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Explaining Intra- and Intersectoral Wage Differentials in Simple General Equilibrium Trade Models

by

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Abstract: The labour markets in the developed countries have experienced two fundamental changes in recent years. Firstly, high-skilled workers have gained at the expense of low-skilled workers, which manifests itself in a rising skill premium and/or a rising disparity in the unemployment rates of these two skill groups. Secondly, sectors with low wage levels have expanded while sectors with high wage levels have contracted. By presenting two insider-outsider general equilibrium models, which analyse the impact of trade on both dimensions of income distribution, this paper seeks to contribute to the ongoing debate on whether the progressing globalisation of the world economy is to blame for these two trends. From this analysis, two important results emerge. Firstly, the distributional effects of trade are highly sensitive to even minor changes to the assumption of the 2 x 2 trade model. This suggests that due attention should be paid to the choice of the structural model. Secondly, there might be a bias inherent to the „mandated-wage approach" that makes most empirical studies fail to find a strong influence of trade on the skill premium.

Key Words: trade, income distribution, real rigidities, insider-outsider model

JEL Classification: F11, J31

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Table of Contents

1 Introduction

During the past 30 years, the world economy has become increasingly interdependent through rapid international integration of product and factor markets. This globalisation has coincided with fundamental changes in the labour markets of developed countries. Two labour market trends are of particular concern. Firstly, the gaps between skilled and unskilled workers in wages and/or unemployment rates have widened. Secondly, the structural change from a manufacturing-based to a services-based economy has brought along a loss of high-paid jobs in the manufacturing sector in exchange for low-paid jobs in the services sector.

In the academic literature, these two dimensions of income distribution, i.e., the *intra*sectoral wage inequality between workers of different skill levels in the same sector, and the *inter*sectoral wage inequality between workers of the same skill level in different sectors, have been discussed separately. Much research in international economics has been undertaken to uncover the main driving forces of the empirically observed changes in the skill premium. Considerably less academic effort has been devoted to evaluating the link between trade and the intersectoral wage differentials.

The aim of this paper is twofold. Firstly, I will present two insider-outsider extensions of the neo-classical 2 x 2 trade model that integrate both dimensions of

income distribution in a single framework. It will be shown that even minor changes to the assumptions of the Heckscher-Ohlin model with regard to the cost of mobility and/or the homogeneity of the production factors have a dramatic impact on the distributional effects of trade. Secondly, as a by-product of this analysis, I will give a possible explanation why most empirical studies fail to find a strong influence of trade on the skill premium.

The paper is in four parts. In the next section, four stylised facts on the correlation patterns between trade and wage data are presented, which serve as an objective benchmark to assess the validity of economic models. In the third section, I will outline the Heckscher-Ohlin model and test its ability to replicate these stylised facts. The comparison of the implications of the model with the empirical data suggests difficulties in explaining especially the intersectoral dimension of income distribution. In order to overcome this misspecification of the model, in the fourth and fifth section, its assumptions concerning the cost of mobility and the homogeneity of the production factors are altered. In doing so, the ability of the model to replicate the empirically observed correlation patterns is improved with regard to both dimensions of income distribution. A final section concludes.

2 Empirical Findings

In this section, stylised facts on the empirical link between trade and income distribution are presented. The aim of this exercise is twofold. Firstly, stylised facts draw attention to the most important aspects of the interaction between the analysed economic variables, and secondly, they serve as an objective benchmark to assess the validity of economic models.

With regard to the intrasectoral dimension of income distribution, there are, firstly, substantial and persistent sectoral differences in the skill premium. Differently stated, in some sectors the ratio of the average wage of low-skilled workers to the one of high-skilled workers is higher than in other sectors. Secondly, in contrast to layman's opinion, most empirical research using sectoral trade and wage data concludes that the link between trade and income distribution is weak. In this literature, Lawrence and Slaughter (1993), Leamer (1996), Baldwin and Cain (1997), and others conclude that the role of trade is small, while only Wood (1994, 1995, 1998) points to a dominant role for trade.[1]

With regard to the intersectoral dimension of income distribution, there are, thirdly, substantial and persistent sectoral differences in the wage levels. That is, some sectors pay higher wages to their workers than other sectors – regardless

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[1] See Burtless (1995) and Haskel (2000) for important overviews of the literature on the "trade versus technology" debate.

whether the workers are low-skilled or high-skilled. And finally, empirical analysis by Katz and Summers (1989) suggests that there is a strong positive correlation between the sectoral wage differentials both across the skill groups and with trade variables.

3 The Heckscher-Ohlin Model

Endowed with a description of the empirically observed correlation patterns of trade and wage data, it is possible to build alternative economic models and test their ability to replicate the stylised facts. In choosing the degree of complexity of the model, there is a trade-off between its ability to replicate the empirically observed correlation patterns and its ability to explain their causes (Cooley 1997). The more complex the model and the greater the number of its structural parameters, the better can it reproduce the stylised facts – irrespective of the validity of its economic assumptions. Understanding the underlying causes and the interaction of the variables, however, requires the model to be simple and the number of structural parameters to be small. Hence, a basic rule in determining the model structure is to augment the complexity of the model only if more elementary models are misspecified to the effect that they cannot replicate important aspects of the empirically observed correlation patterns.

The analysis of economic models is in three parts. First of all, the basic assumptions of the model are presented, then the model is solved algebraically,

and finally, its implications are confronted with the empirically observed stylised facts.

3.1 Basic Assumptions

The standard textbook model to assess the impact of international trade on income distribution is the Heckscher-Ohlin model. It depicts a small open economy without government, where the impact of trade is modelled by terms-of-trade shocks.[2] All markets are perfectly competitive and all prices are perfectly flexible. It is assumed that the economy consists of many firms and households, who are so numerous that the influence of a single economic entity on aggregate variables is negligible. The economy is endowed with two homogeneous production factors: low-skilled labour *N* and high-skilled labour *H*, which are perfectly mobile across sectors, but immobile across countries. There are two sectors of production $j \in \{1, 2\}$, which transform the two production factors into two homogeneous goods. The sectors can be ranked according to their factor intensity. The production of good 1 is assumed to be always more high-skilled labour intensive than the production of good 2, i.e., [3]

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[2] For a similar model that analyses shocks to the net export ratio see Maußner (1999).

[3] In the case of a Cobb-Douglas production function, this condition is equal to $a_1 < a_2$.

(1) $$h_1 := \frac{H_1}{N_1} > \frac{H_2}{N_2} =: h_2 .$$

All firms within a sector are identical with respect to their production technology and all households are identical with respect to their tastes. Hence, it is sufficient to analyse the behaviour of a representative firm and a representative household.

The representative firm of sector *j* combines N_j units of low-skilled labour and H_j units of high-skilled labour to produce Y_j units of good *j* according to a linear homogenous, twice differentiable and strictly concave Cobb-Douglas production function

(2) $$Y_j = N_j^{\alpha_j} H_j^{1-\alpha_j}, \quad 0 < \alpha_j < 1.$$

It determines its supply of goods and its factor demand simultaneously by solving the static maximisation problem

(3) $$\begin{aligned} &\max_{\{N_j, H_j\}} D_j = p_j Y_j - w_j N_j - q_j H_j, \\ &s.t. \quad Y_j = N_j^{\alpha_j} H_j^{1-\alpha_j}, \end{aligned}$$

where D_j denotes the firm's profit, p_j the price of the good *j*, and w_j and q_j the remuneration rates of low-skilled labour and high-skilled labour, respectively. The corresponding first order conditions

(4) $$w_j = p_j \alpha_j \left(\frac{H_j}{N_j} \right)^{1-\alpha_j},$$

$$(5) \qquad q_j = p_j(1-\alpha_j)\cdot\left(\frac{H_j}{N_j}\right)^{-\alpha_j},$$

show that factor remuneration rates are set equal to the value of the marginal product of the corresponding factor. Due to the perfect flexibility of factor prices, all markets clear in equilibrium, i.e.,

$$(6) \qquad \sum_{j=1}^{2} N_j = N,$$

$$(7) \qquad \sum_{j=1}^{2} H_j = H,$$

with N and H being the aggregate supply of low-skilled labour and high-skilled labour, respectively.

A representative household $i \in [0; 1]$ determines its demand for goods and its factor supply by maximising its utility function subject to its budget constraint:

$$(8) \qquad \begin{aligned} &\max_{\{C_{1i},C_{2i}\}} U_i = U_{(C_{1i},C_{2i})}, \\ &s.t.\ \ B_i \geq p_1 C_{1i} + p_2 C_{2i}, \end{aligned}$$

where C_{ji} denotes household i's consumption of good j, and B_i its budget. On the assumption that the economy is small, domestic demand for goods does not have any influence on the terms of trade $\mathrm{j} := \frac{p_1}{p_2}$ nor on the domestic supply of goods so that it does not have to be modelled explicitly. Furthermore, since leisure does

not enter the utility function, aggregate supplies of low-skilled and high-skilled labour are perfectly inelastic to commodity prices and factor remuneration rates.

3.2 Commodity Prices and Factor Remuneration Rates

On the assumption that low-skilled labour and high-skilled labour are homogeneous and perfectly mobile between sectors, any temporary intersectoral wage differential for low-skilled workers $\left(|w_1 - w_2| > 0\right)$ and/or high-skilled workers $\left(|q_1 - q_2| > 0\right)$ induces the respective workers in the low-paying sector to move to the high-paying sector until their corresponding wage rates, w_j and q_j, are equal in both sectors $\left(w_1 = w_2,\ q = q_2\right)$. Consequently, the equilibrium intersectoral relative wage levels

$$(9) \qquad \mathsf{w}_N := \frac{w_1}{w_2} = \mathsf{j} \cdot \frac{\mathsf{a}_1 N_1^{\mathsf{a}_1 - 1} H_1^{1-\mathsf{a}_1}}{\mathsf{a}_2 N_2^{\mathsf{a}_2 - 1} H_2^{1-\mathsf{a}_2}} = 1 \ \Rightarrow \ \frac{d\mathsf{w}_N}{d\mathsf{j}} = 0,$$

$$(10) \quad \mathsf{w}_H := \frac{q_1}{q_2} = \mathsf{j} \cdot \frac{(1-\mathsf{a}_1) N_1^{\mathsf{a}_1} H_1^{-\mathsf{a}_1}}{(1-\mathsf{a}_2) N_2^{\mathsf{a}_2} H_2^{-\mathsf{a}_2}} = 1 \ \Rightarrow \ \frac{d\mathsf{w}_H}{d\mathsf{j}} = 0$$

are unity and not affected by terms-of-trade shocks, and the intrasectoral relative wage of low-skilled workers

$$(11) \quad \mathsf{w}_j := \frac{w_j}{q_j} = \frac{\mathsf{a}_j}{1-\mathsf{a}_j} \cdot \frac{H_j}{N_j} = \left[\frac{\mathsf{j}}{\mathsf{a}_1^{-\mathsf{a}_1} \mathsf{a}_2^{\mathsf{a}_2} (1-\mathsf{a}_1)^{\mathsf{a}_1 - 1} (1-\mathsf{a}_2)^{1-\mathsf{a}_2}} \right]^{\frac{1}{\mathsf{a}_1 - \mathsf{a}_2}},$$

$$\Rightarrow \frac{d\mathsf{w}_j}{d\mathsf{j}} = \frac{1}{\mathsf{a}_1 - \mathsf{a}_2} \cdot \frac{\mathsf{w}_j}{\mathsf{j}} < 0, \ \text{since } \mathsf{a}_1 < \mathsf{a}_2.$$

is equal in both sectors $\left(\mathsf{w}_1 = \mathsf{w}_2 = \mathsf{w}\right)$.

A positive terms-of-trade shock $(d\mathsf{j} > 0)$ causes a temporary intersectoral wage differential $(w_1 > w_2, q_1 > q_2)$ resulting in the movement of low-skilled and high-skilled workers from sector 2 to sector 1. Since the production of good 1 is more high-skilled labour intensive than good 2 (i.e., $\mathsf{a}_1 < \mathsf{a}_2$), the ratio of high-skilled workers to low-skilled workers required for the expansion of sector 1 is higher than the one released in the contraction of sector 2. The excess supply of low-skilled workers and excess demand for high-skilled workers makes the wages of all low-skilled workers fall and the wages of all high-skilled workers rise - irrespective of their sectoral affiliation. Consequently, the intrasectoral relative wages of low-skilled workers in both sectors and the aggregate relative wage of low-skilled workers

$$\Omega := \frac{\frac{1}{N}\sum_{j=1}^{2} w_j N_j}{\frac{1}{H}\sum_{j=1}^{2} q_j H_j} = \frac{H}{N} \cdot \frac{\left[\mathsf{j} \cdot \mathsf{a}_1 Y_1 + \mathsf{a}_2 Y_2\right]}{\left[\mathsf{j} \cdot (1-\mathsf{a}_1) Y_1 + (1-\mathsf{a}_2) Y_2\right]} = \mathsf{w} \tag{12}$$

$$\Rightarrow \frac{d\Omega}{d\mathsf{j}} = (\mathsf{a}_1 - \mathsf{a}_2) \cdot \frac{H}{N} \cdot \frac{Y_1 Y_2}{\left[\mathsf{j}\ (1-\mathsf{a}_1) Y_1 + (1-\mathsf{a}_2) Y_2\right]^2} < 0, \text{ since } \mathsf{a}_1 < \mathsf{a}_2$$

are strictly monotonically decreasing in the terms of trade. Or differently stated, the sectoral and the aggregate skill premia are strictly monotonically increasing functions of the terms of trade.

The implications of the Heckscher-Ohlin model can be summarised as follows: A positive trade shock in a relatively high-skilled labour intensive sector,

e.g., a rise in its terms of trade, benefits all high-skilled workers and harms all low-skilled workers, thereby increasing the skill premium in both sectors of the economy (Stolper-Samuelson theorem). The equilibrium sectoral wage premium, however, is zero and not affected by trade shocks.

3.3 Comparison of the Models Implications to the Empirical Findings

The validity of the implications of the Heckscher-Ohlin model can be examined by comparing them to the stylised facts outlined in section 2. This comparison suggests that important aspects of the empirically observed correlation patterns cannot be replicated by the model. Firstly, it cannot account for sectoral differences in the skill premium. According to the model, these differences should be negligible or at least transitory, while the empirical data show that they are significant and persistent. Secondly, the model predicts a strong link between the terms of trade and the skill premium both on the sectoral and on the aggregate level, which is also not in line with most empirical studies.

Thirdly, since production factors are assumed to be perfectly homogeneous and perfectly mobile across sectors in the Heckscher-Ohlin model, the factor remuneration rates should be identical in all sectors. Consequently, the substantial and persistent sectoral differences in the wage levels would have to be explained by measurement errors. They could either compensate for non-pecuniary differences in job attributes or reflect differences in unmeasured labour quality.

While these factors might inflate the estimates of the sectoral wage differentials, the strong correlation of this variable across skill groups and with trade variables casts considerable doubt on whether measurement errors alone can account for its entire variability.

4 Insider-Outsider Trade Model with Cost of Hiring

The comparison of the stylised facts with the implications of the Heckscher-Ohlin model has revealed that it is misspecified. Consequently, a more complex model is needed to explain the impact of trade on the intra- and intersectoral dimension of income distribution. Above all, more attention should be paid to the explanation of the link between trade and sectoral wage premium. One way of doing so is to give up the assumption of zero cost of mobility.

4.1 Basic Assumptions

The Insider-Outsider trade model with cost of hiring (IO-HO model) shares most of the basic assumptions of the Heckscher-Ohlin model. In contrast to the latter, however, there are two types of each production factor. Low-skilled insiders N_{Ij} and high-skilled insiders H_{Ij} are those workers that are already employed in the sector j before the terms-of-trade shock, while low-skilled outsiders N_{Ej} and high-skilled outsiders H_{Ej} are hired by the representative firm of sector j in

response to the positive terms-of-trade shock. The representative firm of sector *j* faces cost of expanding its workforce[4]

(13) $A_j = a_j w_{Ej} N_{Ej},\ a_j > 0,$

(14) $B_j = b_j q_{Ej} H_{Ej},\ b_j > 0,$

which are assumed to be proportional to the number of outsiders, N_{Ej} and H_{Ej}, and to their wages, w_{Ej} and q_{Ej}, respectively. In this setting, the representative firm of sector *j* determines its supply of goods and its factor demand simultaneously by solving the static maximisation problem

$$\max_{\{N_{Ij}, N_{Ej}, H_{Ij}, H_{Ej}\}} D_j = p_j Y_j - w_{Ij} N_{Ij} - (1+a_j) w_{Ej} N_{Ej} - q_{Ij} H_{Ij} - (1+b_j) q_{Ej} H_{Ej},$$

(15) $$s.t. \quad Y_j = \left(N_{Ij} + N_{Ej}\right)^{\alpha_j} \left(H_{Ij} + H_{Ej}\right)^{1-\alpha_j},$$
$$N_{Ij}, N_{Ej}, H_{Ij}, H_{Ej} \geq 0.$$

The corresponding first order conditions

(16) $w_{Ij} = p_j \alpha_j \left(N_{Ij} + N_{Ej}\right)^{\alpha_j - 1} \left(H_{Ij} + H_{Ej}\right)^{1-\alpha_j},$

(17) $w_{Ej} \geq \frac{1}{1+a_j} p_j \alpha_j \left(N_{Ij} + N_{Ej}\right)^{\alpha_j - 1} \left(H_{Ij} + H_{Ej}\right)^{1-\alpha_j},$

(18) $q_{Ij} = p_j (1-\alpha_j) \left(N_{Ij} + N_{Ej}\right)^{\alpha_j} \left(H_{Ij} + H_{Ej}\right)^{-\alpha_j},$

(19) $q_{Ej} \geq \frac{1}{1+b_j} p_j (1-\alpha_j) \left(N_{Ij} + N_{Ej}\right)^{\alpha_j} \left(H_{Ij} + H_{Ej}\right)^{-\alpha_j}$

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[4] The cost of hiring include the cost of advertising the job, screening the job applicants as well as training the new employees.

can be derived by applying the Kuhn-Tucker theorem and can be interpreted as follows: Insiders are remunerated according to the value of their marginal product in the respective sector, while the reservation wage of outsiders is greater than or equal to the value of their marginal product in the respective sector less the cost of hiring.

Due to the perfect mobility of workers across sectors, the reservation wage of outsiders in one sector is equal to the wage rate they would receive as insiders in the other sector, i.e.,

(20) $w_{E1} = w_{I2}$,

(21) $w_{E2} = w_{I1}$,

(22) $q_{E1} = q_{I2}$,

(23) $q_{E2} = q_{I1}$.

The substitution of conditions (16) to (19) into equations (20) to (23) implies the following relations between the terms of trade and the equilibrium sectoral employment of low-skilled and high-skilled workers:

$$\frac{1}{1+a_2}\cdot\frac{\alpha_2\left(N_{I2}+N_{E2}\right)^{\alpha_2-1}\left(H_{I2}+H_{E2}\right)^{1-\alpha_2}}{\alpha_1\left(N_{I1}+N_{E1}\right)^{\alpha_1-1}\left(H_{I1}+H_{E1}\right)^{1-\alpha_1}} \leq \jmath$$

(24)

$$\leq \left(1+a_1\right)\cdot\frac{\alpha_2\left(N_{I2}+N_{E2}\right)^{\alpha_2-1}\left(H_{I2}+H_{E2}\right)^{1-\alpha_2}}{\alpha_1\left(N_{I1}+N_{E1}\right)^{\alpha_1-1}\left(H_{I1}+H_{E1}\right)^{1-\alpha_1}},$$

$$\frac{1}{1+b_2}\cdot\frac{(1-a_2)(N_{I2}+N_{E2})^{a_2}(H_{I2}+H_{E2})^{-a_2}}{(1-a_1)(N_{I1}+N_{E1})^{a_1}(H_{I1}+H_{E1})^{-a_1}}\leq j$$

(25)

$$\leq(1+b_1)\cdot\frac{(1-a_2)(N_{I2}+N_{E2})^{a_2}(H_{I2}+H_{E2})^{-a_2}}{(1-a_1)(N_{I1}+N_{E1})^{a_1}(H_{I1}+H_{E1})^{-a_1}}.$$

4.2 Commodity Prices and Factor Remuneration Rates

Like in the Heckscher-Ohlin model, the total effect of terms-of-trade shocks on income distribution can be broken down into their partial effects on its intersectoral dimension and on its intrasectoral dimension. In contrast to the Heckscher-Ohlin model, however, the functional relationship between the terms of trade and the intra- and intersectoral relative wages is not unique in the IO-HO model. Depending on the terms of trade, there are three possible outcomes.

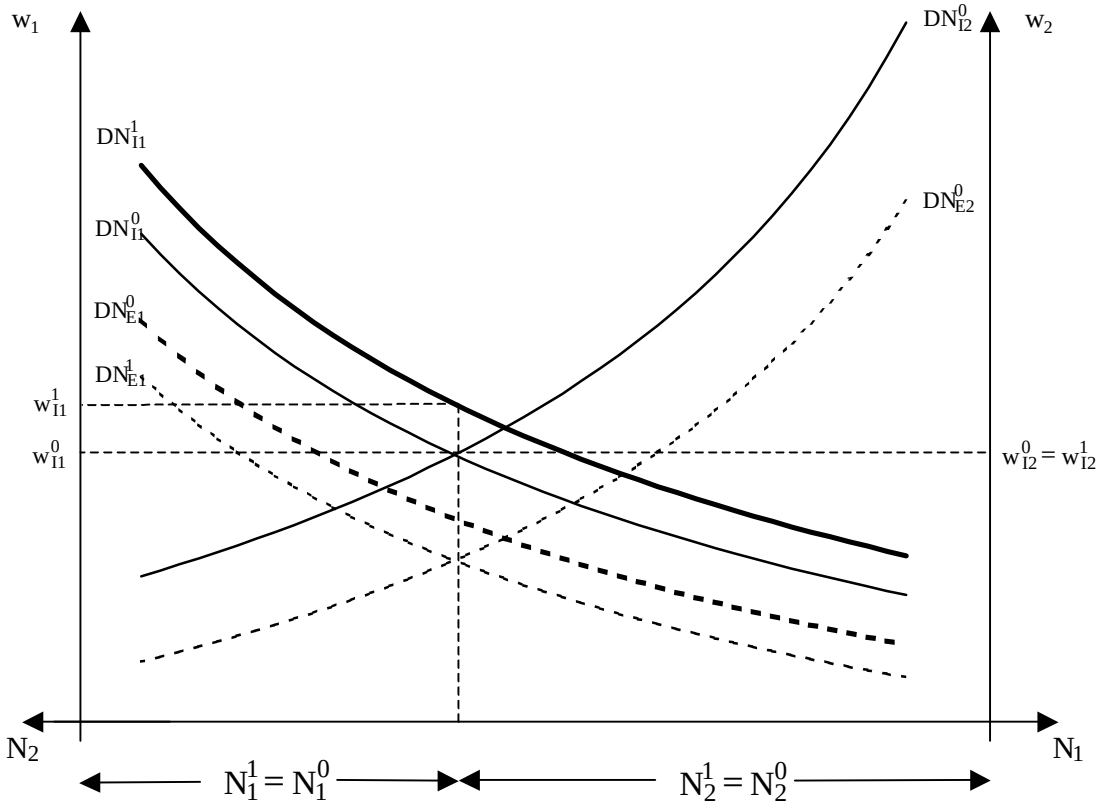
4.2.1 Ricardo Region

If after the terms-of-trade shock strict inequalities prevail in (24) and (25) for the pre-shock employment level,[5] i.e.,

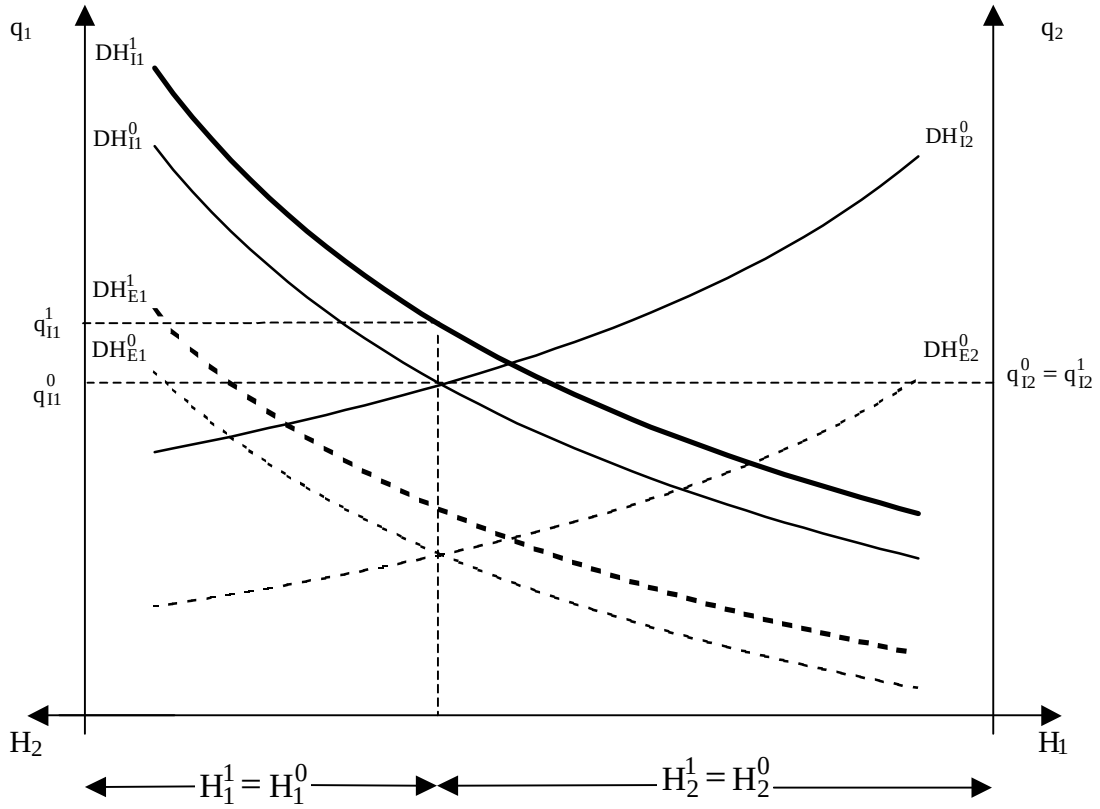
[5] Pre-shock variables are labelled with the superscript 0 and post-shock variables with the superscript 1.

Figure 1: Terms-of-Trade Shock in the Ricardo Region

a) Low-Skilled Workers



b) High-Skilled Workers



$$\text{(26)}\quad \mathsf{j} := \frac{p_1}{p_2} \in \left\{ \mathsf{j} \;\middle|\; \max\left[\frac{1}{1+a_2} \cdot \frac{\mathsf{a}_2 N_{I2}^{0\,\mathsf{a}_2-1} H_{I2}^{0\,1-\mathsf{a}_2}}{\mathsf{a}_1 N_{I1}^{0\,\mathsf{a}_1-1} H_{I1}^{0\,1-\mathsf{a}_1}}; \frac{1}{1+b_2} \cdot \frac{(1-\mathsf{a}_2) N_{I2}^{0\,\mathsf{a}_2} H_{I2}^{0\,-\mathsf{a}_2}}{(1-\mathsf{a}_1) N_{I1}^{0\,\mathsf{a}_1} H_{I1}^{0\,-\mathsf{a}_1}} \right] < \mathsf{j} < \min\left[(1+a_1) \frac{\mathsf{a}_2 N_{I2}^{0\,\mathsf{a}_2-1} H_{I2}^{0\,1-\mathsf{a}_2}}{\mathsf{a}_1 N_{I1}^{0\,\mathsf{a}_1-1} H_{I1}^{0\,1-\mathsf{a}_1}}; (1+b_1) \frac{(1-\mathsf{a}_2) N_{I2}^{0\,\mathsf{a}_2} H_{I2}^{0\,-\mathsf{a}_2}}{(1-\mathsf{a}_1) N_{I1}^{0\,\mathsf{a}_1} H_{I1}^{0\,-\mathsf{a}_1}} \right] \right\}$$

the model is similar to the Ricardo model.

Figure 1 shows the effect of a positive terms-of-trade shock in the Ricardo region of the IO-HO model. It is assumed that the pre-shock wage levels are identical in both sectors $\left(\text{, i.e., } w_{I1}^0 = w_{I2}^0, q_{I1}^0 = q_{I2}^0\right)$. The rise of the price of good 1 from p_1^0 to p_1^1 shifts up the demand curve for low-skilled and high-skilled labour in sector 1 in the same proportion as the price increase. In the Ricardo region of the IO-HO model, the post-shock net value of the marginal product[6] at the pre-shock employment level $\left(N_1^0, N_2^0, H_1^0, H_2^0\right)$ of neither low-skilled nor high-skilled outsiders in sector 1 lies above their corresponding reservation wage $\left(\text{, i.e., } DN_{E1\left(N_1^0\right)}^1 < w_{I2\left(N_1^0\right)}^1, DH_{E1\left(H_1^0\right)}^1 < q_{I2\left(H_1^0\right)}^1\right)$. Consequently, the representative firm of sector 1 does not employ any outsiders so that sectoral employment and sectoral production remain unaffected by terms-of-trade shocks. That is,

$$\text{(27)}\quad N_1^1 = N_{I1}^0,\ N_2^1 = N_{I2}^0 \ \Rightarrow\ \frac{dN_j^1}{d\mathsf{j}} = 0 \ \ \forall \ \ j \in \{1,2\},$$

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[6] The net value of the marginal product of outsiders denotes the value of their marginal product less the cost of hiring them.

(28) $$H_1^1 = H_{I1}^0,\ H_2^1 = H_{I2}^0 \ \Rightarrow\ \frac{dH_j^1}{d\mathrm{j}} = 0 \ \ \forall \ \ j \in \{1,2\},$$

(29) $$Y_j = N_{Ij}^{0\mathrm{a}_j} H_{Ij}^{0^{1-\mathrm{a}_j}} \ \Rightarrow\ \frac{dY_j}{d\mathrm{j}} = 0 \ \ \forall \ \ j \in \{1,2\}.$$

The wage rate of low-skilled and high-skilled insiders in sector *j* is equal to the price of good *j* times the respective marginal labour productivity. Hence, the total effect of terms-of-trade shocks on the intersectoral relative wage of insiders can be broken down into their direct effect on the relative price of good *j* and their indirect effect on the relative marginal labour productivity. In the Ricardo region of the IO-HO model, sectoral employment of low-skilled and high-skilled workers is constant. Consequently, the intersectoral relative wages of low-skilled and high-skilled insiders

(30) $$\mathrm{w}_N^1 := \frac{w_{I1}}{w_{I2}} = \mathrm{j} \ \cdot \frac{\mathrm{a}_1 N_{I1}^{0\,\mathrm{a}_1 - 1}\ H_{I1}^{0\,1-\mathrm{a}_1}}{\mathrm{a}_2 N_{I2}^{0\,\mathrm{a}_2 - 1}\ H_{I2}^{0\,1-\mathrm{a}_2}} < 1 + a_1 \Rightarrow \mathrm{w}_N \sim \mathrm{j}\ ,$$

(31) $$\mathrm{w}_H^1 := \frac{q_{I1}}{q_{I2}} = \mathrm{j} \ \cdot \frac{(1-\mathrm{a}_1) N_{I1}^{0\,\mathrm{a}_1}\ H_{I1}^{0\,-\mathrm{a}_1}}{(1-\mathrm{a}_2) N_{I2}^{0\,\mathrm{a}_2}\ H_{I2}^{0\,-\mathrm{a}_2}} < 1 + b_1 \ \Rightarrow\ \mathrm{w}_H \sim \mathrm{j}$$

are proportional to the terms of trade. Hence, the rise of the price of good 1 in figure 1 drives a wedge between the sectoral wage levels of low-skilled and high-skilled insiders $\left(\text{, i.e., } w_{I1}^1 > w_{I2}^1, q_{I1}^1 > q_{I2}^1\right)$.

Since the sectoral skill intensities are not affected by terms-of-trade shocks the same applies to the intrasectoral relative wages of low-skilled labour

$$(32)\quad \omega_1^1 := \frac{w_{I1}}{q_{I1}} = \frac{\alpha_1}{1-\alpha_1}\cdot\frac{H_{I1}^0}{N_{I1}^0} \Rightarrow \frac{d\omega_1}{d\varphi} = 0,$$

$$(33)\quad \omega_2^1 := \frac{w_{I2}}{q_{I2}} = \frac{\alpha_2}{1-\alpha_2}\cdot\frac{H_{I2}^0}{N_{I2}^0} \Rightarrow \frac{d\omega_2}{d\varphi} = 0.$$

Hence, in neither sector is there a redistribution of income from low-skilled workers to high-skilled workers, nor vice versa.

On the aggregate level, however, terms-of-trade shocks do have an impact on the skill premium. Since sector 1 is always more high-skilled labour intensive than sector 2 $(,\text{i.e.},\alpha_1 < \alpha_2)$, the income redistribution towards sector 1 caused by positive terms-of-trade shocks benefits relatively more high-skilled workers than low-skilled workers. Consequently, the aggregate relative wage of low-skilled workers

$$(34)\quad \Omega := \frac{\frac{1}{N}\cdot\left[\sum_{i=1}^{2} w_{Ij} N_{Ij}^1 + \sum_{j=1}^{2} w_{Ej} N_{Ej}^1\right]}{\frac{1}{H}\cdot\left[\sum_{i=1}^{2} q_{Ij} H_{Ij}^1 \sum_{j=1}^{2} q_{Ej} H_{Ej}^1\right]} = \frac{H}{N}\cdot\frac{\left[\varphi\cdot\alpha_1 Y_1^0 + \alpha_2 Y_2^0\right]}{\left[\varphi\cdot(1-\alpha_1)Y_1^0 + (1-\alpha_2)Y_2^0\right]}$$

$$\Rightarrow \frac{d\Omega}{d\varphi} = (\alpha_1-\alpha_2)\cdot\frac{H}{N}\cdot\frac{Y_1^0 Y_2^0}{\left[\varphi\cdot(1-\alpha_1)Y_1^0 + (1-\alpha_2)Y_2^0\right]^2} < 0, \text{ since } \alpha_1 < \alpha_2$$

is a strictly monotonically decreasing function of the terms of trade

To sum up, in the Ricardo region of the IO-HO model, a rise in the relative price of a relatively high-skilled labour intensive good does not affect the sectoral structure of employment nor production. However, it benefits those employed in its production and harms those employed in the rest of the economy.

Consequently, the sectoral wage premium of all workers in the high-skilled labour intensive sector rises - irrespective of their skill level. Within each sector, the income distribution between low-skilled workers and high-skilled workers is not affected by terms-of-trade shocks. On the aggregate level, however, the skill premium rises because relatively more high-skilled workers than low-skilled workers benefit from the income redistribution from the low-skilled labour intensive sector to the high-skilled labour intensive sector.

4.2.2 The Ricardo–Viner Region

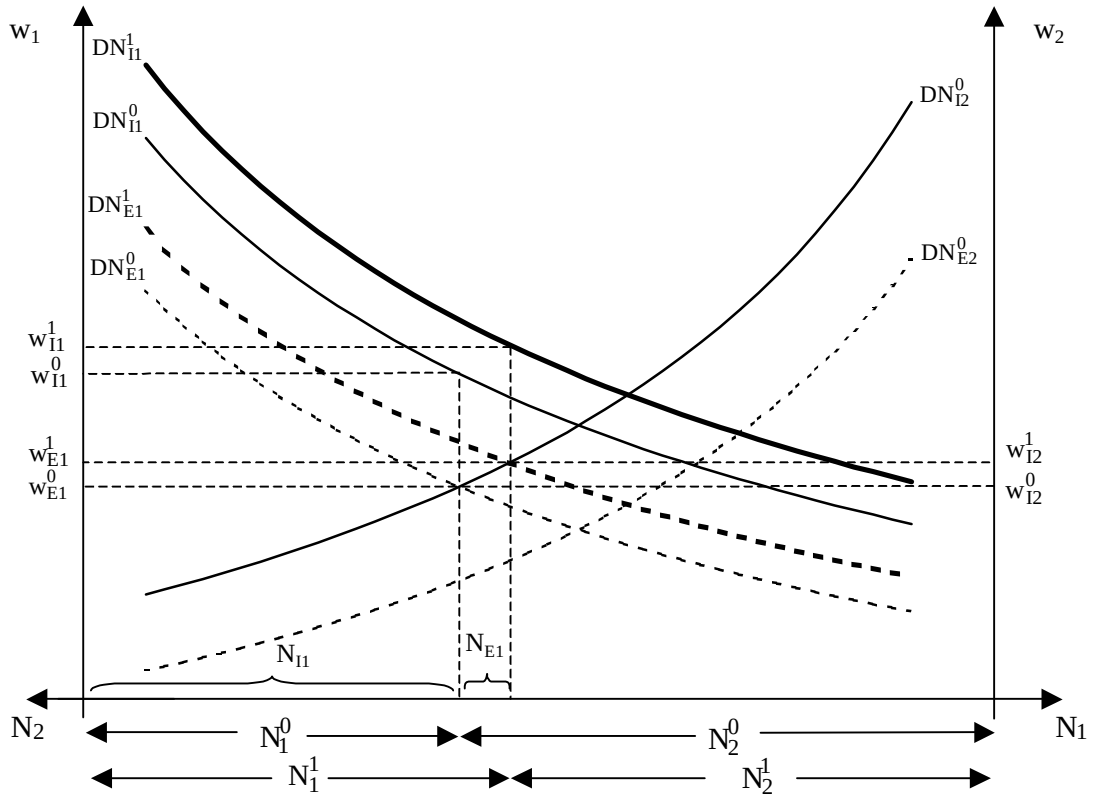
If the terms of trade have risen to such an extent that their post-shock value lies within the following range

$$\mathrm{j} := \frac{p_1}{p_2} \in \left\{ \mathrm{j} \;\middle|\; \max\left[\frac{1}{1+a_2} \cdot \frac{\mathrm{a}_2 N_{I2}^{0\,\mathrm{a}_2-1} H_{I2}^{0\,1-\mathrm{a}_2}}{\mathrm{a}_1 N_{I1}^{0\,\mathrm{a}_1-1} H_{I1}^{0\,1-\mathrm{a}_1}}; \frac{1}{1+b_2} \cdot \frac{(1-\mathrm{a}_2) N_{I2}^{0\,\mathrm{a}_2} H_{I2}^{0\,-\mathrm{a}_2}}{(1-\mathrm{a}_1) N_{I1}^{0\,\mathrm{a}_1} H_{I1}^{0\,-\mathrm{a}_1}}; \right.\right. \tag{35}$$
$$\left.\left. (1+a_1) \frac{\mathrm{a}_2 N_{I2}^{0\,\mathrm{a}_2-1} H_{I2}^{0\,1-\mathrm{a}_2}}{\mathrm{a}_1 N_{I1}^{0\,\mathrm{a}_1-1} H_{I1}^{0\,1-\mathrm{a}_1}} \right] < \mathrm{j} < (1+b_1) \cdot \frac{(1-\mathrm{a}_2) N_{I2}^{0\,\mathrm{a}_2} H_{I2}^{0\,-\mathrm{a}_2}}{(1-\mathrm{a}_1) N_{I1}^{0\,\mathrm{a}_1} H_{I1}^{0\,-\mathrm{a}_1}} \right\},$$

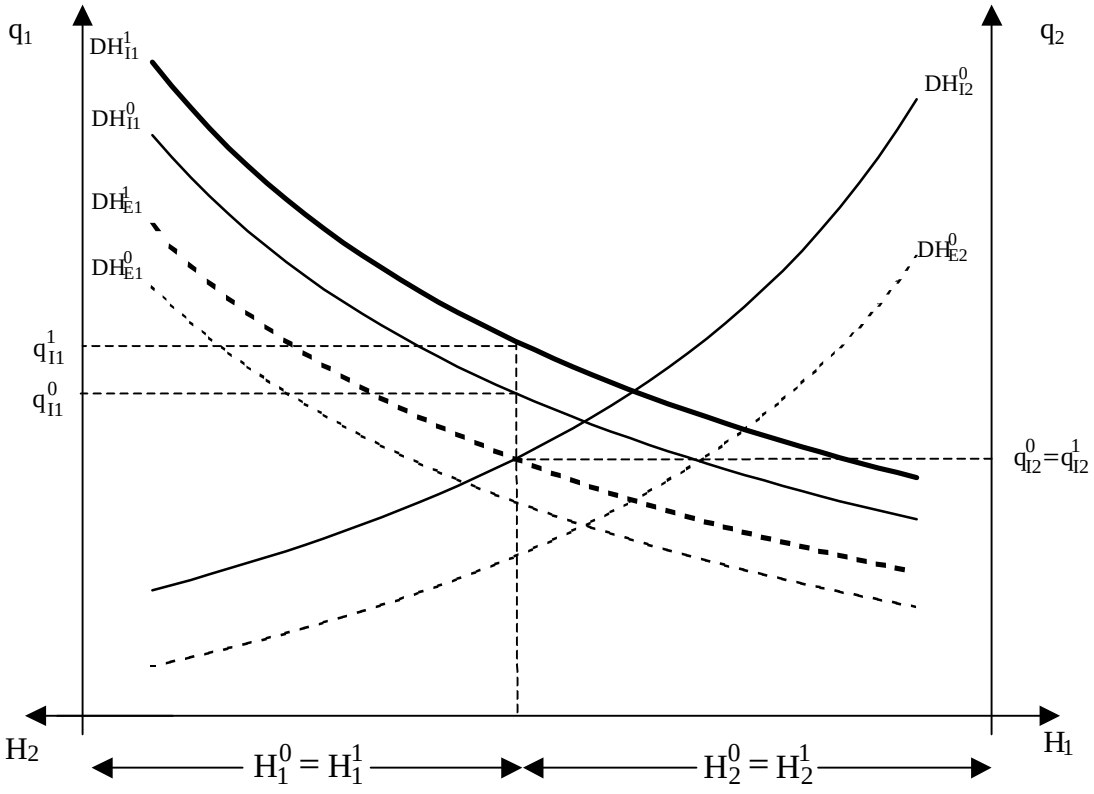
the model is similar to the Ricardo-Viner model.

Figure 2: Terms-of-Trade Shock in the Ricardo-Viner Region

a) Low-Skilled Workers



b) High-skilled Workers



In figure 2 the rise of the price of good 1 from p_1^0 to p_1^1 lifts the post-shock net value of the marginal product at the pre-shock employment level of low-skilled outsiders in sector 1 above their reservation wage, while the reverse applies to high-skilled outsiders in sector 1 $\left(\text{, i.e., } DN^1_{E1(N_1^0)} > w^1_{I2(N_1^0)}, DH^1_{E1(H_1^0)} < q^1_{I2(H_1^0)}\right)$. Hence, hiring low-skilled outsiders is profitable for the representative firm in sector 1 so that it expands its employment of low-skilled workers until this profit opportunity has ceased $\left(\text{, i.e., } DN^1_{E1(N_1^1)} = w^1_{I2(N_1^1)}\right)$. The extent of the sectoral redeployment of low-skilled labour is determined by the size of the terms-of-trade shock. The greater the rise in the relative price of good 1, the more low-skilled outsiders will be employed in sector 1. Consequently, sectoral employment of low-skilled workers in sector 1 (2) is monotonically increasing (decreasing) in the terms of trade[7]

$$(36)\quad N_1^1 = N_{I1}^0 + N_{E1}, \text{ with } \frac{dN_1}{d\mathsf{j}} = \frac{dN_{E1}}{d\mathsf{j}} = \frac{1}{\mathsf{j}} \cdot \left(\frac{1-\mathsf{a}_1}{N_{I1}^0 + N_{E1}} + \frac{1-\mathsf{a}_2}{N_{I2}^0 - N_{E1}} \right)^{-1} > 0,$$

$$(37)\quad N_2^1 = N_{I2}^0 - N_{E1}, \text{ with } \frac{dN_2}{d\mathsf{j}} = -\frac{dN_{E1}}{d\mathsf{j}} = -\frac{1}{\mathsf{j}} \cdot \left(\frac{1-\mathsf{a}_1}{N_{I1}^0 + N_{E1}} + \frac{1-\mathsf{a}_2}{N_{I2}^0 - N_{E1}} \right)^{-1} < 0.$$

Sectoral employment of high-skilled workers, however, continues to be not affected by terms-of-trade shocks

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[7] For a detailed derivation of this result see Appendix A1

$$(38)\quad H_1^1 = H_{I1}^0,\ H_2^1 = H_{I2}^0 \ \Rightarrow\ \frac{dH_j}{d\mathsf{j}} = 0 \ \ \forall \ \ j \in \{1,2\}.$$

Due to the movement of low-skilled workers from sector 2 to sector 1, the production of sector 1 (2) is a strictly monotonically increasing (decreasing) function of the terms of trade

$$(39)\quad \begin{aligned} & Y_1 = \left(N_{I1}^0 + N_{E1}\right)^{\mathsf{a}_1} {H_{I1}^0}^{1-\mathsf{a}_1} \\ & \Rightarrow \frac{dY_1}{d\mathsf{j}} = \frac{\mathsf{a}_1}{\mathsf{j}} \cdot \left(\frac{H_{I1}^0}{N_{I1}^0 + N_{E1}}\right)^{1-\mathsf{a}_1} \left(\frac{1-\mathsf{a}_1}{N_{I1}^0 + N_{E1}} + \frac{1-\mathsf{a}_2}{N_{I2}^0 - N_{E1}}\right)^{-1} > 0, \end{aligned}$$

$$(40)\quad \begin{aligned} & Y_2 = \left(N_{I2}^0 - N_{E1}\right)^{\mathsf{a}_2} {H_{I2}^0}^{1-\mathsf{a}_2} \\ & \Rightarrow \frac{dY_2}{d\mathsf{j}} = -\frac{\mathsf{a}_2}{\mathsf{j}} \cdot \left(\frac{H_{I2}^0}{N_{I2}^0 - N_{E1}}\right)^{1-\mathsf{a}_2} \left(\frac{1-\mathsf{a}_1}{N_{I1}^0 + N_{E1}} + \frac{1-\mathsf{a}_2}{N_{I2}^0 - N_{E1}}\right)^{-1} < 0. \end{aligned}$$

In the Ricardo-Viner region of the IO-HO model, the direct and indirect effect of terms-of-trade shocks on the intersectoral relative wage of low-skilled insiders exactly offset each other. Firstly, a rise of the price of good 1 in figure 2 causes an expansion of the employment of low-skilled workers in sector 1 and a contraction in sector 2. Due to the change in structural employment, the marginal productivity of low-skilled workers falls in sector 1 and rises in sector 2. Consequently, in contrast to the Ricardo region of the model, the wage rate of low-skilled workers in sector 1 rises by less than the price increase and the one in sector 2 also rises. In equilibrium, the wage rate of outsiders in sector 1 is identical to the one of low-skilled insiders in sector 2. Hence, all low-skilled workers previously employed in sector 2 are equally affected by the positive

terms-of-trade shock. Secondly, since the economic resources consumed in the process of hiring are assumed to be a constant proportion of the wage rate of outsiders, the wage differential between low-skilled insiders and low-skilled outsiders in sector 1 is constant[8]. From these two conditions follows that the intersectoral relative wage of low-skilled insiders

$$(41)\quad w_N^1 := \frac{w_{I1}}{w_{I2}} = \varphi \cdot \frac{\alpha_1 \left(N_{I1}^0 + N_{E1}\right)^{\alpha_1 - 1} H_{I1}^{0\,1-\alpha_1}}{\alpha_2 \left(N_{I2}^0 - N_{E1}\right)^{\alpha_2 - 1} H_{I2}^{0\,1-\alpha_2}} = 1 + a_1 \Rightarrow \frac{dw_N}{d\varphi} = 0,$$

is greater than one but not affected by terms-of-trade shocks.

In the case of high-skilled insiders, the direct and the indirect effect of terms-of-trade shocks on the intersectoral relative wage

$$w_H^1 := \frac{q_{I1}}{q_{I2}} = \varphi \cdot \frac{(1-\alpha_1)\left(N_{I1}^0 + N_{E1}\right)^{\alpha_1} H_{I1}^{0\,-\alpha_1}}{(1-\alpha_2)\left(N_{I2}^0 - N_{E1}\right)^{\alpha_2} H_{I2}^{0\,-\alpha_2}} < 1 + b_1$$

$$(42)\quad \Rightarrow \frac{dw_H}{d\varphi} = \frac{w_H}{\varphi} + w_H \left(\frac{\alpha_1}{N_{I1}^0 + N_{E1}} + \frac{\alpha_2}{N_{I2}^0 - N_{E1}} \right) \frac{dN_{E1}}{d\varphi}$$

$$= \frac{w_H}{\varphi} \cdot \frac{N}{(1-\alpha_1)\cdot\left(N_{I2}^0 - N_{E1}\right) + (1-\alpha_2)\cdot\left(N_{I1}^0 + N_{E1}\right)} > 0.$$

amplify each other. Since sectoral employment of high-skilled workers is not affected by terms-of-trade shocks, a rise in the relative price of good 1 causes a proportional increase in the intersectoral relative wage rate of high-skilled

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[8] The result that the wage differential is found between insiders and outsiders in sector 1 and not between workers in sector 1 and workers in sector 2 is due to the assumption that the cost of labour mobility have to be met by the individual firm not by the individual worker.

insiders. This direct effect, which is equivalent to the total effect in the Ricardo region of the IO-HO model, is reflected in the first summand of the derivative of the intersectoral relative wage of high-skilled insiders with respect to the terms of trade. Additionally, the inflow of low-skilled workers into sector 1 caused by the rise of the relative price of good 1 augments the marginal product high-skilled workers in sector 1 and reduces the one in sector 2. This indirect effect, which is reflected in the second summand of the derivative, also contributes to the increase of the intersectoral relative wage of high-skilled insiders.

Due to the shift of low-skilled workers from sector 2 to sector 1, the human capital intensity falls in sector 1 and rises in sector 2. As a result, the intrasectoral relative price of low-skilled insiders

$$\mathsf{w}_1 := \frac{w_{I1}}{q_{I1}} = \frac{\mathsf{a}_1}{1-\mathsf{a}_1} \cdot \frac{H_{I1}^0}{N_{I1}^0 + N_{E1}}$$

$$(43) \quad \Rightarrow \frac{d\mathsf{w}_1}{d\mathsf{j}} = -\frac{\mathsf{a}_1}{1-\mathsf{a}_1} \cdot \frac{H_{I1}^0}{\left(N_{I1}^0 + N_{E1}\right)^2} \cdot \frac{dN_{E1}}{d\mathsf{j}}$$

$$= -\frac{\mathsf{a}_1}{1-\mathsf{a}_1} \cdot \frac{H_{I1}^0}{\left(N_{I1}^0 + N_{E1}\right)^2} \cdot \frac{1}{\mathsf{j}} \cdot \left(\frac{1-\mathsf{a}_1}{N_{I1}^0 + N_{E1}} + \frac{1-\mathsf{a}_2}{N_{I2}^0 - N_{E1}} \right)^{-1} < 0,$$

$$\mathsf{w}_2 := \frac{w_{I2}}{q_{I2}} = \frac{\mathsf{a}_2}{1-\mathsf{a}_2} \cdot \frac{H_{I2}^0}{N_{I2}^0 - N_{E2}}$$

$$(44) \quad \Rightarrow \frac{d\mathsf{w}_2}{d\mathsf{j}} = \frac{\mathsf{a}_2}{1-\mathsf{a}_2} \cdot \frac{H_{I2}^0}{\left(N_{I2}^0 - N_{E1}\right)^2} \cdot \frac{dN_{E1}}{d\mathsf{j}}$$

$$= \frac{\mathsf{a}_2}{1-\mathsf{a}_2} \cdot \frac{H_{I2}^0}{\left(N_{I2}^0 - N_{E1}\right)^2} \cdot \frac{1}{\mathsf{j}} \cdot \left(\frac{1-\mathsf{a}_1}{N_{I1}^0 + N_{E1}} + \frac{1-\mathsf{a}_2}{N_{I2}^0 - N_{E1}} \right)^{-1} > 0$$

is a strictly monotonically decreasing (increasing) function of the terms of trade in sector 1 (2).

The preceding discussion shows that a rise in the price of the relatively high-skilled labour intensive good 1 lowers the aggregate relative wage of low-skilled workers

$$\Omega := \frac{\frac{1}{N}\cdot\left(\sum_{i=1}^{2} w_{Ij}^{1} N_{Ij}^{1} + \sum_{j=1}^{2} w_{Ej}^{1} N_{Ej}^{1}\right)}{\frac{1}{H}\cdot\left(\sum_{i=1}^{2} q_{Ij}^{1} H_{Ij}^{1} + \sum_{j=1}^{2} q_{Ej}^{1} H_{Ej}^{1}\right)} = \frac{H}{N}\cdot\frac{\mathrm{j}\cdot \mathrm{a}_1 Y_1 + \mathrm{a}_2 Y_2}{\mathrm{j}\cdot(1-\mathrm{a}_1)Y_1 + (1-\mathrm{a}_2)Y} \tag{45}$$

$$\Rightarrow \frac{d\Omega}{d\mathrm{j}} < 0, \text{ since } \mathrm{a}_1 < \mathrm{a}_2, \frac{dY_1}{d\mathrm{j}} > 0, \frac{dY_2}{d\mathrm{j}} < 0.$$

for two reasons. Firstly, the redistribution of income from the relatively low-skilled labour intensive sector 2 to the relatively high-skilled intensive sector 1 caused by a positive terms-of-trade shock benefits relatively more high-skilled workers in sector 1 than it harms in sector 2. Secondly, the structural change towards the relatively high-skilled labour intensive sector 1 raises the demand for high-skilled workers and reduces the demand for low-skilled workers. Hence, the aggregate relative wage of low-skilled workers is strictly monotonically decreasing in the terms of trade.

The implications of the Ricardo-Viner region of the IO-HO model can be summarised as follows: On the assumption that the hiring cost of low-skilled outsiders are less weighty than the one of high-skilled outsiders, a positive terms-

of-trade shock in a relatively high-skilled labour intensive sector causes an inflow of low-skilled workers into this sector while the sectoral employment of high-skilled workers is not affected. As a result, the intersectoral relative wage of insiders of the former skill group remains constant while the one of the latter skill group increases. Furthermore, the intrasectoral relative wage of low-skilled insiders falls in the relatively high-skilled labour intensive sector and rises in the other sector. Like in the Ricardo region of the model, the impact of the trade shock on the aggregate relative wage of low-skilled workers is negative.

4.2.3 The Heckscher-Ohlin Region

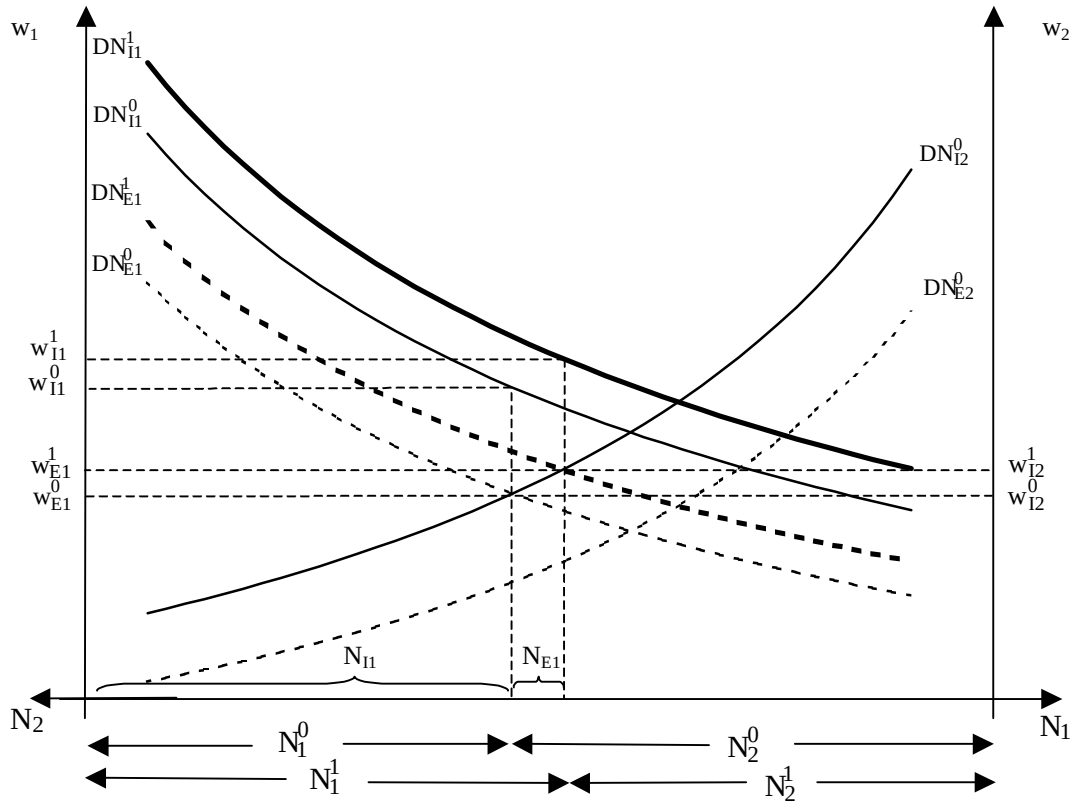
If the terms of trade have risen even further so that their post-shock value lies within the following range

$$\mathrm{j} \coloneqq \frac{p_1}{p_2} \in \left\{ \mathrm{j} \;\middle|\; \max\left[\frac{1}{1+a_2} \cdot \frac{\mathrm{a}_2 N_{I2}^{0\,\mathrm{a}_2-1} H_{I2}^{0\,1-\mathrm{a}_2}}{\mathrm{a}_1 N_{I1}^{0\,\mathrm{a}_1-1} H_{I1}^{0\,1-\mathrm{a}_1}}; \frac{1}{1+b_2} \cdot \frac{(1-\mathrm{a}_2) N_{I2}^{0\,\mathrm{a}_2} H_{I2}^{0\,-\mathrm{a}_2}}{(1-\mathrm{a}_1) N_{I1}^{0\,\mathrm{a}_1} H_{I1}^{0\,-\mathrm{a}_1}}; \right.\right. \\ \left.\left. (1+a_1) \cdot \frac{\mathrm{a}_2 N_{I2}^{0\,\mathrm{a}_2-1} H_{I2}^{0\,1-\mathrm{a}_2}}{\mathrm{a}_1 N_{I1}^{0\,\mathrm{a}_1-1} H_{I1}^{0\,1-\mathrm{a}_1}}; (1+b_1) \cdot \frac{(1-\mathrm{a}_2) N_{I2}^{0\,\mathrm{a}_2} H_{I2}^{0\,-\mathrm{a}_2}}{(1-\mathrm{a}_1) N_{I1}^{0\,\mathrm{a}_1} H_{I1}^{0\,-\mathrm{a}_1}} \right] < \mathrm{j} \right\}, \tag{46}$$

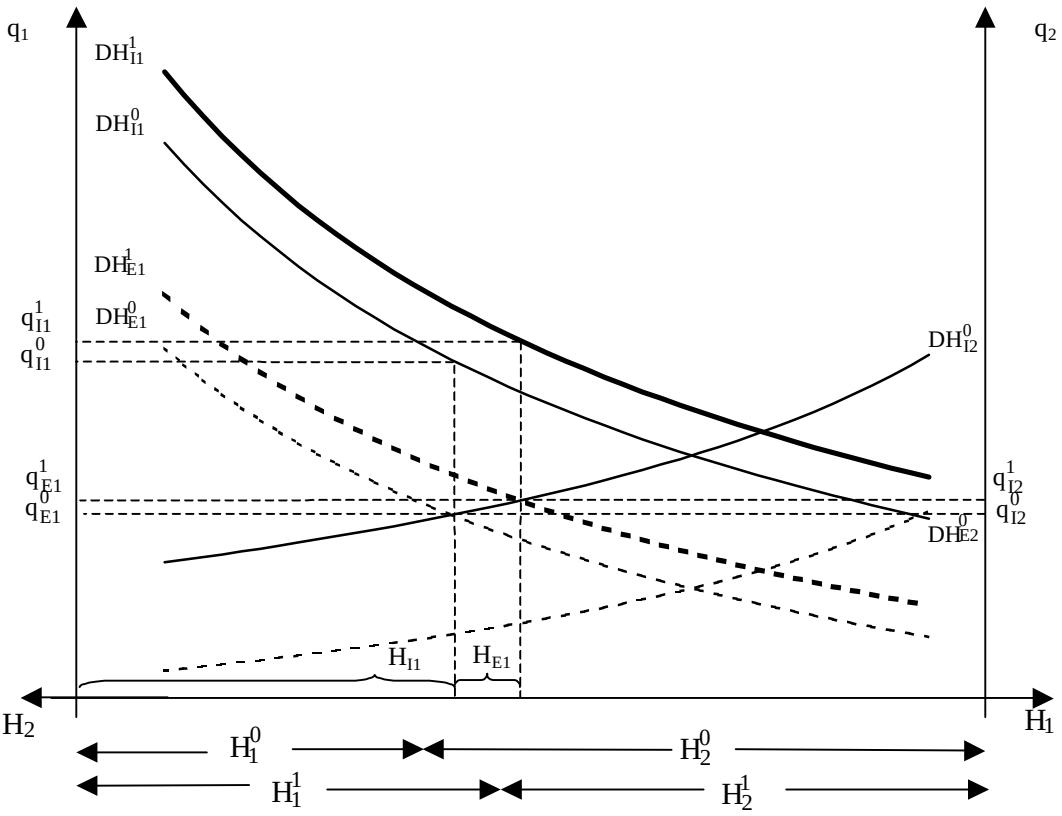
the model is similar to the Heckscher-Ohlin model.

Figure 3: Terms-of-Trade Shock in the Heckscher-Ohlin RegionRicardo Region

a) Low-Skilled Workers



b) High-skilled Workers



In figure 3, the positive terms-of-trade shock $\left(p_1^0 \to p_1^1\right)$ lifts the post-shock net value of the marginal product at the pre-shock employment level of both low-skilled and high-skilled outsiders in sector 1 above their respective reservation rate $\left(\text{, i.e., } DN_{E1\left(N_1^0\right)}^1 > w_{I2\left(N_1^0\right)}^1, DH_{E1\left(H_1^0\right)}^1 > q_{I2\left(H_1^0\right)}^1\right)$. Consequently, the representative firm of sector 1 expands its employment of low-skilled and high-skilled workers. Like in the Ricardo-Viner region of the IO-HO model, the extent of the sectoral shift of labour is determined by the size of the terms-of-trade shock so that sectoral employment of low-skilled and high-skilled workers and sectoral production in sector 1 (2) are monotonically increasing (decreasing) with the relative price of good 1

$$(47) \quad N_1^1 = N_{I1}^0 + N_{E1} \Rightarrow \frac{dN_1}{d\mathrm{j}} = \frac{dN_{E1}}{d\mathrm{j}} > 0,$$

$$(48) \quad N_2^1 = N_{I2}^0 - N_{E1} \Rightarrow \frac{dN_2}{d\mathrm{j}} = -\frac{dN_{E1}}{d\mathrm{j}} < 0,$$

$$(49) \quad H_1^1 = H_{I1}^0 + H_{E1} \Rightarrow \frac{dH_1}{d\mathrm{j}} = \frac{dH_{E1}}{d\mathrm{j}} > 0,$$

$$(50) \quad H_2^1 = H_{I2}^0 - H_{E1} \Rightarrow \frac{dH_2}{d\mathrm{j}} = -\frac{dH_{E1}}{d\mathrm{j}} < 0,$$

$$(51) \quad \begin{aligned} & Y_1 = \left(N_{I1}^0 + N_{E1}\right)^{\mathrm{a}_1}\left(H_{I1}^0 + H_{E1}\right)^{1-\mathrm{a}_1} \\ & \Rightarrow \frac{dY_1}{d\mathrm{j}} = \mathrm{a}_1 \frac{Y_1}{N_1^1} \cdot \frac{dN_{E1}}{d\mathrm{j}} + \left(1-\mathrm{a}_1\right) \cdot \frac{Y_1}{H_1^1} \cdot \frac{dH_{E1}}{d\mathrm{j}} > 0, \end{aligned}$$

$$Y_2 = \left(N_{I2}^0 - N_{E1}\right)^{\alpha_2}\left(H_{I2}^0 - H_{E1}\right)^{1-\alpha_2}$$

(52)
$$\Rightarrow \frac{dY_2}{d\omega} = -\alpha_2 \frac{Y_2}{N_2^1}\cdot\frac{dN_{E1}}{d\omega} - \left(1-\alpha_2\right)\cdot\frac{Y_2}{H_2^1}\cdot\frac{dH_{E1}}{d\omega} < 0.$$

In the Heckscher-Ohlin region of the IO-HO model, the direct and indirect effect of terms-of-trade shocks on the intersectoral relative wage of insiders exactly offset each other both for low-skilled and for high-skilled workers. In equilibrium, the wage differential between outsiders in sector 1 and the corresponding insiders in sector 2 is zero and the one between insiders and the corresponding outsiders in sector 1 is equal to the hiring cost. Consequently, a terms-of-trade shock leaves the intersectoral relative wages of low-skilled and high-skilled insiders

(53)
$$\omega_N^1 := \frac{w_{I1}}{w_{I2}} = \omega \cdot \frac{\alpha_1\left(N_{I1}^0 + N_{E1}\right)^{\alpha_1-1}\left(H_{I1}^0 + H_{E1}\right)^{1-\alpha_1}}{\alpha_2\left(N_{I2}^0 - N_{E1}\right)^{\alpha_2-1}\left(H_{I2}^0 - H_{E1}\right)^{1-\alpha_2}} = 1 + a_1 \Rightarrow \frac{d\omega_N}{d\omega} = 0,$$

(54)
$$\omega_H^1 := \frac{q_{I1}}{q_{I2}} = \omega \cdot \frac{\left(1-\alpha_1\right)\left(N_{I1}^0 + N_{E1}\right)^{\alpha_1}\left(H_{I1}^0 + H_{E1}\right)^{-\alpha_1}}{\left(1-\alpha_2\right)\left(N_{I2}^0 - N_{E1}\right)^{\alpha_2}\left(H_{I2}^0 - H_{E1}\right)^{-\alpha_2}} = 1 + b_1 \Rightarrow \frac{d\omega_N}{d\omega} = 0,$$

unchanged.

The economic mechanism through which positive terms-of-trade shocks feed into the sectoral skill premium is identical to the one in the Heckscher-Ohlin model. Hence, the structural change caused by a rise in the relative price of final good 1 makes the wages of all low-skilled workers fall and the wages of all high-

skilled workers rise – irrespective of their sectoral affiliation. Consequently, the intrasectoral relative wages of low-skilled insiders

$$(55)\quad \mathsf{w}_1^1 := \frac{w_{I1}^1}{q_{I1}^1} = \left[\frac{\mathsf{j}}{\mathsf{a}_1^{-\mathsf{a}_1}\mathsf{a}_2^{\mathsf{a}_2}(1-\mathsf{a}_1)^{\mathsf{a}_1-1}(1-\mathsf{a}_2)^{1-\mathsf{a}_2}\cdot(1+b_1)^{1-\mathsf{a}_2}\cdot(1+a_1)^{\mathsf{a}_2}} \right]^{\frac{1}{\mathsf{a}_1-\mathsf{a}_2}}$$
$$\Rightarrow \frac{d\mathsf{w}_1}{d\mathsf{j}} = \frac{1}{\mathsf{a}_1-\mathsf{a}_2}\cdot\frac{\mathsf{w}_1^1}{\mathsf{j}} < 0, \text{since} \mathsf{a}_1 < \mathsf{a}_2,$$

$$(56)\quad \mathsf{w}_2^1 := \frac{w_{I2}^1}{q_{I2}^1} = \left[\frac{\mathsf{j}}{\mathsf{a}_1^{-\mathsf{a}_1}\mathsf{a}_2^{\mathsf{a}_2}(1-\mathsf{a}_1)^{\mathsf{a}_1-1}(1-\mathsf{a}_2)^{1-\mathsf{a}_2}\cdot(1+b_1)^{1-\mathsf{a}_1}\cdot(1+a_1)^{\mathsf{a}_1}} \right]^{\frac{1}{\mathsf{a}_1-\mathsf{a}_2}}$$
$$\Rightarrow \frac{d\mathsf{w}_2}{d\mathsf{j}} = \frac{1}{\mathsf{a}_1-\mathsf{a}_2}\cdot\frac{\mathsf{w}_2^1}{\mathsf{j}} < 0, \text{since} \mathsf{a}_1 < \mathsf{a}_2,$$

are strictly monotonically decreasing in the terms of trade in both sectors. The same applies to the aggregate relative wage

$$(57)\quad \Omega := \frac{\frac{1}{N}\cdot\left(\sum_{i=1}^{2} w_{Ij}^1 N_{Ij}^1 + \sum_{j=1}^{2} w_{Ej}^1 N_{Ej}^1\right)}{\frac{1}{H}\cdot\left(\sum_{i=1}^{2} q_{Ij}^1 H_{Ij}^1 + \sum_{j=1}^{2} q_{Ej}^1 H_{Ej}^1\right)} = \frac{H}{N}\cdot\frac{\mathsf{j}\cdot\mathsf{a}_1 Y_1 + \mathsf{a}_2 Y_2}{\mathsf{j}\cdot(1-\mathsf{a}_1)Y_1 + (1-\mathsf{a}_2)Y}$$
$$\Rightarrow \frac{d\Omega}{d\mathsf{j}} < 0, \text{ since } \mathsf{a}_1 < \mathsf{a}_2, \frac{dY_1}{d\mathsf{j}} > 0, \frac{dY_2}{d\mathsf{j}} < 0.$$

In conclusion, in the Heckscher-Ohlin region of the IO-HO model, a rise in the relative price of a relatively high-skilled labour intensive good benefits all high-skilled workers and harms all low-skilled workers, thereby, augmenting the skill premium both on the sectoral and on the aggregate level. The sectoral wage

premium is not affected by terms-of-trade shocks. In contrast to the Heckscher-Ohlin model, however, it is not zero.

4.3 Comparison of the Models Implications to the Empirical Findings

Like in section 3.3, the validity of the implications of the IO-HO model can be examined by comparing them to the empirical findings outlined in section 2 of the paper. By introducing cost of hiring into the 2 x 2 trade model, its ability to replicate the stylised facts has improved along both dimensions of income distribution.

Firstly, the IO-HO model can account for the significant and persistent sectoral differences in the skill premium. Cost of hiring represents an obstacle to the sectoral redeployment of labour and prevents the equalisation of the relative remuneration rates across sectors. Secondly, the model predicts that the link between the terms of trade and the skill premium should be strong on the aggregate level but weak on the sectoral level. If the terms of trade are such that the sectoral employment of neither production factor is affected by trade shocks (Ricardo region), the intrasectoral relative wage of low-skilled workers is also not affected, both in absolute terms and relative to the other sector. If both production factors move between sectors in response to a trade shock (Heckscher-Ohlin region), the skill premium changes in absolute terms but not relative to the other sector. And finally, if the sectoral employment of only one production factor

adapts to trade shocks (Ricardo-Viner region), this variable changes both in absolute and in relative terms. This ambiguity in the response of the sectoral skill premium (as opposed to the aggregate skill premium)[9] to trade shocks casts doubt on the explicative power of a series of empirical tests on the link between trade and income distribution. Recent empirical studies in this field predominantly apply Leamer's (1996) "mandated-wage approach". This approach decomposes the empirically observed changes of the skill premium into portions attributable to trade and technology shocks by regressing reduced-form estimation equations derived from the Stolper-Samuelson theorem using sectoral trade, wage and employment data. By neglecting the influence of hiring cost, these empirical studies might significantly underestimate the impact of trade on income distribution.

Thirdly, the model can account for the empirically observed differences in the wage levels across sectors. According to the model, they are caused by differing degrees of insider power of the workers across sectors. And finally, it shows that hiring cost can at least partially explain the positive correlation of the sectoral wage differentials both across skill groups and with trade variables.

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[9] In the IO-HO model, the aggregate relative wage of low-skilled workers responds to a trade shock in line with the Stolper-Samuelson theorem – irrespective of the level of the terms of trade.

5 Insider-Outsider Trade Model with Productivity Differentials

Up to now, the economic intuition of the insider-outsider model has been told from the perspective of the representative firm and the cost of mobility were modelled by constant cost of hiring. This model specification, however, is not the only possibility to obtain the results outlined in the last section. Another way to do so is to introduce a Ricardian aspect into the Heckscher-Ohlin model by giving up the assumption of perfect homogeneity of the production factors.

5.1 Basic Assumptions

The basic assumptions of the insider-outsider trade model with productivity differentials (IO-HO2 model), which is based on Ruffin's (2001) concept of quasi-specific factors, are mainly identical to the ones of the IO-HO model. However, instead of introducing cost of hiring into the Heckscher-Ohlin model, the production factors in the IO-HO2 model are assumed to be not homogeneous. It is assumed that low-skilled insiders N_{Ij} and high-skilled insiders H_{Ij}, are more productive than low-skilled outsiders N_{Ej} and high-skilled outsiders H_{Ej}, respectively.[10] Letting $\frac{1}{a_{Ij}}$ and $\frac{1}{b_{Ij}}$ be the efficiency factors of low-skilled

[10] These differentials in labour productivity are the result of sector-specific human capital accumulation.

insiders and high-skilled insiders, respectively, and $\frac{1}{a_{Ej}}$ and $\frac{1}{b_{Ej}}$ be the ones of the corresponding outsiders, the following conditions hold:

$$(58)\quad \frac{a_{I1}}{a_{E2}} < \frac{a_{E1}}{a_{I2}},$$

$$(59)\quad \frac{b_{I1}}{b_{E2}} < \frac{b_{E1}}{b_{I2}}.$$

In this model specification, the static maximisation problem of the representative firm of sector *j* reads

$$\max_{\{N_{Ij},N_{Ej},H_{Ij},H_{Ej}\}} D_j = p_j Y_j - w_{Ij}N_{Ij} - w_{Ej}N_{Ej} - q_{Ij}H_{Ij} - q_{Ej}H_{Ej},$$

$$(60)\quad s.t.\quad Y_j = \left(\frac{N_{Ij}}{a_{Ij}} + \frac{N_{Ej}}{a_{Ej}}\right)^{\alpha_j}\left(\frac{H_{Ij}}{b_{Ij}} + \frac{H_{Ej}}{b_{Ej}}\right)^{1-\alpha_j},$$

$$N_{Ij}, N_{Ej}, H_{Ij}, H_{Ej} \geq 0,$$

and renders the following first order conditions:

$$(61)\quad w_{Ij} = \frac{1}{a_{Ij}} p_j \alpha_j \left(\frac{N_{Ij}}{a_{Ij}} + \frac{N_{Ej}}{a_{Ej}}\right)^{\alpha_j - 1}\left(\frac{H_{Ij}}{b_{Ij}} + \frac{H_{Ej}}{b_{Ej}}\right)^{1-\alpha_j},$$

$$(62)\quad w_{Ej} \geq \frac{1}{a_{Ej}} p_j \alpha_j \left(\frac{N_{Ij}}{a_{Ij}} + \frac{N_{Ej}}{a_{Ej}}\right)^{\alpha_j - 1}\left(\frac{H_{Ij}}{b_{Ij}} + \frac{H_{Ej}}{b_{Ej}}\right)^{1-\alpha_j},$$

$$(63)\quad q_{Ij} = \frac{1}{b_{Ij}} p_j (1-\alpha_j) \cdot \left(\frac{N_{Ij}}{a_{Ij}} + \frac{N_{Ej}}{a_{Ej}}\right)^{\alpha_j}\left(\frac{H_{Ij}}{b_{Ij}} + \frac{H_{Ej}}{b_{Ej}}\right)^{-\alpha_j},$$

$$(64)\quad q_{Ej} \geq \frac{1}{b_{Ej}} p_j (1-\alpha_j) \cdot \left(\frac{N_{Ij}}{a_{Ij}} + \frac{N_{Ej}}{a_{Ej}}\right)^{\alpha_j}\left(\frac{H_{Ij}}{b_{Ij}} + \frac{H_{Ej}}{b_{Ej}}\right)^{-\alpha_j}.$$

Like in the IO-HO model, the reservation wage of outsiders in one sector is equal to the wage rate they would receive as insiders in the other sector so that in equilibrium, the following relations between the terms of trade and the sectoral employment of low-skilled and high-skilled workers hold:

$$\frac{a_{I1}}{a_{E2}} \cdot \frac{\mathsf{a}_2 \left(\frac{N_{I2}}{a_{I2}} + \frac{N_{E2}}{a_{E2}} \right)^{\mathsf{a}_2 - 1} \left(\frac{H_{I2}}{b_{I2}} + \frac{H_{E2}}{b_{E2}} \right)^{1-\mathsf{a}_2}}{\mathsf{a}_1 \left(\frac{N_{I1}}{a_{I1}} + \frac{N_{E1}}{a_{E1}} \right)^{\mathsf{a}_1 - 1} \left(\frac{H_{I1}}{b_{I1}} + \frac{H_{E1}}{b_{E1}} \right)^{1-\mathsf{a}_1}} \leq \mathsf{j}$$

(65)

$$\leq \frac{a_{E1}}{a_{I2}} \cdot \frac{\mathsf{a}_2 \left(\frac{N_{I2}}{a_{I2}} + \frac{N_{E2}}{a_{E2}} \right)^{\mathsf{a}_2 - 1} \left(\frac{H_{I2}}{b_{I2}} + \frac{H_{E2}}{b_{E2}} \right)^{1-\mathsf{a}_2}}{\mathsf{a}_1 \left(\frac{N_{I1}}{a_{I1}} + \frac{N_{E1}}{a_{E1}} \right)^{\mathsf{a}_1 - 1} \left(\frac{H_{I1}}{b_{I1}} + \frac{H_{E1}}{b_{E1}} \right)^{1-\mathsf{a}_1}},$$

$$\frac{b_{I1}}{b_{E2}} \cdot \frac{(1-\mathsf{a}_2) \cdot \left(\frac{N_{I2}}{a_{I2}} + \frac{N_{E2}}{a_{E2}} \right)^{\mathsf{a}_2} \left(\frac{H_{I2}}{b_{I2}} + \frac{H_{E2}}{b_{E2}} \right)^{-\mathsf{a}_2}}{(1-\mathsf{a}_1) \cdot \left(\frac{N_{I1}}{a_{I1}} + \frac{N_{E1}}{a_{E1}} \right)^{\mathsf{a}_1} \left(\frac{H_{I1}}{b_{I1}} + \frac{H_{E1}}{b_{E1}} \right)^{-\mathsf{a}_1}} \leq \mathsf{j}$$

(66)

$$\leq \frac{b_{E1}}{b_{I2}} \cdot \frac{(1-\mathsf{a}_2) \cdot \left(\frac{N_{I2}}{a_{I2}} + \frac{N_{E2}}{a_{E2}} \right)^{\mathsf{a}_2} \left(\frac{H_{I2}}{b_{I2}} + \frac{H_{E2}}{b_{E2}} \right)^{-\mathsf{a}_2}}{(1-\mathsf{a}_1) \cdot \left(\frac{N_{I1}}{a_{I1}} + \frac{N_{E1}}{a_{E1}} \right)^{\mathsf{a}_1} \left(\frac{H_{I1}}{b_{I1}} + \frac{H_{E1}}{b_{E1}} \right)^{-\mathsf{a}_1}}.$$

5.2 Commodity Prices and Factor Remuneration Rates

Like in the IO-HO model, the functional relationship between the terms of trade and the intra- and intersectoral relative wages is not unique. Depending on the extent of the terms-of-trade shock, there are three possible outcomes.

5.2.1 Ricardo Region

If after the terms-of-trade shock strict inequalities prevail in (65) and (66) for the pre-shock employment level, the model is similar to the Ricardo model. In this case, all insiders earn economic rents[11] at the pre-shock employment level- irrespective of their skill level and their sectoral affiliation. Consequently, all workers are only willing to work as insiders in the sector in which they enjoy their respective comparative advantage. Hence, sectoral employment and sectoral production is not affected by terms-of-trade shocks.

Since a rise in the terms of trade leaves the sectoral employment of low-skilled and high-skilled workers constant, the intersectoral relative wages of low-skilled and high-skilled insiders

[11] The term "economic rent" is defined as the difference between the wage rate of insiders in one sector and the wage rate they would earn as outsiders in the other sector.

$$(67)\quad w_N^1 := \frac{w_{I1}}{w_{I2}} = \varphi \cdot \frac{a_{I2}}{a_{I1}} \cdot \frac{\alpha_1 \left(\frac{N_{I1}^0}{a_{I1}}\right)^{\alpha_1 - 1} \left(\frac{H_{I1}^0}{b_{I1}}\right)^{1-\alpha_1}}{\alpha_2 \left(\frac{N_{I2}^0}{a_{I2}}\right)^{\alpha_2 - 1} \left(\frac{H_{I2}^0}{b_{I2}}\right)^{1-\alpha_2}} < \frac{a_{E1}}{a_{I1}} \Rightarrow w_N \sim \varphi ,$$

$$(68)\quad w_H^1 := \frac{q_{I1}}{q_{I2}} = \varphi \cdot \frac{b_{I2}}{b_{I1}} \cdot \frac{(1-\alpha_1) \cdot \left(\frac{N_{I1}^0}{a_{I1}}\right)^{\alpha_1} \left(\frac{H_{I1}^0}{b_{I1}}\right)^{-\alpha_1}}{(1-\alpha_2) \cdot \left(\frac{N_{I2}^0}{a_{I2}}\right)^{\alpha_2} \left(\frac{H_{I2}^0}{b_{I2}}\right)^{-\alpha_2}} < \frac{b_{E1}}{b_{I1}} \Rightarrow w_H \sim \varphi$$

are proportional to the terms of trade. Differently stated, due to the redistribution of economic rents from sector 2 to sector 1, the sectoral wage premium is monotonically increasing in the terms of trade.

In the Ricardo region of the IO-HO2 model, the sectoral skill intensities are also not affected by terms-of-trade shocks so that the same applies to the intrasectoral relative wages of low-skilled labour

$$(69)\quad w_1^1 := \frac{w_{I1}}{q_{I1}} = \frac{\alpha_1}{1-\alpha_1} \cdot \frac{H_{I1}^0}{N_{I1}^0} \Rightarrow \frac{dw_1}{d\varphi} = 0,$$

$$(70)\quad w_2^1 := \frac{w_{I2}}{q_{I2}} = \frac{\alpha_2}{1-\alpha_2} \cdot \frac{H_{I2}^0}{N_{I2}^0} \Rightarrow \frac{dw_2}{d\varphi} = 0.$$

Hence, the income shares of both skill groups are constant within either sector.

Like in the IO-HO model, however, terms-of-trade shocks do have an impact on the aggregate skill premium since they benefit relatively more high-skilled

workers than low-skilled workers. Consequently, the aggregate relative wage of low-skilled workers

$$\Omega := \frac{\frac{1}{N}\cdot\left[\sum_{i=1}^{2} w_{Ij} N_{Ij}^{1} + \sum_{j=1}^{2} w_{Ej} N_{Ej}^{1}\right]}{\frac{1}{H}\cdot\left[\sum_{i=1}^{2} q_{Ij} H_{Ij}^{1} \sum_{j=1}^{2} q_{Ej} H_{Ej}^{1}\right]} = \frac{H}{N}\cdot\frac{\left[\mathrm{j}\cdot \mathrm{a}_1 Y_1^0 + \mathrm{a}_2 Y_2^0\right]}{\left[\mathrm{j}\cdot(1-\mathrm{a}_1) Y_1^0 + (1-\mathrm{a}_2) Y_2^0\right]} \tag{71}$$

$$\Rightarrow \frac{d\Omega}{d\mathrm{j}} = (\mathrm{a}_1 - \mathrm{a}_2)\cdot\frac{H}{N}\cdot\frac{Y_1^0 Y_2^0}{\left[\mathrm{j}\cdot(1-\mathrm{a}_1) Y_1^0 + (1-\mathrm{a}_2) Y_2^0\right]^2} < 0, \text{ since } \mathrm{a}_1 < \mathrm{a}_2.$$

is strictly monotonically decreasing in the terms of trade.

5.2.2 The Ricardo–Viner Region

If the terms of trade have risen to such an extent that the post-shock value of the marginal product at the pre-shock employment level of low-skilled outsiders in sector 1 is greater than the one of low-skilled insiders in sector 2, the model is similar to the Ricardo-Viner model. The wage differential causes a movement of low-skilled workers from sector 2 to sector 1. As a result, sectoral production and sectoral employment of low-skilled workers in sector 1 (2) is a monotonically increasing (decreasing) function of the terms of trade, while sectoral employment of high-skilled workers continues to be not affected by terms-of-trade shocks.

In the Ricardo-Viner region of the IO-HO2 model, the direct and indirect effect of terms-of-trade shocks on the intersectoral relative wage of low-skilled insiders again exactly offset each other. The inflow of low-skilled workers into sector 1 ceases when the wage rate of low-skilled outsiders in sector 1 is equal to

the one of low-skilled insiders in sector 2. Differently stated, the economic rents of low-skilled insiders in sector 2 are zero in equilibrium - irrespective of the terms of trade. Hence, low-skilled insiders in sector 2 are protected against further losses in their economic rents. Furthermore, since low-skilled insiders in sector 1 face the competitive threat of being replaced by low-skilled outsiders. they are deprived of further gains in their economic rents.

As a result, terms-of-trade shocks leave the intersectoral relative wage of low-skilled insiders

$$(72)\quad \omega_N^1 := \frac{w_{I1}}{w_{I2}} = \varphi \cdot \frac{a_{I2}}{a_{I1}} \cdot \frac{\alpha_1 \left(\frac{N_{I1}^0}{a_{I1}} + \frac{N_{E1}}{a_{E1}} \right)^{\alpha_1 - 1} \left(\frac{H_{I1}^0}{b_{I1}} \right)^{1-\alpha_1}}{\alpha_2 \left(\frac{N_{I2}^0 - N_{E1}}{a_{I2}} \right)^{\alpha_2 - 1} \left(\frac{H_{I2}^0}{b_{I2}} \right)^{1-\alpha_2}} = \frac{a_{E1}}{a_{I1}} \Rightarrow \frac{d\omega_N}{d\varphi} = 0,$$

unchanged.

In the case of high-skilled insiders, the direct and indirect effect of terms-of-trade shocks on the intersectoral relative wage

$$w_H^1 := \frac{q_{I1}}{q_{I2}} = \jmath \cdot \frac{b_{I1}}{b_{I2}} \cdot \frac{(1-a_1)\cdot\left(\frac{N_{I1}^0}{a_{I1}} + \frac{N_{E1}}{a_{E1}}\right)^{a_1}\left(\frac{H_{I1}^0}{b_{I1}}\right)^{-a_1}}{(1-a_2)\cdot\left(\frac{N_{I2}^0 - N_{E1}}{a_{I2}}\right)^{a_2}\left(\frac{H_{I2}^0}{b_{I2}}\right)^{-a_2}} < \frac{b_{E1}}{b_{I1}}$$

$$(73) \quad \Rightarrow \frac{dw_H}{d\jmath} = \frac{w_H}{\jmath} + w_H\left(\frac{a_1}{\frac{a_{E1}}{a_{I1}}N_{I1}^0 + N_{E1}} \cdot \frac{a_2}{N_{I2}^0 - N_{E1}}\right)\cdot\frac{dN_{E1}}{d\jmath}$$

$$= \frac{w_H}{\jmath} \cdot \frac{\frac{a_{E1}}{a_{I1}}N_{I1}^0 + N_{I2}^0}{(1-a_1)\cdot\left(N_{I2}^0 - N_{E1}\right) + (1-a_2)\cdot\left(\frac{a_{E1}}{a_{I1}}N_{I1}^0 + N_{E1}\right)} > 0.$$

again amplify each other. That is, in response to a positive terms-of-trade shock, the intersectoral relative wage of high-skilled insiders rises, firstly, because of the redistribution of economic rents of high-skilled workers from sector 2 to sector 1, and secondly, because the inflow of low-skilled workers into sector 1 augments the marginal product of high-skilled workers in sector 1 and reduces the one in sector 2.

The structural change towards the relatively high-skilled labour intensive sector also decreases the human skill intensity in sector 1 and increases the one in sector 2. As a result, the intrasectoral relative of low-skilled workers of the two sectors diverge, falling in sector 1 and rising in sector 2, i.e.,

$$\mathsf{w}_1 := \frac{w_{I1}}{q_{I1}} = \frac{\mathsf{a}_1}{1-\mathsf{a}_1} \cdot \frac{H_{I1}^0}{N_{I1}^0 + \frac{a_{I1}}{a_{E1}} N_{E1}}$$

$$(74) \quad \Rightarrow \frac{d\mathsf{w}_1}{d\mathsf{j}} = -\frac{\mathsf{a}_1}{1-\mathsf{a}_1} \cdot \frac{a_{I1}}{a_{E1}} \cdot \frac{H_{I1}^0}{\left(N_{I1}^0 + \frac{a_{I1}}{a_{E1}} N_{E1}\right)^2} \cdot \frac{dN_{E1}}{d\mathsf{j}}$$

$$= -\frac{\mathsf{a}_1}{1-\mathsf{a}_1} \cdot \frac{a_{I1}}{a_{E1}} \cdot \frac{H_{I1}^0}{\left(N_{I1}^0 + \frac{a_{I1}}{a_{E1}} N_{E1}\right)^2} \cdot \frac{1}{\mathsf{j}} \cdot \left(\frac{1-\mathsf{a}_1}{\frac{a_{E1}}{a_{I1}} N_{I1}^0 + N_{E1}} + \frac{1-\mathsf{a}_2}{N_{I2}^0 - N_{E1}} \right)^{-1} < 0,$$

$$\mathsf{w}_2 := \frac{w_{I2}}{q_{I2}} = \frac{\mathsf{a}_2}{1-\mathsf{a}_2} \cdot \frac{H_{I2}^0}{N_{I2}^0 - N_{E1}}$$

$$(75) \quad \Rightarrow \frac{d\mathsf{w}_2}{d\mathsf{j}} = \frac{\mathsf{a}_2}{1-\mathsf{a}_2} \cdot \frac{H_{I2}^0}{\left(N_{I2}^0 - N_{E1}\right)^2} \cdot \frac{dN_{E1}}{d\mathsf{j}}$$

$$= \frac{\mathsf{a}_2}{1-\mathsf{a}_2} \cdot \frac{H_{I2}^0}{\left(N_{I2}^0 - N_{E1}\right)^2} \cdot \frac{1}{\mathsf{j}} \cdot \left(\frac{1-\mathsf{a}_1}{\frac{a_{E1}}{a_{I1}} N_{I1}^0 + N_{E1}} + \frac{1-\mathsf{a}_2}{N_{I2}^0 - N_{E1}} \right)^{-1} > 0.$$

The preceding discussion shows that in the case of a positive terms-of-trade shock, both the shift of economic rents of high-skilled workers from sector 2 to sector 1 and the structural change towards the relatively high-skilled labour intensive sector contribute to the income redistribution from low-skilled to high-skilled workers. Hence, the aggregate relative wage of low-skilled workers

$$(76)\qquad \Omega := \frac{\frac{1}{N}\cdot\left(\sum_{i=1}^{2} w_{Ij}^{1} N_{Ij}^{1} + \sum_{j=1}^{2} w_{Ej}^{1} N_{Ej}^{1}\right)}{\frac{1}{H}\cdot\left(\sum_{i=1}^{2} q_{Ij}^{1} H_{Ij}^{1} + \sum_{j=1}^{2} q_{Ej}^{1} H_{Ej}^{1}\right)} = \frac{H}{N}\cdot\frac{\mathrm{j}\cdot a_1 Y_1 + a_2 Y_2}{\mathrm{j}\cdot(1-a_1)Y_1 + (1-a_2)Y}$$

$$\Rightarrow \frac{d\Omega}{d\mathrm{j}} < 0 \text{ since } a_1 < a_2, \frac{dY_1}{d\mathrm{j}} > 0, \frac{dY_2}{d\mathrm{j}} < 0.$$

is strictly monotonically decreasing in the terms of trade.

5.2.3 The Heckscher-Ohlin Region

If the terms of trade have risen even further so that the post-shock values of the marginal product at the pre-shock employment level of both low-skilled and high-skilled outsiders in sector 1 are greater than the ones of the respective insiders in sector 2, the model is similar to the Heckscher-Ohlin model. A rise in the relative price of good 1 causes an expansion of sector 1 and a contraction of sector 2. Hence, the sectoral employment of low-skilled and high-skilled workers as well as the sectoral production in sector 1 (2) is monotonically increasing (decreasing) in the terms of trade.

In the Heckscher-Ohlin region of the IO-HO2 model, the economic rents of both low-skilled and high-skilled insiders in sector 2 are zero in equilibrium - irrespective of the terms of trade. Consequently, the intersectoral relative wages of low-skilled and high-skilled insiders

$$(77)\quad \omega_N^1 := \frac{w_{I1}}{w_{I2}} = \varphi \cdot \frac{\alpha_1 \left(\frac{N_{I1}^0}{a_{I1}} + \frac{N_{E1}}{a_{E1}} \right)^{\alpha_1 - 1} \left(\frac{H_{I1}^0}{b_{I1}} + \frac{H_{E1}}{b_{E1}} \right)^{1-\alpha_1}}{\alpha_2 \left(\frac{N_{I2}^0 - N_{E1}}{a_{I2}} \right)^{\alpha_2 - 1} \left(\frac{H_{I2}^0 - H_{E1}}{b_{I2}} \right)^{1-\alpha_2}} = \frac{a_{E1}}{a_{I1}} \Rightarrow \frac{d\omega_N}{d\varphi} = 0,$$

$$(78)\quad \omega_H^1 := \frac{q_{I1}}{q_{I2}} = \varphi \cdot \frac{(1-\alpha_1) \cdot \left(\frac{N_{I1}^0}{a_{I1}} + \frac{N_{E1}}{a_{E1}} \right)^{\alpha_1} \left(\frac{H_{I1}^0}{b_{I1}} + \frac{H_{E1}}{b_{E1}} \right)^{-\alpha_1}}{(1-\alpha_2) \cdot \left(\frac{N_{I2}^0 - N_{E1}}{a_{I2}} \right)^{\alpha_2} \left(\frac{H_{I2}^0 - H_{E1}}{b_{I2}} \right)^{-\alpha_2}} = \frac{b_{E1}}{b_{I1}} \Rightarrow \frac{d\omega_N}{d\varphi} = 0,$$

is greater than one but not affected by terms-of-trade shocks.

The economic mechanism through which positive terms-of-trade shocks feed into the sectoral skill premium is again identical to the one in the Heckscher-Ohlin model. Consequently, the relative wages of low-skilled insiders

$$(79)\quad \omega_1^1 := \frac{w_{I1}^1}{q_{I1}^1} = \frac{b_{I1}}{a_{I1}} \cdot \left[\frac{\varphi}{\alpha_1^{-\alpha_1} \alpha_2^{\alpha_2} (1-\alpha_1)^{\alpha_1 - 1} (1-\alpha_2)^{1-\alpha_2} \cdot \left(\frac{b_{E1}}{b_{I2}} \right)^{1-\alpha_2} \cdot \left(\frac{a_{E1}}{a_{I2}} \right)^{\alpha_2}} \right]^{\frac{1}{\alpha_1 - \alpha_2}}$$

$$\Rightarrow \frac{d\omega_1}{d\varphi} = \frac{1}{\alpha_1 - \alpha_2} \cdot \frac{\omega_1^1}{\varphi} < 0, \text{ since } \alpha_1 < \alpha_2,$$

$$(80)\quad \omega_2^1 := \frac{w_{I2}^1}{q_{I2}^1} = \frac{b_{I2}}{a_{I2}} \left[\frac{\varphi}{\alpha_1^{-\alpha_1} \alpha_2^{\alpha_2} (1-\alpha_1)^{\alpha_1 - 1} (1-\alpha_2)^{1-\alpha_2} \cdot \left(\frac{b_{E1}}{b_{I2}} \right)^{1-\alpha_1} \cdot \left(\frac{a_{E1}}{a_{I2}} \right)^{\alpha_1}} \right]^{\frac{1}{\alpha_1 - \alpha_2}}$$

$$\Rightarrow \frac{d\omega_2}{d\varphi} = \frac{1}{\alpha_1 - \alpha_2} \cdot \frac{\omega_2^1}{\varphi} < 0, \text{ since } \alpha_1 < \alpha_2,$$

$$\Omega := \frac{\frac{1}{N}\cdot\left(\sum_{i=1}^{2} w_{Ij}^{1} N_{Ij}^{1} + \sum_{j=1}^{2} w_{Ej}^{1} N_{Ej}^{1}\right)}{\frac{1}{H}\cdot\left(\sum_{i=1}^{2} q_{Ij}^{1} H_{Ij}^{1} + \sum_{j=1}^{2} q_{Ej}^{1} H_{Ej}^{1}\right)} = \frac{H}{N}\cdot\frac{\mathrm{j}\cdot a_1 Y_1 + a_2 Y_2}{\mathrm{j}\cdot(1-a_1)Y_1 + (1-a_2)Y} \tag{81}$$

$$\Rightarrow \frac{d\Omega}{d\mathrm{j}} < 0, \text{ since } a_1 < a_2, \frac{dY_1}{d\mathrm{j}} > 0, \frac{dY_2}{d\mathrm{j}} < 0.$$

are strictly monotonically decreasing in the terms of trade - both on a sectoral and on the aggregate level.

5.3 Comparison of the Models Implications to the Empirical Findings

The preceding discussion has shown that the distributional effects of the IO-HO2 model are qualitatively identical to the ones of the IO-HO model. That is, the ability of these models to replicate the stylised facts outlined in section 2 depends only on the existence of a gap between the labour demand functions for insiders and outsiders but not on whether it is caused by hiring cost or by sector-specific human capital.

6 Conclusion

The labour markets in the developed countries have experienced two fundamental changes in recent years. Firstly, high-skilled workers have gained at the expense of low-skilled workers, which manifests itself in a rising skill premium and/or a rising disparity in the unemployment rates of these two skill groups. Secondly, sectors with low wage levels have expanded while sectors with high wage levels

have contracted. Several scholars have linked these two labour market trends to the progressing globalisation of the world economy. In this paper, two insider-outsider general equilibrium models are applied to analyse the impact of trade on both dimensions of income distribution simultaneously. It is demonstrated that even seemingly minor changes to the basic assumptions of the 2 x 2 trade model have far-reaching consequences for the distributional effects of trade. This result suggests that instead of applying ever more sophisticated econometric methods and/or ever more disaggregate data sets to test the link between trade and income distribution, alternative general equilibrium models should be applied to explore the causal links between these two economic variables. Especially fruitful might prove the integration of economies of scale, sticky prices and information asymmetries into such models.

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8 Appendix A1

In equilibrium, the wage rate of low-skilled outsiders in sector 1 is identical to the one of low-skilled insiders in sector 2, i.e.,

$$\frac{1}{1+a_1}\cdot p_1 \mathsf{a}_1 \left(N_{I1}^0 + N_{E1}\right)^{\mathsf{a}_1 - 1} H_{I1}^{0\ 1-\mathsf{a}_1} = p_2 \mathsf{a}_2 \left(N_{I2}^0 - N_{E1}\right)^{\mathsf{a}_2 - 1} H_{I2}^{0\ 1-\mathsf{a}_2}.$$

Rearranging the terms of the equation yields a relationship between the terms of trade and the employment of low-skilled outsiders in sector 1

$$F_{(\mathsf{j}, N_{E1})} = (1+a_1)\frac{\mathsf{a}_2 \left(N_{I2}^0 - N_{E1}\right)^{\mathsf{a}_2 - 1} H_{I2}^{0\ 1-\mathsf{a}_2}}{\mathsf{a}_1 \left(N_{I1}^0 + N_{E1}\right)^{\mathsf{a}_1 - 1} H_{I1}^{0\ 1-\mathsf{a}_1}} - \mathsf{j} \ = 0.$$

Using the theorem of implicit functions, one obtains the derivative of the employment of low-skilled outsiders with respect to the terms of trade

$$\frac{dN_{E1}}{d\mathsf{j}} = -\frac{F_{\mathsf{j}}}{F_{N_{E1}}} = \frac{1}{\mathsf{j}}\cdot\left(\frac{1-\mathsf{a}_1}{N_{I1}^0 + N_{E1}} + \frac{1-\mathsf{a}_2}{N_{I2}^0 - N_{E1}}\right)^{-1}.$$