Markusen, James R.; Venables, Anthony

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James R. Markusen
Anthony J. Venables

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Postfach 5560
D-78434 Konstanz

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THE ROLE OF MULTINATIONAL FIRMS IN THE WAGE-GAP DEBATE

James R. Markusen
Department of Economics
University of Colorado, Boulder
and NBER

Anthony J. Venables
London School of Economics
and CEPR

Abstract

The observation of an increase in the ratio of skilled to unskilled wages in the high-income countries and in some cases in low/middle income countries has led to considerable discussion and indeed controversy as to its cause. Virtually none of the analysis has considered a possible role of multinational investment in explaining the wage gap phenomenon, despite the fact that direct investment surged during the late 1970's and 1980's, the same time in which the wage gap began to rise sharply in the US after years of decline. This paper adapts our earlier work to consider what role multinationals might play in factor markets. For a skilled-labor abundant country, we find that the wage gap may rise as countries become more similar in size and in relative endowments, and as investment is liberalized. However, falling trade costs may have the opposite effect on the wage gap, and the effect of grow in the world economy depends upon a number of initial conditions. Corresponding results are derived for initially unskilled-labor abundant countries.

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two countries (h and f), two goods (X and Y), and two factors (S and L). The factors will be called skilled and unskilled labor respectively, although it may be more useful to think of the L as a "composite" of unskilled labor and physical capital.

Y is a competitive sector producing with constant returns to scale. X is an increasing-returns, imperfectly-competitive sector. X production is composed of three conceptually distinct activities. First, there are firm-level fixed costs using skilled labor (e.g., R&D). Second, plant-level fixed costs use a mix of skilled and unskilled labor and third, final production requires only unskilled labor (again, it may be useful to think of unskilled labor as a composite of unskilled labor and physical capital). A firm in the X sector may serve the other country by exports (then referred to as a national firm) or by building a branch plant (becoming a multinational firm). Shipping costs between markets are in units of unskilled labor.

Factor intensities are crucial to the results of the paper. While our assumptions may seem quantitatively rather arbitrary, we feel that they are qualitatively well grounded in extensive empirical work.[2] We assume that integrated X production is skilled-labor intensive relative to Y production. Within the X sector, firm-level fixed costs are more skilled-labor intensive than plant-level fixed costs which are more skilled-labor intensive than final production. Final production is less skilled-labor intensive than Y production. Multinational firms are more skilled labor intensive than national firms, for a given total output, because the former require additional skilled labor for branch plants, while

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[2]Extensive empirical work is reviewed in Caves (1996) and Markusen (1995). Assumptions presented below are motivated by direct observations on the characteristics of multinational firms: they tend to be R&D intensive, produce new and/or technically complex products, have large numbers of scientific, technical, and other non-production workers, and have high degrees of product differentiation. Our characterization that parent firms are more skilled-labor intensive than subsidiaries is motivated by Slaughter (1995). Other motivations are more indirect. Our model has implications (Markusen and Venables 1995, 1996a,b) that fit well with results from studies that relate bilateral investment stocks to country characteristics. These include Brainard (1993a,b), Eaton and Tamura (1994), and Ekholm (1995). In particular, bilateral investment is high between countries that are similar in size and in relative endowments, and outward direct investment is strongly associated with a country's human capital endowment.

1. Introduction

The observation of a rising gap between the wages of skilled and unskilled workers in the United States and rising unemployment in Europe has generated considerable controversy and debate as to the causes of this phenomenon. A more liberal world trading and investment regime is an immediate suspect insofar as the Heckscher-Ohlin model predicts that liberalization should help a country's abundant factor (skilled labor in the US and Europe) and harm its scarce factor. Some find evidence to support this relationship, notably Wood (1994) and Leamer (1994, 1996a,b). Others have argued by indirect logic that trade is not to blame, including Lawrence and Slaughter (1993), Krugman and Lawrence (1993) and Krugman (1995). There is a deplorable tendency to simply say that "technical change" is the culprit when some other cause is dismissed, without ever attempting to measure or estimate anything to do with technology.

Despite the fact that we now have a substantial literature on trade with industrial-organization effects (sometimes called the "new trade theory"), almost none of these IO variables have been discussed in this debate. The purpose of this paper is to provide a theoretical analysis of the wage gap problem by introducing key elements of the new trade theory into the debate. In particular, we will focus on the role of multinational firms and how they may contribute or fail to contribute to the empirical observations on wages. One motivation for doing so is that the late 1970's and 1980's, which was the period of growth in the wage gap in the US, was also a period (begun after 1973) of tremendous growth in direct investment.[1]

The model quite deliberately resembles a standard Heckscher-Ohlin type trade model with

[1]The role of trade in explaining the growing gap in skilled-unskilled wages has been an important policy issue in the United States. An excellent discussion of the evidence and conceptual arguments is present in articles by Freeman, Richardson, and Wood in a recent issue of the Journal of Economic Perspectives (summer 1995). No role for multinationals is identified by these authors. This paper suggests that such a role should be considered, especially due to the empirical fact that direct investment has grown much more rapidly that trade over the last two decades.

the latter require additional unskilled labor for shipping costs. These factor-intensive rankings, beginning with the most skilled-labor intensive, are summarized as:

[firm-level fixed costs] > [plant-level fixed costs] > [integrated X production] > [Y production] > [final X production]

[multinational firms] > [national firms] (at common output scale)

One other aspect of factor intensities that is important to the results involves firm scale. An increase in firm scale makes the firm less skilled-labor intensive overall as skilled-labor-intensive R&D activities are spread over a larger output. Some readers may find this property of the model counter-empirical. While it is reasonable to suppose that firms become more physical-capital intensive at higher production levels, we know of no empirical evidence or logical argument to suggest that they become more skilled-labor intensive at higher scale. Our assumption is capturing the notion that there are indivisibilities in certain knowledge-intensive activities such as R&D, management, and marketing, logically implying lower skilled-labor intensity at higher scale. In any case, only one of the principal results relies on this property, and we will be careful to point out when it is needed.

The term "firm type" will denote a headquarters location and a number of plants for a given firm. Four firm types are permitted in the model. Firm types n_h and n_f are single-plant national firms with their headquarters and plants in countries h and f respectively. Firm types m_h and m_f are two-plant multinational firms with their headquarters in countries h and f respectively. The set of firm types active in equilibrium is referred to as the "regime".

After characterizing the equilibrium regime as a function of country characteristics and trade costs, several results are derived. First, we show how international differences in factor prices depend on country characteristics for a given world endowment of the factors. Results indicate that convergence in relative sizes and endowments will lead to increases in the skilled-unskilled wage ratio in the skilled-labor abundant country. Convergence in country size leads to an increased in the wage ratio in both countries, as multinational firms displace national firms.

Second, investment liberalization leads to an increase in the wage gap in the skilled-labor abundant country, and to an increase in the gap in both countries when they differ significantly in relative endowments but are similar in size.

Third, the effects of falling trade costs are complex. Falling trade costs can harm skilled labor in two ways. First, it may replace more skilled-labor intensive multinational firms with less-skilled-labor intensive national firms. Second, it can lead to firm-scale increases which lower the skilled-labor-intensity of the X sector at constant factor prices. Results indicate that falling trade costs harm skilled labor in the skilled-labor-abundant country unless the two countries are very different in size. In the latter situation, the wage gap can rise in both countries, but due to reasons that have nothing to do with multinationals.[3]

Fourth, growth in the world economy (exogenous growth in factor supplies) also has complex effects. Growth favors skilled labor to the extent that more skilled-labor-intensive multinational firms displace less skilled-labor-intensive national firms. But growth also brings a firm-scale effect of the type just noted which may harm skilled labor. Results confirm the tension between the two effects. If multinational firms dominate in the initial equilibrium, then the scale effect dominates and the wage gap tends to fall in both countries. If national firms dominate in the initial equilibrium, the regime-shifting effect tends to dominate following growth, with the wage gap increasing in the skilled-labor abundant country which becomes the headquarters of new multinational firms.

Results suggest testable hypotheses for future empirical work. In particular, the wage gap in skilled-labor-abundant countries is likely to increase as (1) countries become more similar in relative endowments and size, (2) investment restrictions in the world economy are liberalized and, if national

[3]We decided to model trade barriers as real costs rather than tariffs in the paper for a couple of reasons. First, it may well be that real costs have fallen faster than tariffs during the last two decades. Second, we can make the incidence of trade costs on factor markets more clear (since factor intensities are explicit) than with tariffs, which have indirect effects.

firms are relatively dominant initially, (3) the world economy grows. The wage gap may rise in the initially unskilled-labor-abundant country at the same time if (1) countries become more similar in size, or (2) investment restrictions are liberalized.[4] Falling trade costs alone are predicted to lower the return to skilled labor in the skilled-labor-abundant country and possibly lower it in both countries.

[4]Rising skilled-unskilled wage gaps in both north and south have been discussed, modelled, and hypotheses tested in a number of recent papers, including Feenstra and Hanson (1995a,b), Hanson and Harrison (1995), Robbins (1994, 1995), Hong and Batra (1995), Pissarides (1995), Cragg and Epelbaum (1995), and Berman, Machlin, and Bound (1995).

2. Model Structure

As noted above the model has two countries (h and f) producing two homogeneous goods, Y and X. There are two factors of production, L (unskilled labor), and S (skilled labor). L and S are mobile between industries but internationally immobile. Y will be used as numeraire throughout the paper.

Subscripts (i,j) will be used to denote the countries (f,h). The output of Y in country i is a CES function, identical in both countries. The production function for Y is

$$(1) \qquad Y_i = (aL_{iy}^{\epsilon} + (1-a)S_{iy}^{\epsilon})^{1/\epsilon} \qquad i = h,f.$$

where L_{iy} and S_{iy} are the unskilled and skilled labor used in the Y sector in country i. The elasticity of substitution $(1/(1-\epsilon))$ is set at 5.0 in the simulation runs reported later in the paper.

Superscripts (n,m) will be used to designate a variable as referring to national firms and multinational firms respectively. (m_i,n_i) will also be used to indicate the number of active m firms and n firms based in country i. Hopefully, it will always be clear from the context what is being represented (e.g., n_i as a variable in an equation always refers to the number of national firms in country i).

In order to enter X production with one plant, a firm must incur a fixed cost in units of skilled labor, denoted F, and a fixed cost in units of unskilled labor G: national-firm fixed costs are thus $L_i = G$, $S_i = F$.

A two-plant multinational headquartered in country i incurs additional fixed costs in both countries. These include both skilled and unskilled labor costs in the branch-plant in country j, and additional skilled-labor costs in the source country i. Total fixed costs for a two-plant multinational headquartered in country i are:

$$L_i = G, \quad L_j = \beta G, \quad S_i = F + \gamma F, \quad S_j = \delta F, \quad 1 \geq \beta > (\gamma + \delta)$$

The inequality on the right expresses the assumptions that the second plant is more unskilled-labor intensive than the first, and that there are multi-plant economies of scale arising from the joint-input nature of knowledge capital. γ can be thought of as a technology-transfer cost. Later in the paper our central-case uses $\beta = 0.75$, $(\gamma + \delta) = 0.5$ ($\gamma = 0.1$, $\delta = 0.4$). The second plant thus requires 75% more unskilled labor than the first plant (all drawn from the host country) and 50% more skilled labor (10% from the source country and 40% from the host country).[5]

Marginal factor requirements are constant in units of unskilled labor. X^n_{ij} denotes the sales in country j of a national firm based in country i. Let w_i, and v_i, denote the prices of unskilled labor and skilled labor respectively in country i. A national firm undertakes all its production in its base country, so the cost function of one national firm in country i is given by

$$(2) \qquad w_i L_i^n + v_i S_i^n = w_i[cX_{ii}^n + (c + \tau)X_{ij}^n + G] + v_i F, \qquad i,j = h,f, \quad i \neq j.$$

where c is the constant marginal production cost. c, F, and G are identical across countries. τ is the amount of unskilled labor needed to transport one unit of X from country i to country j, which we assume to be the same in both directions.

A multinational based in country i has sales in country j, X^m_{ij}. It operates one plant in each country incurring fixed costs, $(G_i, (1+\gamma)F_i)$ in its base country, and fixed costs $(\beta G_j, \delta F_j)$ in country j. Sales are met entirely from local production not trade. $L^m_{ij}(S^m_{ij})$ denotes a country i multinational

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[5]The technology-transfer cost ($\gamma > 0$) is motivated by empirical results, especially those of Teece (1977, 1986), that direct investments require significant further investments in skilled-labor-intensive activities for multinational firms. The assumption that the branch-plant's (affiliate's) fixed costs are significantly less skilled-labor intensive than the parent's is motivated by the findings of Slaughter (1995) that the share of non-production workers is much higher in parents than in affiliates.

firm's demand for unskilled (skilled) labor in country j. A firm type m_i thus has a cost function

$$(3) \qquad w_i L_{ii}^m + w_j L_{ij}^m + v_i S_{ii}^m + v_j S_{ij}^m = w_i[cX_{ii}^m + G] + w_j[cX_{ij}^m + \beta G] + v_i(1+\gamma)F + v_j \delta F.$$

In our calibration, multinational firms are generally more skilled-labor intensive than national firms, using more skilled labor for branch-plant fixed costs versus the additional unskilled labor for transport costs used by national firms. This depends, however, on firm scale.[6]

Let $\bar{L}_i$ and $\bar{S}_i$ denote the total labor endowments of country i. Adding labor demand from n_i national firms, m_i multinationals based in country i, and m_j multinationals based in country j, gives country i factor market clearing:

$$(4) \qquad \begin{aligned} \bar{L}_i &= L_{iy} + n_i L_i^n + m_i L_{ii}^m + m_j L_{ji}^m \\ \bar{S}_i &= S_{iy} + n_i S_i^n + m_i S_{ii}^m + m_j S_{ji}^m \end{aligned}$$

In equilibrium, the X sector makes no profits so country i income, denoted M_i, is

$$(5) \qquad M_i = w_i \bar{L}_i + v_i \bar{S}_i \qquad i = h,f.$$

p_i denotes the price of X in country i, and X_{ic} and Y_{ic} denote the consumption of X and Y. Utility of the representative consumer in each country is Cobb-Douglas,

$$(6) \qquad U_i = X_{ic}^{\alpha} Y_{ic}^{1-\alpha}, \qquad X_{ic} \equiv n_i X_{ii}^n + n_j X_{ji}^n + m_i X_{ii}^m + m_j X_{ji}^m$$

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[6]An exception can occur when the two countries are very similar. The removal of an investment barrier leads, in equilibrium, to multinational firms with significantly higher output per firm than the national firms they displace, a type of pro-competitive effect. Since final output is unskilled-labor intensive, the difference in equilibrium firm scale contributes toward making the multinational firms less skilled-labor intensive. In the simulation results we report, this firm-scale effect approximately cancels out the fixed-cost effect (making multinationals more skilled-labor intensive at common scale) so that the equilibrium skilled-labor wage and the skilled-unskilled wage gap are essentially unaffected by the removal of an investment ban when the countries are identical.

giving demands

(7) $$X_{ic} = \alpha M_i/p_i, \qquad Y_{ic} = (1-\alpha)M_i.$$

Equilibrium in the X sector is determined by pricing equations (marginal revenue equals marginal cost) and free-entry conditions. We denote proportional markups of price over marginal cost by e^k_{ij}, (k = n,m), so, for example, e^m_{ji} is the markup of a country j multinational in market i. Pricing equations of national and multinational firms in each market are (written in complementary-slackness form with associated variables in brackets):

(8) $$p_i(1 - e^n_{ii}) \le w_i c \qquad (X^n_{ii})$$

(9) $$p_j(1 - e^n_{ij}) \le w_i(c + \tau) \qquad (X^n_{ij})$$

(10) $$p_i(1 - e^m_{ii}) \le w_i c \qquad (X^m_{ii})$$

(11) $$p_j(1 - e^m_{ij}) \le w_j c \qquad (X^m_{ij})$$

In a Cournot model with homogeneous products, the optimal markup formula is given by the firm's market share divided by the Marshallian price elasticity of demand in that market. In our model, the price elasticity is one (see equation (7)), reducing the firm's markup to its market share. This gives, (also using demand equations (7)),

(12) $$e^k_{ij} = \frac{X^k_{ij}}{X_{jc}} = \frac{p_j X^k_{ij}}{\alpha M_j} \qquad k = n,m, \qquad i,j = h,f.$$

There are four zero-profit conditions corresponding to the numbers of the four firm types. Given equations (8)-(11), zero profits can be written as the requirement that markup revenues equal fixed costs.

$$(13) \qquad p_h e^n_{hh} X^n_{hh} + p_f e^n_{hf} X^n_{hf} \le w_h G + v_h F \qquad (n_h)$$

$$(14) \qquad p_f e^n_{ff} X^n_{ff} + p_h e^n_{fh} X^n_{fh} \le w_f G + v_f F \qquad (n_f)$$

$$(15) \qquad p_h e^m_{hh} X^m_{hh} + p_f e^m_{hf} X^m_{hf} \le w_h G + v_h(1+\gamma)F + w_f \beta G + v_f \delta F \qquad (m_h)$$

$$(16) \qquad p_f e^m_{ff} X^m_{ff} + p_h e^m_{fh} X^m_{fh} \le w_f G + v_f(1+\gamma)F + w_h \beta G + v_h \delta F \qquad (m_f)$$

To summarize the X sector in the model, the eight inequalities (8)-(11) are associated with the eight output levels (two each for four firm types), the eight equations in (12) are associated with the eight markups, and the four inequalities in (13)-(16) are associated with the number of firms of each type. Additionally goods prices are given by (7), income levels from (5) and factor prices from factor market clearing equation (4) together with labor demand from the Y sector.

The model is quite complex and inherently involves inequalities making traditional analytical, comparative-statics methods of limited value. The problems introduced by inequalities are compounded by the factor that we have four different production activities (Y, X-sector output, national-firm fixed costs, multinational-firm fixed costs), all using factors in different proportions. We will therefore analyze the model numerically, using Rutherford's (1994, 1995) non-linear complementarity solver (now a subsystem of GAMS).

Readers interested in a more analytical development of the theory are referred to Markusen and Venables (1995, 1996b). In those papers, we are able to make good analytical progress either through the use of partial-equilibrium assumptions and/or the assumption that all X-sector activities use factors in the same proportions.

3. Equilibrium Regime and Factor Prices in Relation to Country Characteristics

Figure 1 presents qualitative information on the equilibrium regime in relation to country characteristics (relative size and relative endowments) for transport costs $\tau = .15$. Figure 1 is an Edgeworth box with the total world endowment of skilled labor on the vertical axis and the total world endowment of unskilled labor on the horizontal axis. Country h's endowment is measured from the south-west corner and that of country f from the northeast corner. Any point in the box constitutes a division of the total world endowment between the two countries. For future reference, we note that due to scaling, the factor-price ratio through the center of the box is quite steep, so basically at any point to the left of column 10, country f has the larger total income and, symmetrically, country h has the larger income to the right of column 10.

Because the results are rather complex, simplified versions of Figure 1 are presented in Figure 2. In the top panel of Figure 2, we plot the areas of Figure 1 in which type-n_h and type-n_f firms are active, ignoring types-m_h and m_f firms. The bottom panel of Figure 2 does the opposite, plotting areas where types-m_h and m_f firms are active, ignoring national firms. National firms are always active in equilibrium when the countries are very different in size or very different in relative endowments (top panel). National firms are the only firms active in equilibrium when the countries are extremely different in size (inferred from the bottom panel).

Multinational firms are the only firms active in equilibrium in the center of the box and in the area around the NW-SE diagonal of the factor box where one country is relatively small but relatively well endowed with skilled labor.

The patterns in the two panels of Figure 2 are quite different. For single-plant national firms n_h and n_f, both relative endowments and market size are determinants of "comparative advantage". A large domestic market creates what is generally referred to as a "home market advantage" in the trade-industrial-organization literature. With increasing returns to scale and Cournot competition,

a large domestic market favors firms located in that market and equilibrium tends to be characterized by firms concentrating in the larger country more than in proportion to the country-size differences. If only relative endowments mattered, the region of type-n_h firms in the top panel of Figure 2 would lie above the SW-NE diagonal. If only country size mattered, all those points would lie to the right of column 10. In fact, we see that a combination of size and relative endowments determines equilibrium.

The pattern of multinational firms, types-m_h and m_f, on the other hand, is related much more closely to relative endowments, and not to country size. When the countries differ significantly in relative endowments, all type-m firms that do exist are located in the skilled-labor abundant country. Country size does not influence much whether we have type-m_h or type-m_f firms since they both have plants in both countries. The dominant type will depend on which country has the lower price for skilled labor, which in turn depends on relative endowments (of course, labor costs are endogenous, a point to which we will return shortly). However, both type-m firms become uncompetitive with national firms located in the larger country when the countries are very different in size. If one country has a very large internal market, a national firm located in that market benefits from high sales in that market, and incurs transport costs on only a small volume of sales to the small country. A multinational firm is disadvantaged by having to maintain a costly plant in the small market.

In section 4, we will consider the effects of falling trade costs or investment liberalization, in the latter case beginning from an equilibrium in which multinationals are initially banned from entering. With reference to Figure 2, the effect of lowering trade costs is to expand the two shaded regions in the top panel toward one another. Eventually they intersect, creating regions of "duopoly" competition between type-n_h and type-n_f firms reminiscent of the "new trade theory". In the lower panel, the shaded and hatched regions shrink toward the center, with multinational firms disappearing entirely as τ approaches zero.

The effect of a prohibitive investment ban is essentially to change Figure 1 into the top panel of Figure 2, except that the two shaded regions of types-n_h and n_f firms fill the entire parameter space and overlap somewhat in the middle.

Figure 3 plots the real wage of skilled labor (the wage divided by the commodity price index) for the equilibria shown in Figures 1 and 2.[7] There is considerable "Heckscher-Ohlin" quality to this diagram. In the center, there is a region of factor-price equalization. To the northwest of this central region, country h, the skilled-labor-abundant country, has a lower wage for skilled labor than country f. The opposite is true to the southeast of the central region. The principal qualitative difference between this diagram and a Heckscher-Ohlin case lies in the points surrounding the SW-NE diagonal. In a HO model (and its extensions for single-plant monopolistic competition in Helpman and Krugman (1985)), these would also be points of factor-price equalization.

In our model, movements along the SW-NE diagonal away from the central region generate regime switches. National firms enter as countries become significantly different in size. Referring back to our earlier discussion of factor intensities, this regime shift is a shift from more skilled-labor-intensive multinational firms to less skilled-labor-intensive national firms. Aggregate demand for skilled labor falls at constant factor prices, and in general equilibrium the real wage of skilled labor falls in both countries.

Figure 3 provides an interesting thought experiment about changes in factor price as countries become more similar in size and in relative endowments, holding the total world supply of factors

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[7]Changes in the real wage of skilled labor are almost always associated with the same direction of change in the skilled-unskilled wage ratio. This does not have to be the case due to scale economies. The real wage of both skilled and unskilled labor could rise at the same time that the relative wage of skilled labor falls. But the only time something like this actually occurs in our model, is when a country is specialized in Y, so some change affects the real wage of both factors, but not their ratio. This is discussed below in connection with Figures 5 and 6.

fixed.[8] If the countries converge in size, the real wage of skilled labor and the skilled/unskilled wage ratio will rise in both countries, offering a possible explanation for the empirical observations noted earlier in the paper. If the countries converge in relative endowments, the skilled wage and the wage ratio will rise in the skilled-labor-abundant country. This may offer a partial explanation of observations regarding the US and Europe.

[8]This is a somewhat artificial exercise, since in practice convergence generally involves lower income countries catching up to the high income countries, so total world absolute and relative endowments are changing. This adds complicated firm-scale effects to this model which in turn complicate the results. A discussion of overall growth in the world economy is postponed until a later section.

4. Investment Liberalization and Falling Trade Costs

Consider first investment liberalization in our two-country world. This requires some well-specified counterfactual. What we have done is to re-compute the model suppressing or "banning" types-m_h and m_f multinational firms. The resulting regime looks similar to the top panel of Figure 2, except that the two shaded regions expand toward the middle and overlap considerably. We then compare the values of variables in this restricted equilibrium to the unrestricted case in Figures 1 and 2 ($\tau = .15$).

The effects of removing the investment barrier on the wage of skilled labor are shown in Figure 4. Liberalization always raises the wage of skilled labor in the skilled-labor-abundant country and raises the skilled-labor wage in both countries over a considerable range of parameter values. The latter tends to occur when the countries are rather different in relative endowments.

Consider first the darker shaded region in Figure 4 where v_h increases but v_f falls. Referring back to Figure 1 and to the lower panel of Figure 2, the effect of liberalization is to allow type-m_h firms to enter in equilibrium. This creates a shift from predominantly type-n_f firms but also from some type-n_h firms in part of the dark-shaded region. Both shifts, but particularly the former, result in an increased demand for country h skilled labor and an increase in v_h in equilibrium. Country f, on the other hand, loses type-n_f firms which are replaced by type-m_h firms in equilibrium. This causes a fall in the demand for skilled labor in country f, as domestic firms are displaced by branch plants of country h multinationals, the latter demanding significantly less country f skilled labor than the displaced national firms. v_f falls in equilibrium.

The explanation for the unshaded regions in Figure 4 in which the skilled-labor wage rises in both countries is a bit more subtle. Consider the upper unshaded region. When investment is banned, type-n_h firms are the dominant type and in most cells the only firm type active in equilibrium. Investment liberalization leads to the entry of type-m_h firms, displacing some of the type-n_h firms.

This increases the demand for skilled labor in country h since the multinational firms are more skilled-labor intensive than national firms even considering just their home-country demands. But the demand for skilled labor also increases in country f, since the branch plants of type-m_h firms are drawing resources from the unskilled-labor-intensive Y sector, not from type-n_f or m_f firms.

Now consider a fall in trade costs (with multinationals initially permitted), the effects of which are shown in Figure 5. Figure 5 contrast sharply with Figure 4. In the latter, there are regions in which the real wage of skilled labor rises in both countries while in Figure 5, there are regions in which the wage falls in both countries. In addition, the locations of the areas in which one country's wage rises and the other falls are reversed. For example, in Figure 4 v_h rises and v_f falls when country h is skilled-labor-abundant and small, while in Figure 5 the same results hold when country h is large and unskilled-labor-abundant.

There are three factors at work that tend to affect factor prices when trade costs fall. First, multinational firms may be displaced by less-skilled-labor-intensive national firms, which may depress the skilled-labor wage in both countries, but particularly in the skilled-labor-abundant country which tends to be the headquarters' country for most multinational firms. The skilled-labor wage could rise in a larger, skilled-labor scarce country if its national firms displace foreign branch plants. Third, if one country basically specializes in X production before and after liberalization, the real wage of skilled labor could rise in that country as trade liberalization expands its X sector. But the real wage in the other country could rise as well as the price index falls. This is a possible case where the real wages of both factors rise but their ratio does not change.

These effects collectively explain the results in Figure 5. Both v_h and v_f fall in the unshaded regions. These are regions in which, at $\tau = .15$, production is dominated by type-m_h firms (upper region) or type-m_f firms (lower region). Trade liberalization displaces these firms with type-n_h and type-n_f firms respectively, causing a fall in the demand for skilled labor in both countries (essentially

opposite to the effect of investment liberalization discussed above).

In the lighter-shaded region of Figure 5, type-m_h firms tend to be displaced by type-n_f firms, resulting in an increased demand for skilled labor in country f and a fall in country h. The converse applies to the darker shaded region of Figure 5, in which type-m_f firms tend to be displaced by type-n_h. The fall in trade costs creates a home-market advantage for national firms in the large, skilled-labor-scarce country displacing less-skilled-labor-intensive branch plants of firms headquartered in the small country.

The hatched regions of Figure 5 are areas in which the skilled-labor wage rises in both countries. Consider the left-hand hatched region. At the initial high level of trade costs, almost all production is by type-n_f firms due to a strong home-market advantage (there is a very small amount of production by type-m_h firms at the uppermost of these points). Trade liberalization has little effect on the number or types of firms in country h in this region, and on X sector output. But it does have a price-index effect, in that trade liberalization lowers the price of X. The ratio of skilled to unskilled wages is essentially unaffected in country h, but the real wage of skilled labor rises in h. From country f's point of view, trade liberalization expands the size of the market for X, its export good, and the general-equilibrium effect of expanding the X sector is to increase v_f.

5. Growth in the World Economy

One reasonable hypothesis about the wage gap, particularly the observations that it has grown in developing countries as well as in advanced economies, is that some feature of growth in the world economy has caused the change. Various aspects of technical change could of course be responsible, but a goal of this paper is explicitly to suggest other possibilities, especially in light of some economists' tendency to use technical change as a sort of Deus ex Machina when some other explanation fails.

A good reference scenario to consider here is simply to allow the world economy to grow in its endowment of all factors of production. While this is surely not a very accurate characterization of world growth in recent decades, such a scenario is useful in pointing out some of the opposing forces at work.

Figure 6 plots the effects of a 100% growth in the world supply of both factors on the real wage of skilled labor in both countries. The upper panel does this for a trade cost of $\tau = .15$ while the bottom panel does this for a trade cost of $\tau = .03$. In the top panel, the initial regime is as given in Figure 1. In the bottom panel, the initial regime is composed almost solely of types-n_h and n_f firms, as in the top panel of Figure 2 except that the shaded areas cover the entire parameter space and intersect.

The unshaded regions of both diagrams are areas in which the skilled labor wage falls in both countries. This dominates the top panel, but is far less important in the bottom panel. The reason lies in the observation that in the top panel, multinational firms are already fairly dominant in equilibrium before growth. The effects of growth are largely that firm scale increases, which implies

that the demand for skilled labor grows more slowly than the supply.[9] In the lower panel, national firms are dominant before growth. Growth results in considerable shifting from national to multinational firms, the latter being more skilled-labor intensive than national firms, and hence the demand for skilled labor growth faster than the supply, at least in the country which tends to be chosen as headquarters of the new multinational firms. Thus a firm-scale effect strongly influences the top panel while a regime-switching effect strongly influences the bottom panel. Thus the effects of growth depend closely on where we start; in particular, whether national or multinational firms are initially dominant.

A few more specific comments about Figure 6 are in order. In the top panel, the dark-shaded area in the SW corner (and up each axis) is an area where the increase in v_h is due to a price index effect as discussed in the previous section (the ratio of the skilled to unskilled wage v_h/w_h does not rise). The area in the NW corner is due to the substitution of some type-m_h firms for type-n_h firms, the former being more skilled labor intensive. There is a small hatched area in the top of this panel (and a much larger one in the bottom panel) in which the skilled-labor wage increases in both countries, due to the substitution of type-m_h firms for type-n_h firms, increasing the demand for skilled labor in both countries. Similarly, the hatched area at the bottom is a substitution of type-m_f firms for type-n_f firms.

The bottom panel results are the consequence of more regime shifting from national to multinational firms as noted, but the price index effect is important in and near the SW and NE corners. The interesting result here is that the small country tends to experience a rise in the return

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[9]Again, there may be some discomfort in the notion that an increase in firm scale implies lower skilled-labor intensity. But while we may have a good intuitive feel for physical capital to unskilled or semi-skilled labor ratios in relation to plant scale, I don't know that we have good evidence about human capital intensity. Does doubling plant scale require doubling the number of scientists, engineers, and managers? We don't know. Allowing for some required increase in the demand for skilled labor as plant scale increases should shrink the unshaded regions in both panels of Figure 6.

to skilled labor regardless of whether or not it is skilled-labor abundant or scarce. Different effects dominate in different sections of the dark-shaded region in the lower panel (and correspondingly in the light-shaded region). But basically they are the same effects noted in the previous paragraph with more regime shifting in the hatched areas of the box. The small set of points in the NW area where v_h falls is due to the displacement of type-m_h firms by type-n_f firms.

In summary, the effects of "neutral" growth in world factor supplies are a tension between firm scale effects and regime shifting effects in the model. The more dominant that national firms are initially, the more likely that growth results in increases in the return to skilled labor in at least one country. That country will generally be the smaller of the two countries. If country h is small and is skilled-labor abundant, there is a substitution of type-m_h firms for type-n_h firms, and if it is skilled-labor scarce, there is price-index effect (fall in the price of X with no change in relative factor prices).

9. Conclusions

The purpose of this paper is to adapt our earlier work to consider what role multinational firms might have in influencing factor prices, in particular the difference between skilled and unskilled wages. Multinational firms fragment production geographically, and the crucial assumptions of the paper involve how factor intensities differ among different aspects of production. Drawing on extensive empirical literature, we assume that the rankings of skilled-unskilled ratios among activities and firm types is:

[firm-level fixed costs] > [plant-level fixed costs] > [integrated X production] > [Y production] > [final X production]

[multinational firms] > [national firms] (at common output scale)

Results are as follows:

(1) Multinational firms are more likely to arise in equilibrium when two countries are similar in both relative factor endowments and in size, and when trade costs are moderate to high.

(2) Convergence in country size and in relative endowments holding world endowments constant raises the real wage of skilled labor and the skilled-unskilled wage gap in the skilled-labor-abundant country. When convergence is in country size, the skilled wage and the wage ratio can rise in both countries as more skilled-labor-intensive multinational firms replace less-skilled-labor abundant national firms.

(3) Investment liberalization raises the real wage of skilled labor and the wage ratio in the skilled-labor abundant country as new multinational firms headquartered there displace its own national firms or foreign-headquartered national firms. Over a significant portion of parameter space the skilled wage rises in both countries. Assuming country h is the skilled-labor abundant country, this occurs when type-m_h firms displace type-n_h firms, and the branch plants in country f draw resources from the Y sector, not from type-n_f firms.

(4) Falling trade costs tend to have the opposite effect in some loose sense. Trade liberalization puts downward pressure on the skilled-labor wage for two reasons. First, less-skilled-labor intensive national firms can displace more skilled-labor-intensive multinational firms and second, a pro-competitive effect can raise firm scale, lowering skilled-labor intensity. The wage of skilled labor rises in a large, unskilled-labor-abundant country as some national firms in that country displace foreign branch plants. The only case in which falling trade costs raises the skilled wage in both countries occurs when they are very different in size so that all X production is by national firms in the larger country. Then liberalization expands the X sector in the large country and has a favorable effect in the small country via a fall in the price index (with no change in the wage ratio).

(5) Neutral growth in all factors in the world economy has effects that depend in large part on whether national or multinational firms are dominant initially. If national firms are dominant initially, then growth results in regime switching to multinational firms with the skilled wage rising in one or both countries. If multinational firms are already dominant initially, then growth results in pro-competitive effects leading to an increase in firm scale, so that skilled-labor demand does not grow in proportion to supply. The skilled-labor wage then falls over significant portions of parameter space.

To summarize, the results provide motivation for empirical work on the role of multinationals in the wage-gap problem. If country characteristics are converging and if indeed investment restrictions have fallen faster than trade costs (including tariffs), then multinationals may explain some part of the wage-gap phenomenon.

REFERENCES

Berman, Eli, Stephen Machin, and John Bound (1995), "Implications of Skill Biased Technological Change: International Evidence", Working Paper.

Bernard, Andrew B. and J. Bradford Jensen (1995), "Exporters, Skill Upgrading, and the Wage Gap", MIT working paper.

Brainard, S. Lael (1993b), "An Empirical Assessment of the Factor Proportions Explanation of Multinationals Sales", NBER Working Paper No. 4583.

Brainard, S. Lael (1993c), "An Empirical Assessment of the Proximity-Concentration Tradeoff between Multinational Sales and Trade", NBER Working Paper No. 4580.

Caves, Richard E. (1996), Multinational Enterprise and Economic Analysis. London: Cambridge University Press. (second addition)

Cragg, Michael Ian, and Mario Epelbaum (1995), "The Premium for Skills in LDCs: Evidence from Mexico", Working Paper.

Eaton, Jonathan and Akiko Tamura (1994), "Bilateralism and Regionalism in Japanese and US Trade and Direct Foreign Investment Patterns", Journal of the Japanese and International Economies 8, 478-510.

Ekholm, Karolina (1995), Multinational Production and Trade in Technological Knowledge, Lund Economic Studies, Number 58.

Feenstra, Robert C. and Gordon H. Hanson (1995a), "Foreign Investment, Outsourcing, and Relative Wages", in Political Economy of Trade Policy: Essays in Honor of Jagdish Bhagwati. Cambridge: MIT Press.

Feenstra, Robert C. and Gordon H. Hanson (1995b), "Foreign Direct Investment and Relative Wages: Evidence from Mexico's Maquiladoras", Working Paper.

Freeman, Richard B. (1995), "Are Your Wages set in Beijing?", Journal of Economic Perspectives 9, 15-32.

Hanson, Gordon H. and Ann Harrison (1995), "Trade, Technology, and Wage Inequality", NBER Working Paper No. 5110.

Helpman, Elhanan and Paul Krugman (1985), Market Structure and Foreign Trade. Cambridge: MIT Press.

Krugman, Paul R. (1995), "Technology, Trade, and Factor Prices", NBER working paper 5355.

Krugman, Paul and Robert Lawrence (1993), "Trade, Jobs, and Wages", NBER working paper 4478.

Lawrence, Robert and Mathew Slaughter (1993), "International Trade and American Wages", Brookings Papers on Economic Activity, 161-226.

Leamer, Edward E. (1993), "Wage Effects of a US-Mexican Free Trade Agreement", in Peter M. Garber (editor), The Mexico-US Free Trade Agreement, Cambridge: MIT Press, 57-125.

Leamer, Edward E. (1994), "Trade, Wages, and Revolving Door Ideas", NBER working paper 4716.

Leamer, Edward E. (1996a), "In Search of Stolper-Samuelson Effects on U.S. Wages", NBER working paper 5427.

Leamer, Edward E. (1996b), "What's the Use of Factor Content Calculations", NBER working paper 5448.

Markusen, James R. and Anthony J. Venables (1995), "Multinational Firms and the New Trade Theory", NBER working paper 5036.

Markusen, James R. and Anthony J. Venables (1996a), "Multinational Production, Skilled Labor, and Real Wages", NBER working paper 5483.

Markusen, James R. and Anthony J. Venables (1996b), "The Theory of Endowment, Intra-Industry and Multinational Trade", NBER working paper 5529.

Markusen, James R. (1995), "The Boundaries of Multinational Enterprises and the Theory of International Trade", Journal of Economic Perspectives 9, 169-189.

Pissarides, Christopher A. (1995), "Trade and the Returns to Human Capital in Developing Countries", LSE working paper.

Richardson, J. David (1995), "Income Inequality and Trade: What to Think, What to Conclude", Journal of Economic Perspectives 9, 33-56.

Riker, David and S. Lael Brainard (1996), "U.S. Multinationals and Competition from Low Wage Countries", MIT working paper.

Robbins, Donald J. (1994), "Earnings Disperions in Chile after Trade Liberalization", manuscript.

Robbins, Donald J. (1995), "Wage Dispersion and Trade in Columbia: An Analysis of Greater Bogota: 1976-1989", manuscript.

Slaughter, Matthew J. (1995), "Multinational Corporations, Outsourcing, and American Relative Wage Divergence", NBER working paper 5253.

Tan, Hong and Geeta Batra (1995), "Technology and Industry Wage Differentials: Evidence from Three Developing Countries", The World Bank.

Teece, David (1986), The Multinational Corporation and the Resource Cost of International Technology Transfer, Cambridge: Ballinger.

Teece, David (1977), "Technology Transfer By Multinational Firms: The Resource Cost of Transferring Technological Know-How", Economic Journal 87, 242-61.

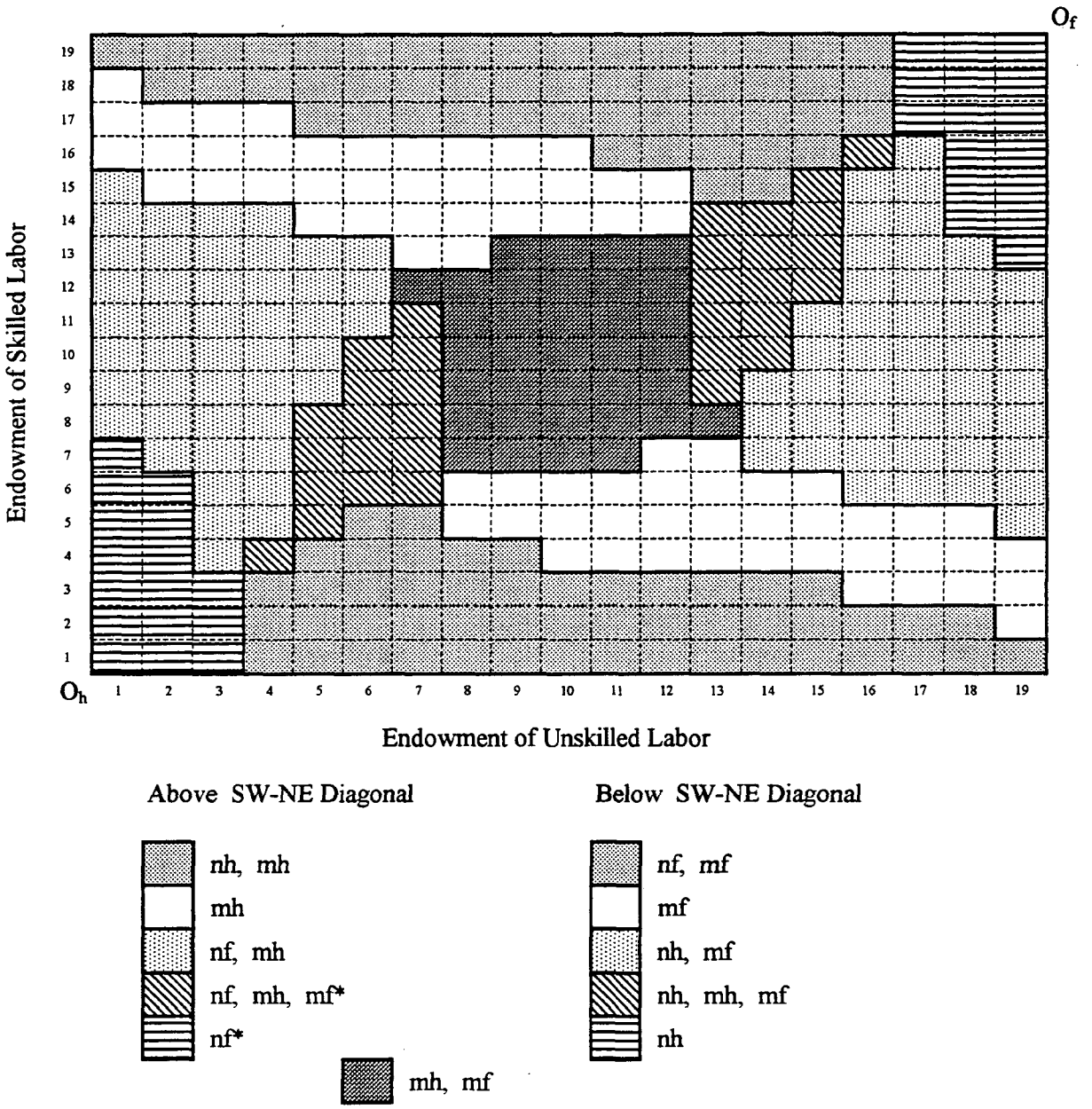
Rutherford, Thomas F. (1994), Applied General-Equilibrium Modelling with MPS/GE as a GAMS subsystem, working paper.

Rutherford, Thomas F. (1995), "Extensions of GAMS for Complementarity Problems Arising in Applied Economics", Journal of Economic Dynamics and Control.

Wood, Adrian (1995), "How Trade Hurt Unskilled Workers", Journal of Economic Perspectives 9, 57-80.

Wood, Adrian (1994), North-South Trade, Employment and Inequality, Oxford: Clarendon Press.

Figure 1: Production Regime with Transport Costs, $\tau = .15$



* These regions overlaps the diagonal somewhat, they refer to the region SW of the center point

Figure 2: Regions of type-n and type-m firms, Transport Costs $\tau = .15$

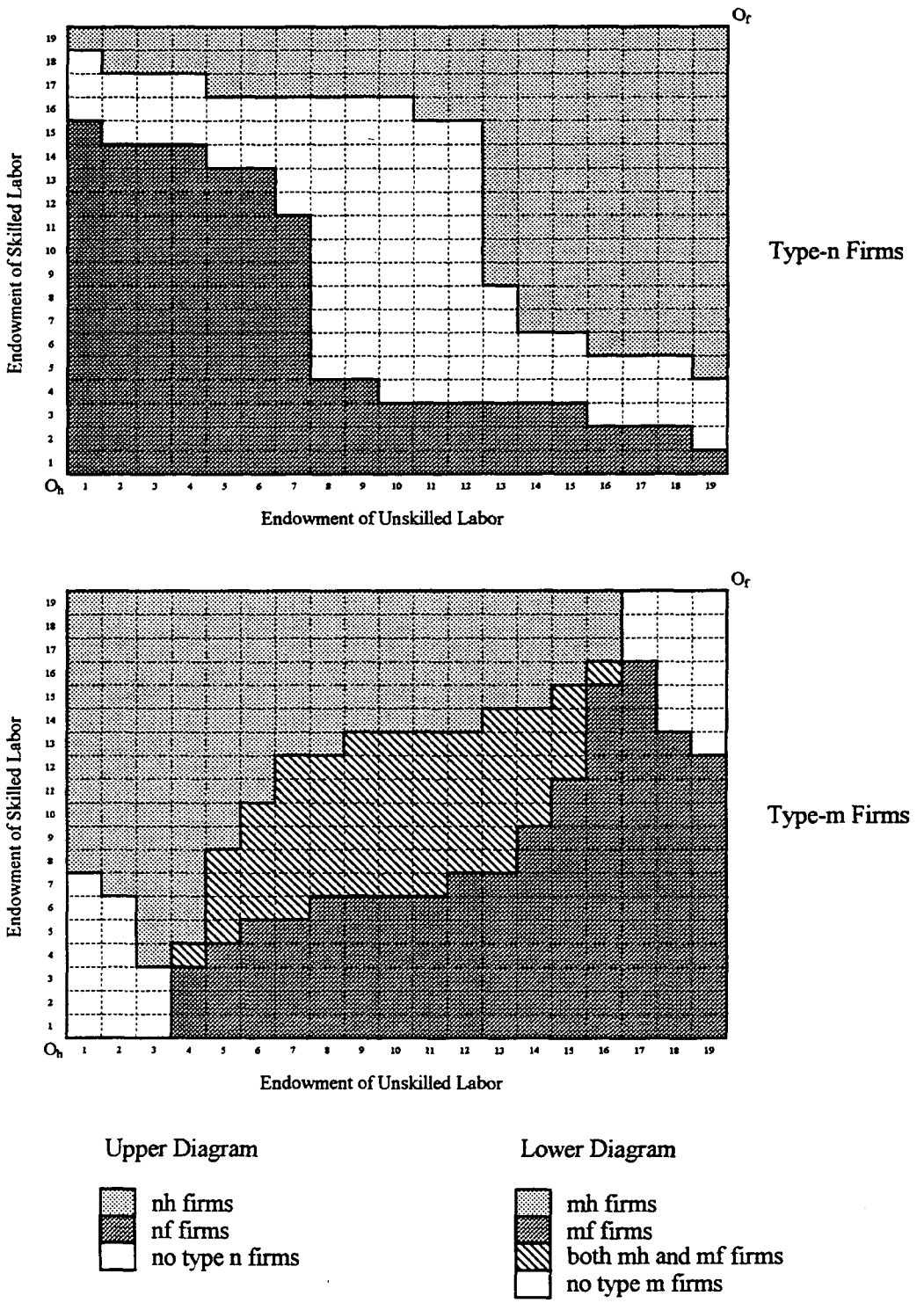


Figure 3: Asymmetries in Country Characteristics and the Real Wage of Skilled Labor, Transport Costs, $\tau = .15$

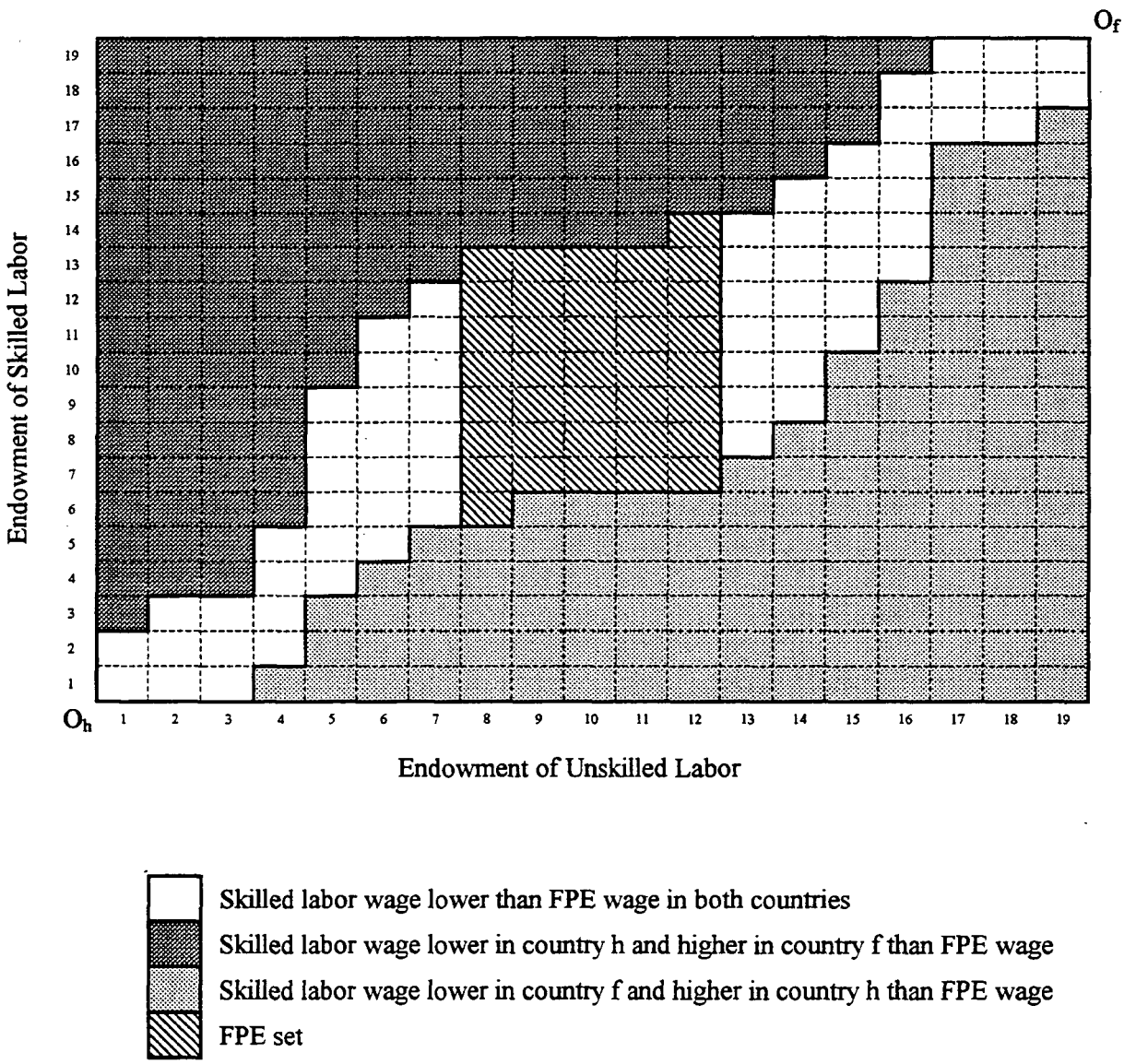
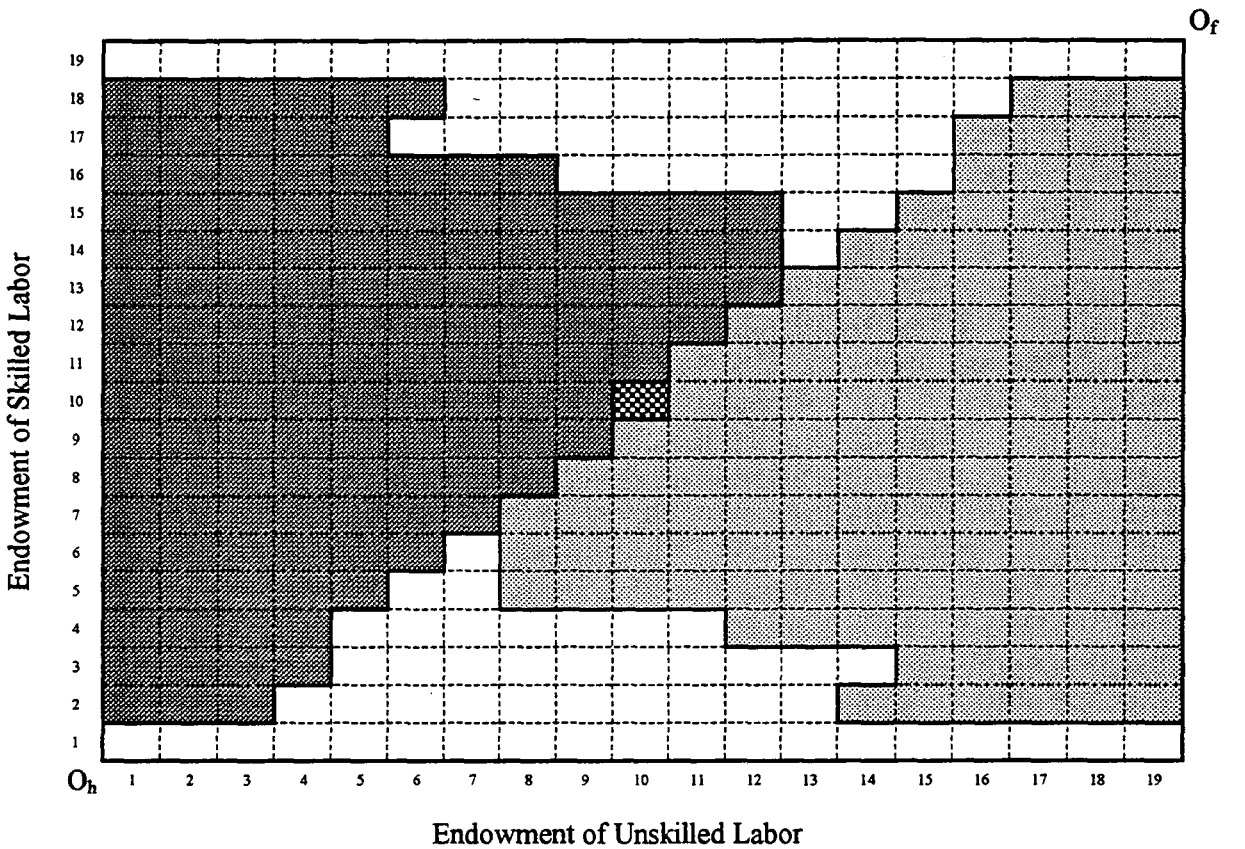


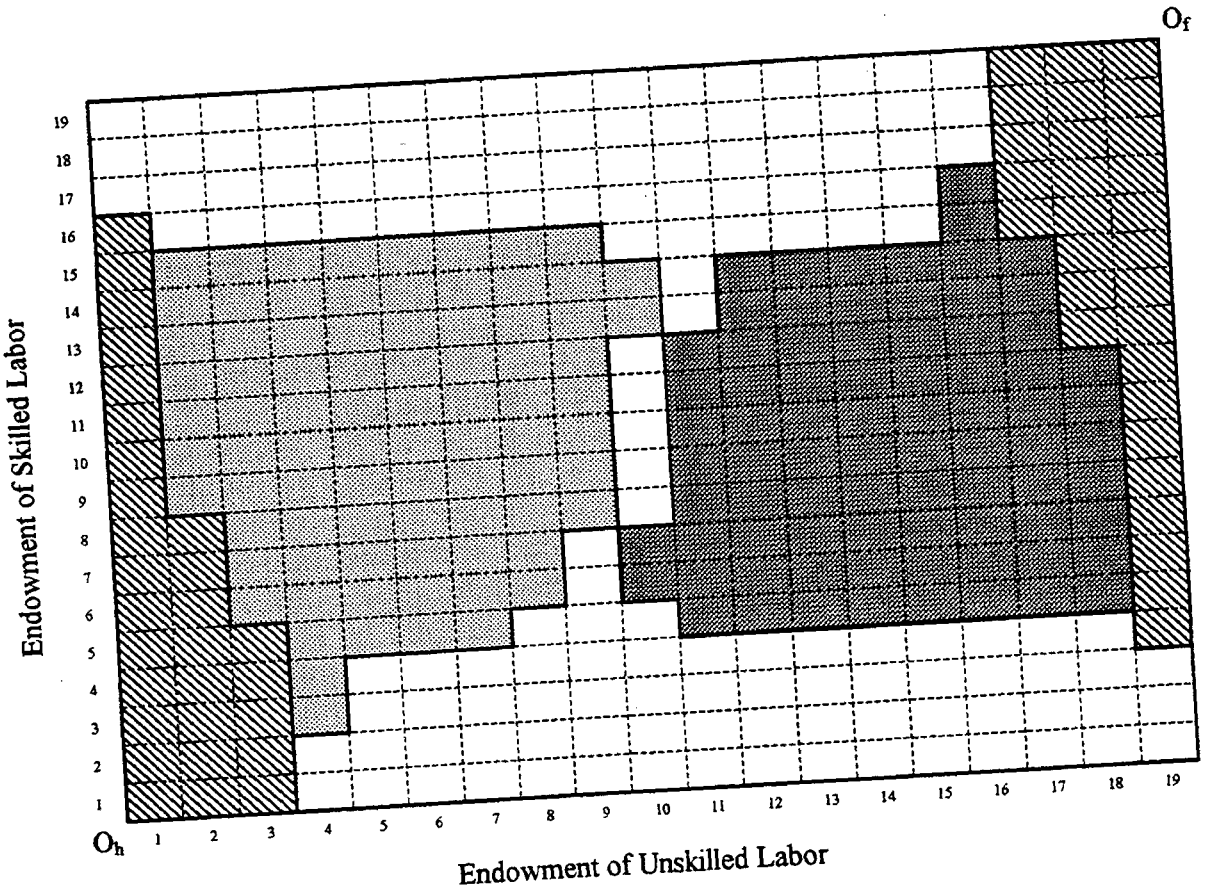
Figure 4: Effect of Investment Liberalization on the Real Wage of Skilled Labor, Transport Costs, $\tau = .15$



Investment Liberalization results in:

- Skilled labor wage rises in both countries
- Skilled labor wage rises in country h, falls in country f
- Skilled labor wage rises in country f, falls in country h
- Virtually no change

Figure 5: Effect of Trade Liberalization on the Real Wage of Skilled Labor, Trade Costs Reduced from .15 to .03



Trade Liberalization results in:

- Skilled labor wage falls in both countries
- Skilled labor wage rises in country h, falls in country f
- Skilled labor wage rises in country f, falls in country h
- Skilled labor wage rises in one country, rises or is constant in the other

Figure 6: Effect of 100% Growth on the Real Wage of Skilled Labor, $\tau = .15, .03$