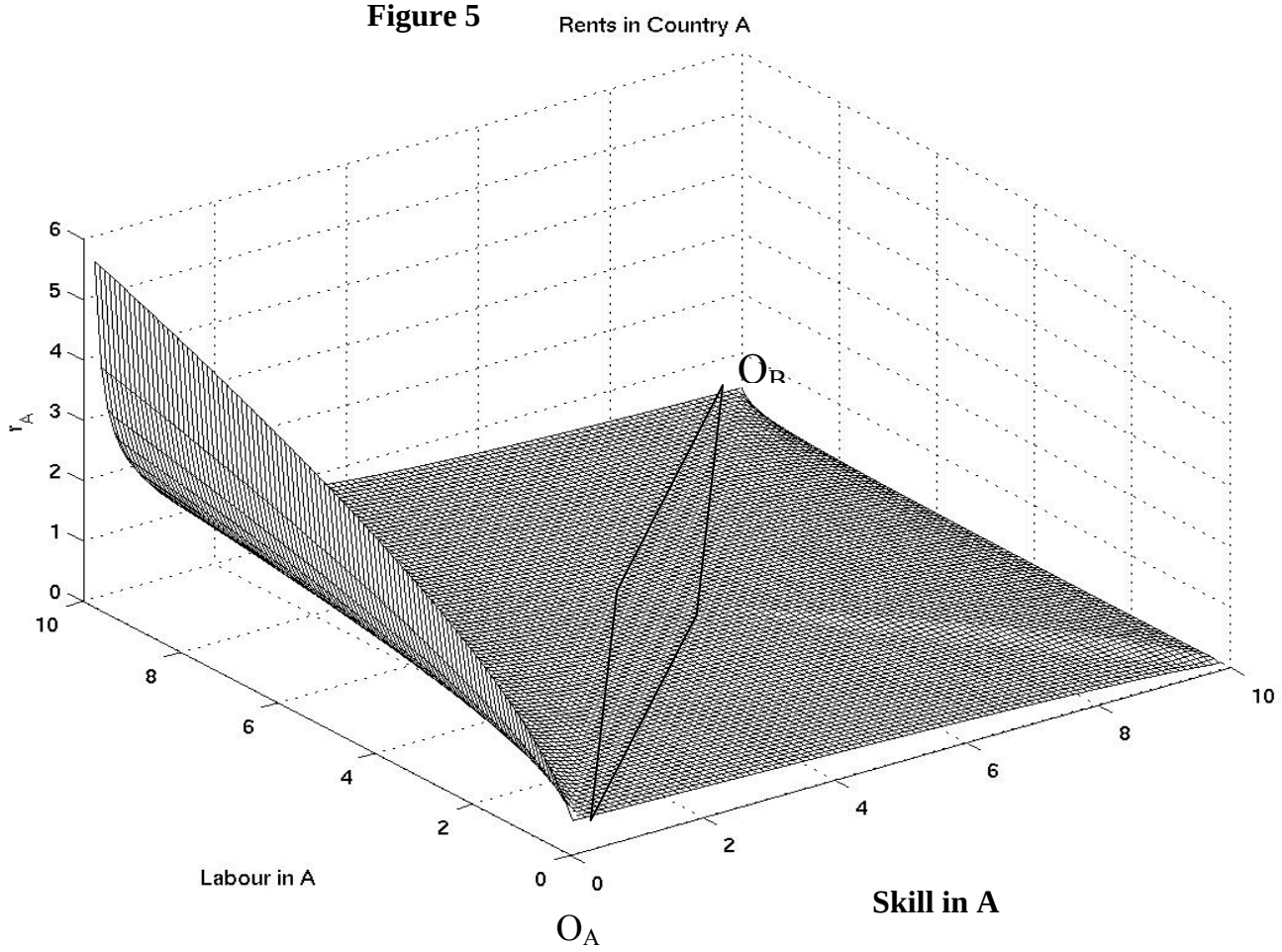

Figure 6

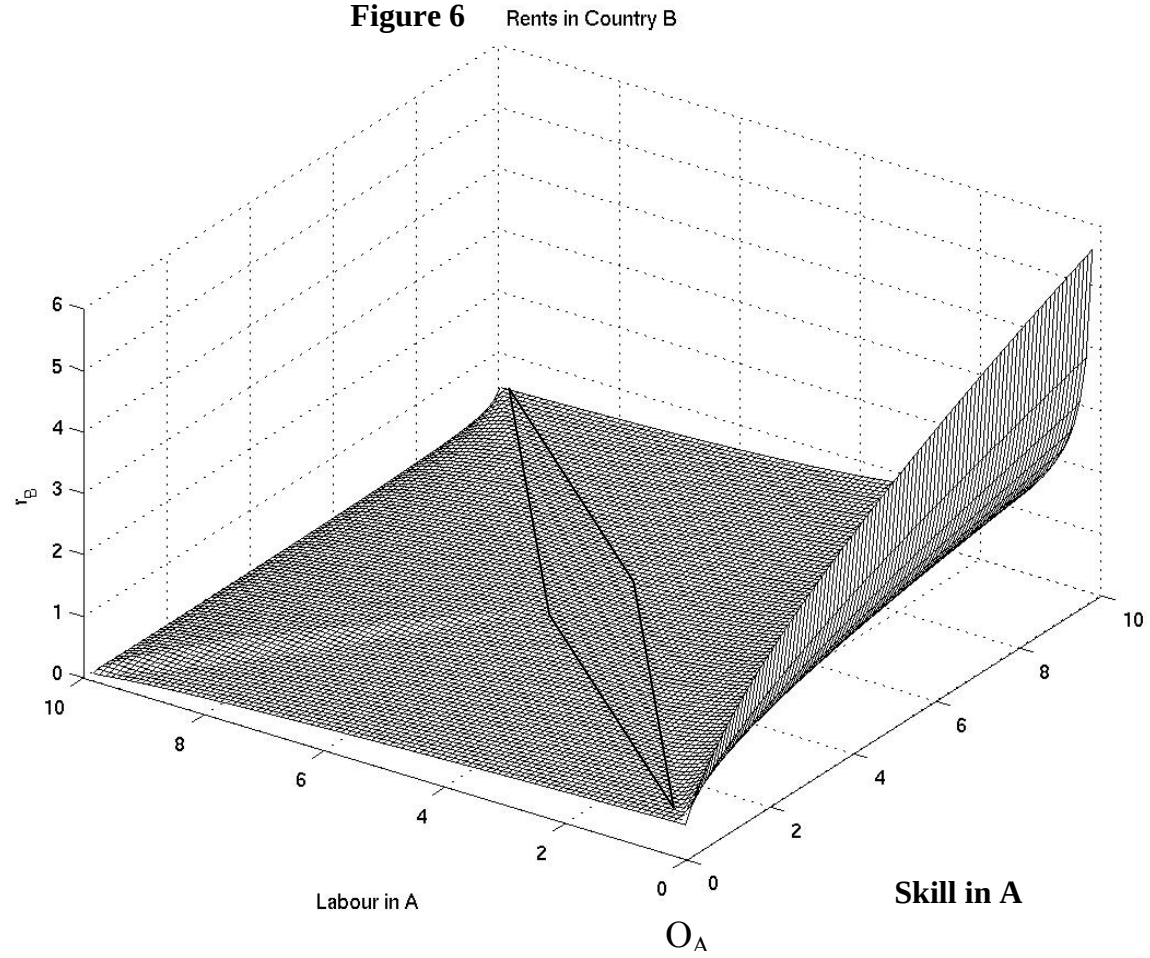

Figure 7

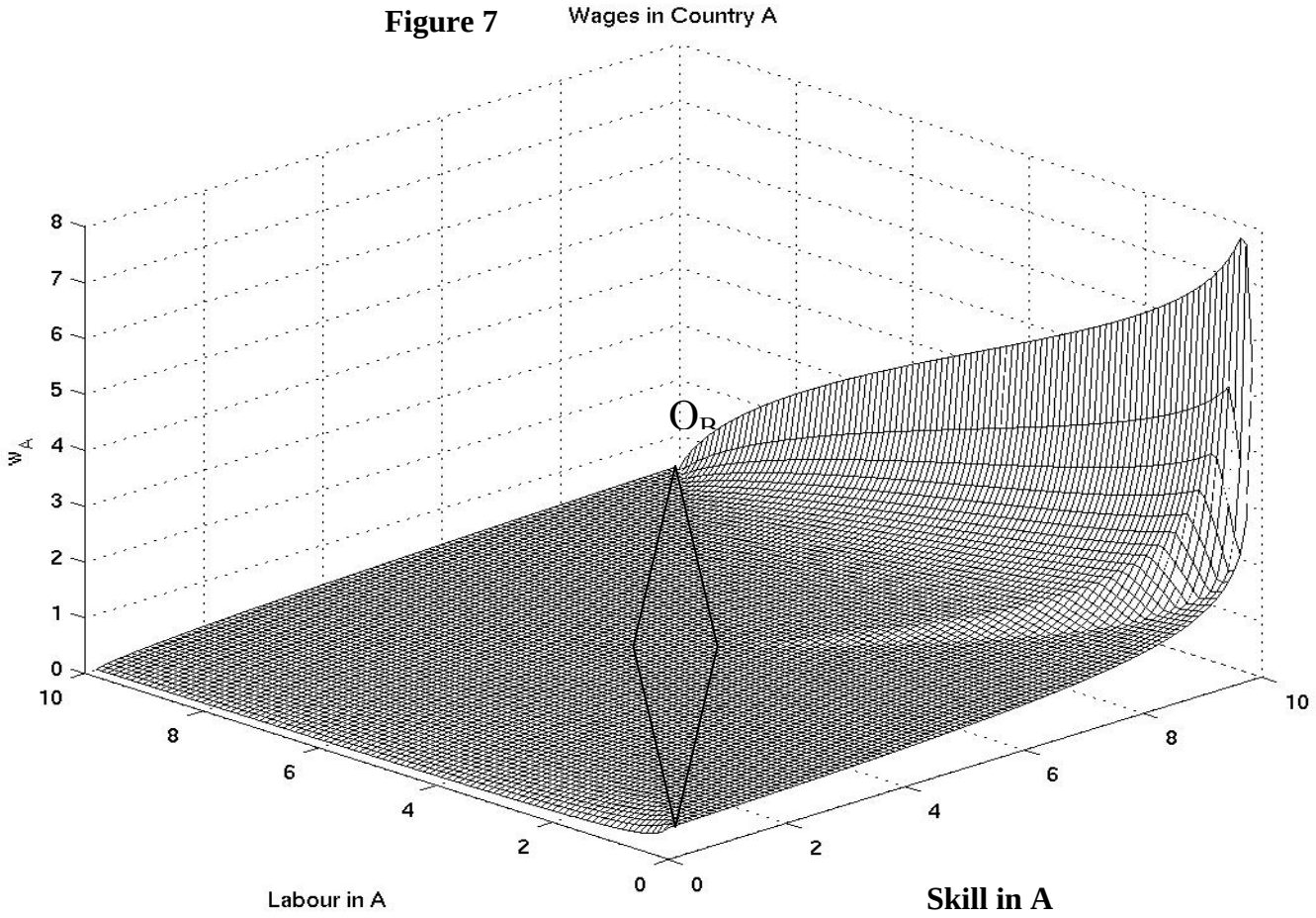

Figure 8

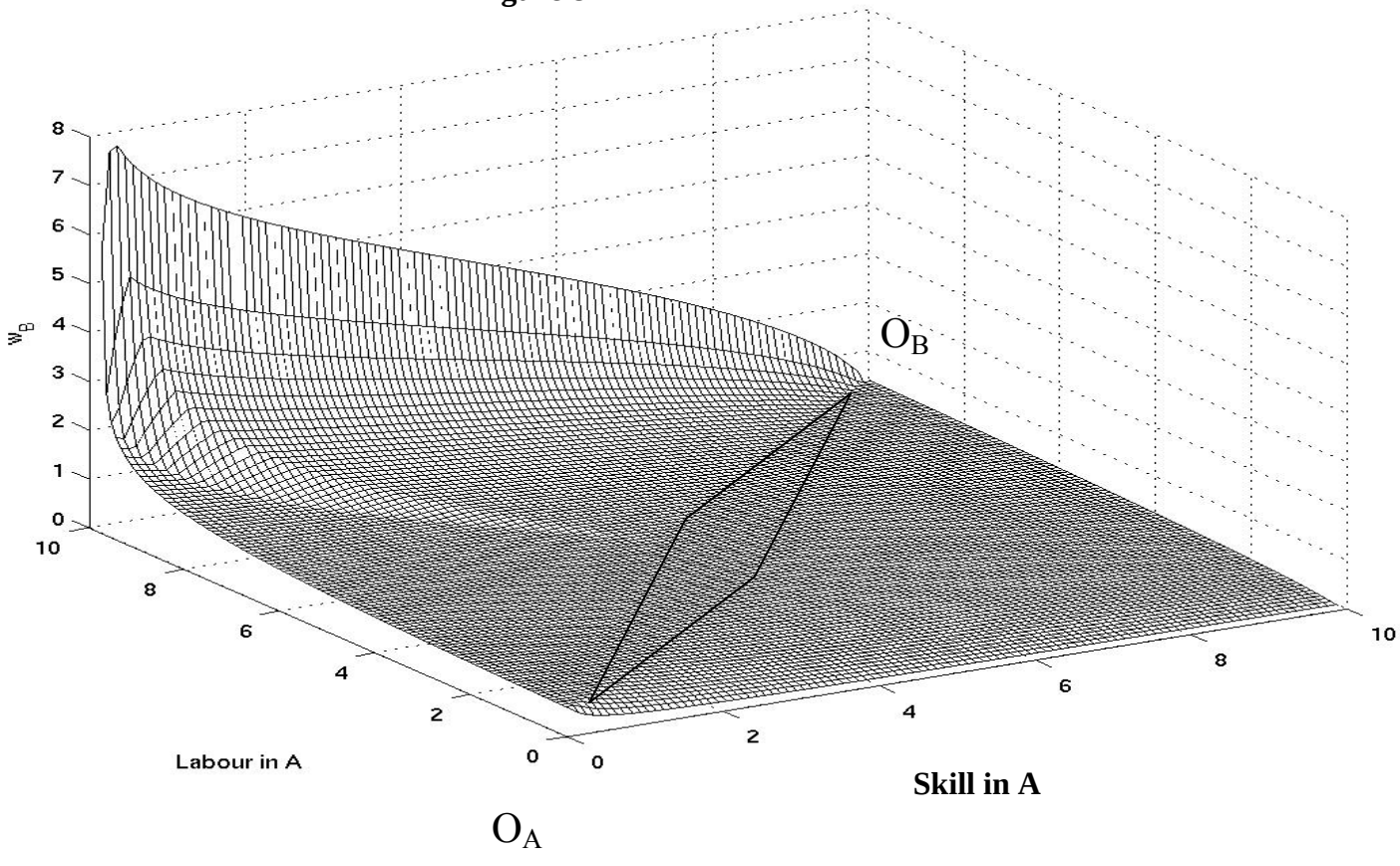

Figure 9 – Free Trade Inequality Surfaces

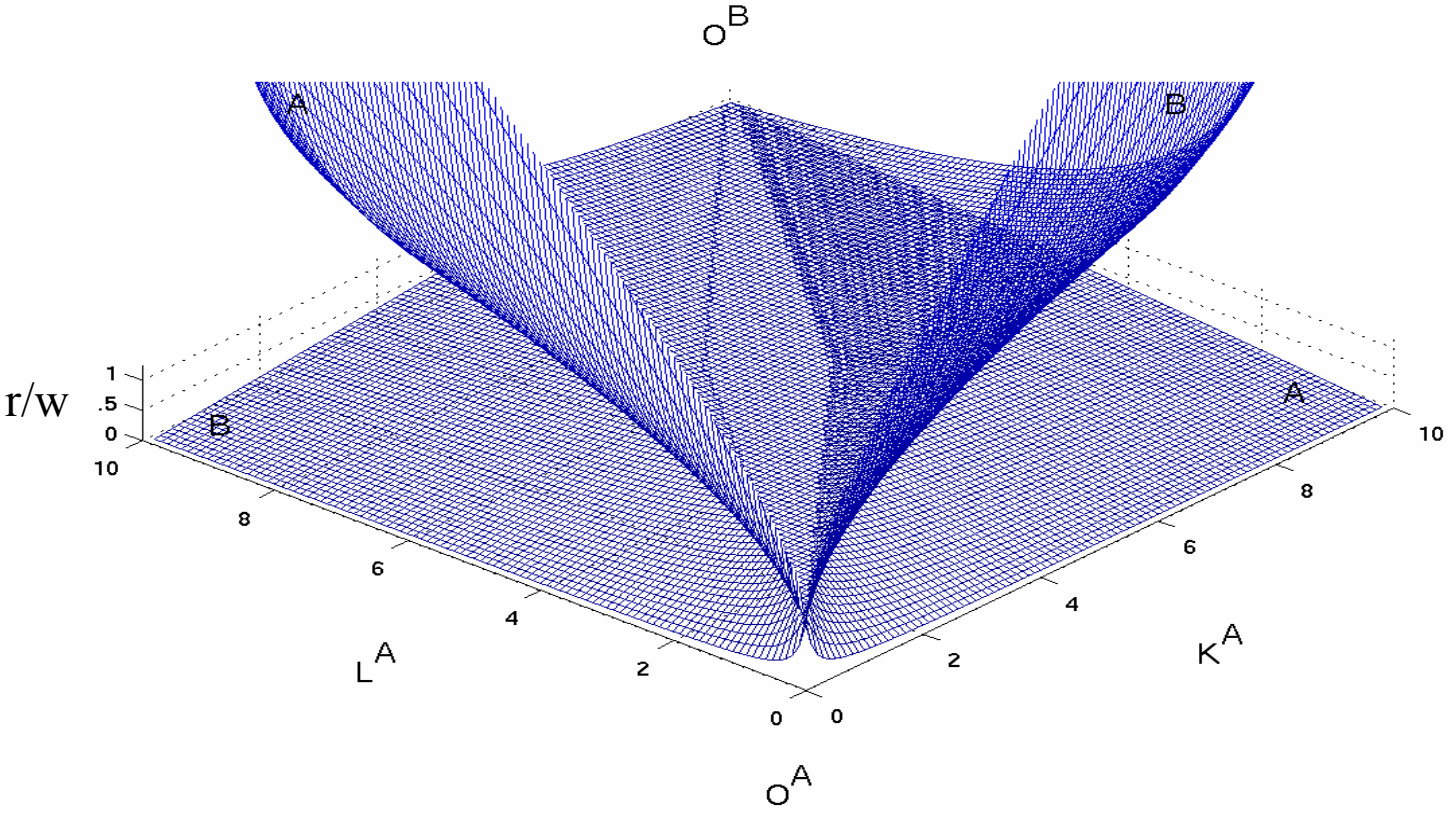

Figure 10 –Effect of Migration Flows on Inequality

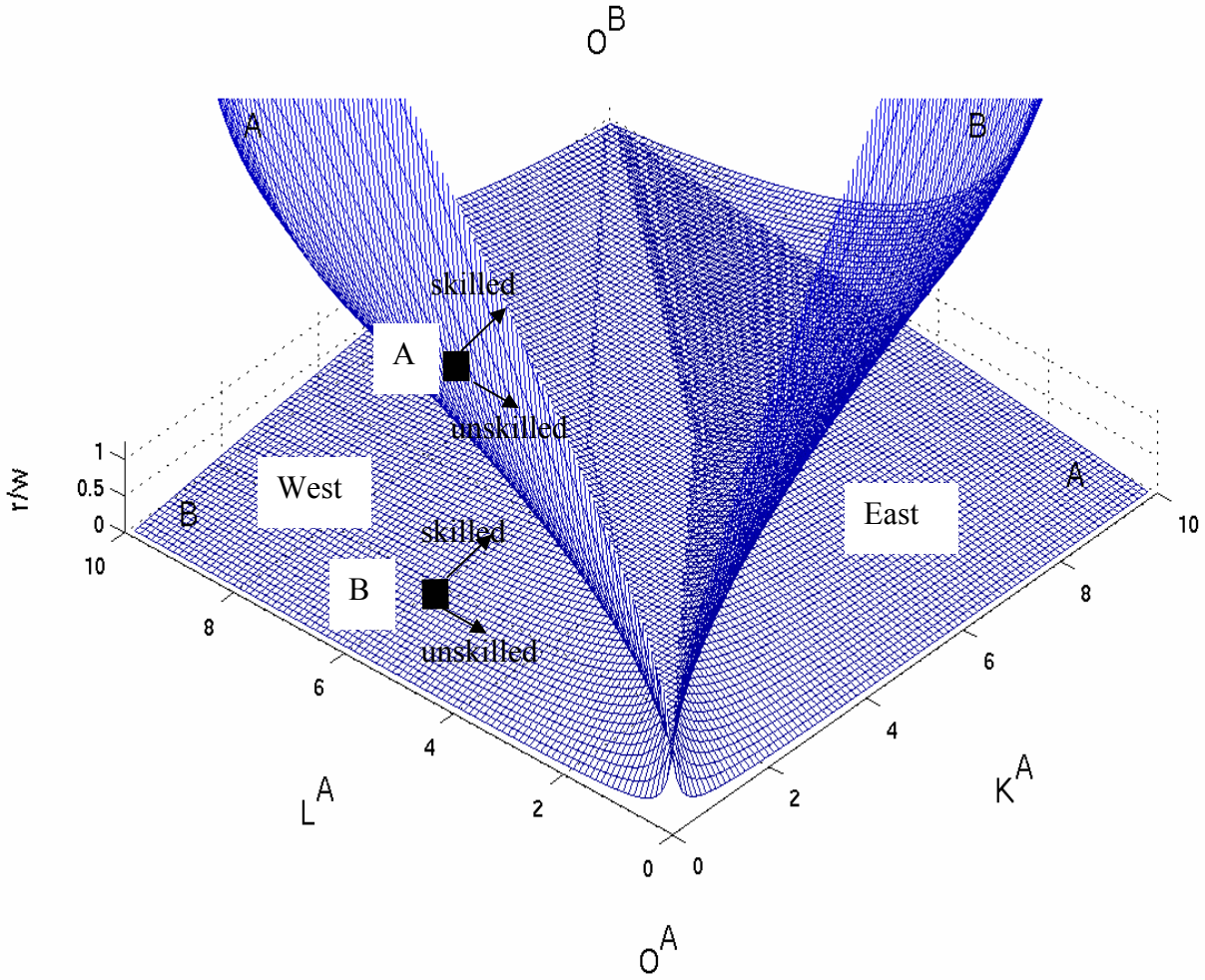

Figure 11 – Labour Endowment Expands

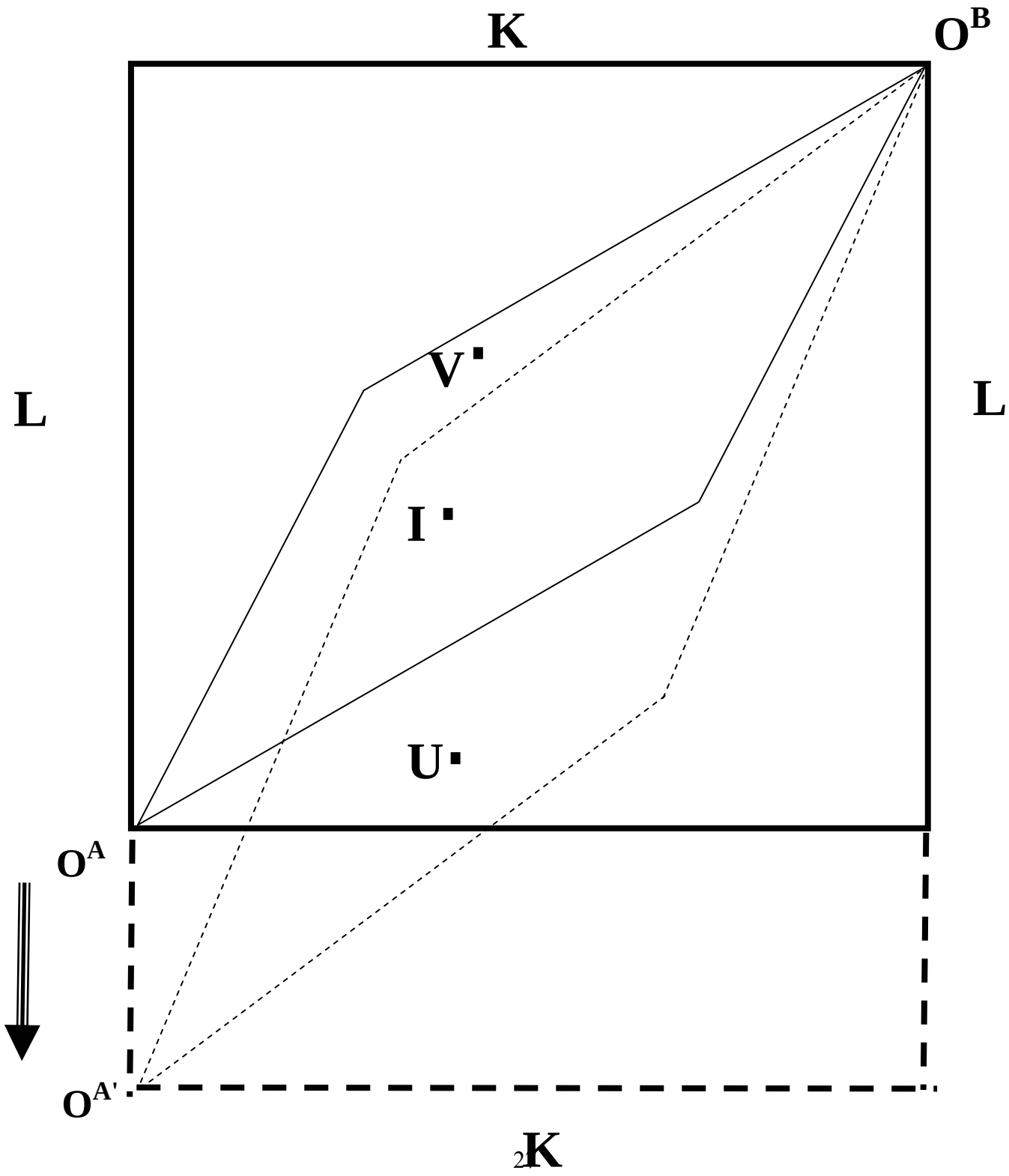

Figure 12 –Effect of Labour Endowment Expansion on Inequality