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Managerial Versus Production Wages: Offshoring, Country Size and Endowments

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Abstract

We look at managerial and production wages in countries that differ in size and relative endowments. Production labor is assumed to be a variable input composed of tradable tasks, while managerial labor is a fixed, non-tradable input. Task performance is subject to increasing returns to scale on the country level, as in Grossman & Rossi-Hansberg (2010). We first analyze country size and relative endowment effects on wages, ruling out task trade altogether, followed by numerical simulations highlighting the "degree of freeness" of task trade as an important further determinant of relative wages, both within and across countries, as well as determinants of international gaps in income per capita.

JEL-Classification: F12, F16, F23
Keywords: Offshoring, Economies of Scale, Income distribution, International Inequality

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1 Introduction

There is a widespread presumption that, other things equal, larger countries should pay higher wages. The underlying assumption is that, in one form or another, many industries feature advantages of large scale production, which should be reflected in higher equilibrium factor rewards for larger countries.

However, other things are seldom equal. In particular, many people still prefer to live in small countries, where their specific abilities or skills are scarce, relative to other types of labor and relative to capital or land. The small country disadvantage may then be more than offset by a scarcity premium on their skills. Conversely, workers living in large countries may still face relatively low wages, if their abilities and skills are in abundant supply, relative to demand, in these countries. In other words, in general equilibrium wages for different types of labor are governed by both, a country's size and its relative labor endowment.

Of course, equilibrium wages also depend on a country's international economic integration. Trade theory offers a long tradition of models that explore the role of relative endowments, as well as models that highlight the role of country size for wage determination under alternative "regimes" of internationalization. Unfortunately, theoretical models have been developed in different strands of the literature, with very little common ground. The traditional models stressing relative abundance and factor prices typically rule out all economies of scale, while "new trade theory" models allowing for economies of scale typically downplay the importance of relative factor abundance.

Endowment-based models typically draw a line between high- and low-skilled labor.[1] However, this distinction has very limited meaning, unless we explicitly model skill formation. It is also notoriously difficult to pin down empirically. The empirical literature sometimes distinguishes between production and non-production workers as a rough proxy for the distinction between the high- and low-skilled part of the labor force; see for instance Feenstra (2010). But arguably, a lot of production work involves more skills and human capital than much non-production work.

In this paper, propose a different approach. We distinguish between managerial and production work, instead of high- and low-skilled labor. This distinction has so far not received much attention in the trade literature. It is, first and foremost, one between different types of activities. Following Rosen (1982), we argue that managerial

[1] See Lawrence (2008) and Krugman (2008) for recent examples.

activities are often characterized by indivisibility and scale economies.[2] We model this in a very simple way by defining managerial activity to be a fixed input required in the productionby of any one variety of a final good. In contrast, production activities are modeled as representing a variable input. We deliberately abstain from any assumption regarding the skills needed to perform managerial and production activities, respectively. Management may, but need not be associated with task requiring more skills or education than poruction work. Modern economies feature deeply entrenched and complex mechanisms of sorting individuals into managerial and production activities.[3] Arguably, these mechanisms differ across countries, leading to different compositions of the work force in terms of managerial and production activities. We therefore allow countries to differ in both, their size as well as their relative supplies of managerial and production workers, respectively. We simplify by assuming exogenous country endowments with the two types of labor.

If managerial work is a fixed input, then production necessarily features some form of increasing returns to scale. We must therefore expect country size, in addition to relative supplies of managers and production workers, to be an important determinant of managerial incomes and wages for production workers. By the same token, country size and relative endowments with the two types of labor should be important explanatory factors also for international gaps in income per capita. And both, internal as well as international distribution of income will also be influenced by the extent to which countries engage in international division of labor through trade. A detailed analysis of this influence should enhance our understanding of the perennial issue of "trade and wages" as well as the issue of "international convergence and globalization".

In this paper, we address internal as well as international income inequality in a two-country general equilibrium model of trade and offshoring. We focus on two forms of international trade. The first is trade in differentiated final goods along the lines of the standard model of trade that combines scale economies from a fixed (managerial) cost with "love of variety". The second is direct trade in services of production workers, or tasks. More specifically, following Grossman & Rossi-Hansberg (2008), we define the input of production labor as being composed of different tasks that may be traded, albeit subject to an additional cost that arises from linking tasks performed in different countries. In contrast, managerial input draws on a uniform, nontradable task. Each production task is assumed to be subject to increasing returns to scale that are external

[2] In Rosen's own words: *"Management involves discrete and indivisible choices and commands, such as which goods to produce, in what varieties and volume, and how to produce them. Supervision insures that management directives are carried through at the production level. Indivisibilities inherent in management decisions are represented analytically as a form of total factor productivity improvement and, as such, imply a strong scale economy, not unlike a public good but limited to the confines of the firm. For example, the decision of which good to produce is largely independent of scale, applying equally well to a very large enterprise as to a very small one."* (Rosen, 1982, p. 312).

[3] Rosen (1982) presents a model that describes sorting of individuals into managerial and production activities based on individual abilities.

to the firm, but strictly national in scope. This installs a rationale for trade in tasks also between similar countries, but it leads to multiple trading equilibria.

Our present analysis assumes that all individuals, whether workers or managers, are immobile across countries. But due to economies of scale, our model does not feature factor price equalization through trade. Hence, a natural next step should be to allow for international migration and to explore the potential for agglomeration that might arise from the aforementioned external scale economies.

Our model is closely related to Grossman & Rossi-Hansberg (2010). They assume a uniform relative endowment with workers and managers across countries, focusing on levels of production wages in the two countries that trade in final goods and production tasks. We explore the interaction between country size and differing relative endowments with managers. Moreover, we extend our analysis to address internal income distribution, looking at managerial wage premia, and we also address international inequality by looking at gaps in income per capita.

We are able to pin down analytical results on how country size and relative endowments determine managerial and production wages, if trade is restricted to final goods only. We find that a proportional increase in either type of labor in any one country raises both types of wages proportionally – a pure scale effect. Perhaps less obviously, it harms both managers and production workers in the other country. An unbalanced increase in a country's endowment with managers depresses its managerial wage, while raising its production wage - a conventional complementarity result. However, an unbalanced increase in a country's production work has an ambiguous effect on its production wage. A wage increase for production workers on account of the external scale effect in production tasks comes about only if this scale effect is sufficiently strong and the elasticity of substitution across final good varieties is sufficiently large. However, the cross effect on managerial wages are always positive – complementarity again prevails between the two types of activities.

Once we allow for trade in production tasks, analytical results are much harder to come by. Moreover, as often in cases where there are external economies of scale, we are facing multiple equilibria. As in Grossman & Rossi-Hansberg (2010), we therefore resort to numerical simulations. However, we extend our focus to the interaction between country size and relative endowments and the "freeness" of trade in tasks on the one hand, and domestic as well as international inequality on the other.

The paper is structured as follows. Section 2 provides a brief literature discussion that shows how our framework relates to existing strands of the literature. Section 3 presents the key relationships of our model, and section 4 derives the comparative statics of size and endowments for the benchmark case of free trade in final goods, but no trade in tasks. In section 5, we derive the equilibrium conditions that govern trade in tasks. We discuss possible equilibrium locations of task performance. Since

there are multiple trading equilibria that defy analytical solution, section 6 proceeds with a numerical treatment that sheds light on how "freeness of task trade" affects the interaction between country size and relative endowments in determining managerial and production workers' wages. Section 7 concludes the paper.

2 A brief literature discussion

Traditional models of international trade based on general equilibrium under perfect competition focus on the scarcity premium, stressing factor abundance and ruling out scale economies altogether. There is a relatively long tradition of using such models, in order to explain the increase in wage inequality, mostly in the form of a rising skill-premium, that many countries have observed over the past two decades. However, the explanations have been less than fully convincing. While theory does suggest that higher wage inequality is a conceivable outcome of enhanced trade, establishing the empirical significance of trade as an explanatory factor for observed wage patterns over time has been notoriously difficult.[4] From a trade theory perspective, perhaps the most important caveat to bear in mind is that factor remunerations are primarily determined by goods prices, and not by the volume and the factor content of trade per se.[5] Some authors have argued that trade in intermediate inputs, or offshoring, is a more convincing explanatory candidate for the rising skill premium than trade in final goods.[6] However, recent theoretical treatments have shown that under very plausible conditions offshoring of production components or labor services to more labor abundant countries with lower wages may well lower, rather than increase, the domestic skill premium.[7]

If traditional abundance models fail to fully explain what we observe, where should we look for alternative, or complementary explanations? Models that focus on scarcity premia and trade to explain wage inequality, almost be definition, have a north-south flavor, meaning that the focus lies on trade between countries with different relative endowments. Yet, a lot of the more recent increase in world trade has taken place in north-north direction, i.e., trade between countries with similar relative endowments. The mainstream "new trade theory" models commonly used to analyze this type of trade place much emphasis on advantages of large scale production as a rationale and determinant of trade. The models typically feature economies of scale in at least one of two forms. The first are scale effects internal to the firm, arising from fixed cost

[4]See Krugman (1995) for an early critique. For recent review of the evidence see Lawrence (2008).

[5]See the discussion in Deardorff (2000), Krugman (2000), Leamer (2000), and Panagariya (2000).

[6]See Feenstra & Hanson (1997, 1999, 2003) and Krugman (2008). Based on a version of the traditional model that is similar to Feenstra & Hanson (1997), Zhu & Trefler (2005) show that catching-up of less developed countries may entail a systematic effect towards increasing their skill premium.

[7]See Kohler (2004) and Grossman & Rossi-Hansberg (2008).

of production, with markets typically assumed to feature product differentiation and monopolistic competition. The second are external scale economies due to the so-called variety effect in the use of differentiated intermediate inputs.[8]

As expected, allowing for scale economies implies that country size becomes important for real wages. But interestingly, it does so only if trade is costly. The reason is that in these models economies of scale are international in scope, which makes country size irrelevant if trade is costless. But if trade is costly, then country size matters, and larger countries do pay higher real wages, thus substantiating the expectation mentioned at the outset. This is the well known "home market effect".[9]

However, "new trade theory" models typically remain silent about wage inequality within countries, assuming that homogeneous labor is the only input. If other factors are allowed for, technology is typically assumed to be *homothetic*, meaning that firms draw on the same type of labor in both, their fixed as well as their variable inputs.[10] This implies that country size, if relevant at all, works equally for all types of factor income. There is no potential for country size effects per se to either aggravate or ameliorate wage inequality by trickling down asymmetrically to different types of labor. This seems questionable. As we shall see below, there are strong arguments suggesting that different types of labor are in vastly different positions regarding the advantage of large scale production.

A further feature of these "new trade theory" models is that there is no scope for multiple trading equilibria, and no issue of conflict over who ends up enjoying the fruits of international division of labor under economies of large scale production. The reason is that all scale economies are international in scope. However, the specter of multiplicity and conflict does arise if scale economies do not extend beyond country borders, and if industries differ in the degree of scale economies.[11] Under certain con-

[8]The potential for product differentiation in intermediate inputs to generate external scale economies has first been pointed out in Ethier (1982a).

[9]See Krugman (1980) who was the first to point out this "home market effect". Very often, the home market effect is portrayed as a tendency for larger countries to also have a larger *share* of production taking place in increasing returns to scale industries; see Davis (1998). For our purpose the important point is that under the usual conditions they pay higher wages, which is indeed the baseline version of the "home market effect" in Krugman (1980).

[10]For a general treatment of this type of homotheticity in monopolistic competition models, see Horn (1983). Early models that allow for two factors are reviewed in Helpman & Krugman (1985). A notable exception from the assumption of homotheticity in factor input use is Helpman's theory of the multinational firm; see Helpman (1984). However, these models do not systematically explore the interaction between country size and relative endowments in the determination of skill premia and international differences in wage levels.

[11]The classic reference here is Ethier (1982b) which is the first modern treatment of a concern, first expressed in 1923 by Frank Graham, that countries may lose from trade if they end up specializing in industries without, or with relatively low degrees of scale economies. For a thorough analysis of the conflict potential that derives from scale economies that are national in scope, see Gomory & Baumol (2000).

ditions, it becomes advantageous for countries to host industries where scale economies are most pronounced. However, if countries are not too different in their size, market clearing conditions alone do not determine the pattern of international specialization. Unless the size difference between countries is large enough, it need not be the larger countries that in the end reap the advantages of large scale production, and hence pay higher wages. This feature will also be present in our model, although we shall see that outsourcing per se reduces the scope of indeterminacy. Moreover, in our case it will be specialization in tasks instead of industries, and the large country advantage derives from specializing in tasks where the cost of offshoring is particularly high. This is reminiscent of the Krugman-type home market effect mentioned above. But again, these advantages operate differently in the use of different types of labor, whence we should expect a potentially complex interaction between country size and relative endowment that determines international and within-country wage inequality.

The first paper to analyze this interaction is Epifani & Gancia (2008). However, they remain within the realm of conventional "new trade theory", where external scale economies are international in scope, deriving from a variety effect in the use of differentiated intermediate inputs, as in Ethier (1982a). Moreover, they stick to the distinction between high-skilled and low-skilled workers. Importantly, technology is homothetic, meaning that the two types of labor are equally important for fixed and variable cost. It turns out that for a closed economy country size works in favor of high-skilled labor, provided that i) the degree of external scale economies based on the variety effect is larger for the high-skill-intensive industry than the low-skill-intensive industry, and ii) the elasticity of substitution in demand for the goods of the two industries is larger than 1. The intuition is quite obvious: For any given composition of the labor force, an increase in country size has a positive effect on income per capita, due to enhanced differentiation of intermediate inputs. However, since the effect is stronger for the skill-intensive industry and since the price and income effects by assumption do not offset each other in demand, the outcome is a higher scarcity premium for high-skilled labor. What is true for a closed economy becoming larger is also true for two or many economies becoming more integrated, whence all countries similarly reap the benefits from serving a larger (world) market.

As we have argued in the introduction, the distinction between high- and low-skilled labor has little significance, unless one esplicitly models skill-formation. Perhaps reflecting this point, recent literature has focused on the type of activities performed, instead of the skills embodied in a particular worker. There are two different criteria that have been brought into play. Models of task trade emphasize the varying degree to which the performance of tasks require face to face contact between, and physical pres-

ence of, workers.[12] A very different criterion is emphasized in Rosen (1982), who draws a line of distinction between managerial activities and production work. He argues that managerial activities (oversight, coordination etc.) are inherently fixed inputs, while production labor is a variable input. This should have important implications for income distribution. Specifically, modeling a process of ability-based self-sorting by individuals into managerial and production work, Rosen (1982) shows that this distinction may give rise to an income distribution which is skewed to the right, as observed in the real world.[13]

If one follows Rosen (1982), then any model that assumes all types of labor to be equally important as fixed and variable inputs into production, as in the mainstream "new trade theory" models, misses an important part of the story.[14] We therefore assume that these two types of inputs involve fundamentally different tasks, drawing on different segments of the labor force. The fixed input requires managerial tasks, drawing on managerial labor, while the variable input requires production tasks performed by production workers. Economies have idiosyncratic institutions and mechanisms that translates a given distribution of innate individual abilities and preferences into supply of managerial and production labor, respectively. We simplify our analysis by assuming these supplies to be exogenous, but we stress cross-country differences in the relative endowments with managerial and production labor. The managerial labor force may, but need not, feature higher skills than production labor. The crucial point here is that it performs tasks that are inherently fixed inputs in production, while production work constitutes a variable input.

This simplification allows us to embed the distinction between managerial and production work in a general equilibrium model of trade that highlights the interaction between relative endowments and country size for the remuneration of managers and production workers. In our model, country size becomes important on account of two types of scale economies. The first is conventional, deriving from the fixed managerial input. This form of increasing returns to scale is internal to the firm, modeled in the usual way by assuming monopolistic competition. However, instead of assuming zero profits in equilibrium, we close the model by an endogenous determination of the managerial wage, given the number of available managers. The second type of scale economies is external to the firm, and it applies only to production labor. More specifically, following Grossman & Rossi-Hansberg (2010), we assume that such economies

[12] Of course, the two lines of distinction may be combined, as in the seminal paper by Grossman & Rossi-Hansberg (2008). Blinder (2009) emphasizes that the line between tasks that may be performed at a distance from the "production line" is almost orthogonal to the line between high-skilled and low-skilled workers.

[13] The sorting of workers into activities in Rosen (1982) is akin to the sorting of individuals into different sectors in Ohnsorge & Trefler (2007).

[14] Indeed, it implies that some of the measured wage inequality between production and non-production workers, as for instance in Feenstra & Hanson (1999), may reflect size effects, not skill effects.

are present on the level of individual tasks performed by production labor, as opposed to the entire industry as in Ethier (1982b).

In stark contrast to all models with homothetic technology (see above), in our model the two types of labor are in fundamentally different positions regarding economies of scale. Managerial workers reap internal economies due to fixed cost, thus extending to the foreign operations (tasks) of a firm, while production workers reap economies that are external to the firm, but are strictly national in nature. As we shall see, the implication of this distinction for the determination of wages heavily depends on the trading regime, i.e., on whether or not we allow for trade in tasks and on the "degree of freeness" in task trade.[15]

3 Benchmark model: trade in final goods

We assume two countries (domestic and foreign), sharing identical preferences and technology but differing in their exogenous endowments with managerial labor and production workers. Managerial labor endowement is denoted by H for the domestic country and by H^* for the foreign country. Both types of labor are immobile across countries. The supply of workers is denoted by L and L^* for the domestic and the foreign country. Preferences feature "love of variety", modeled as usual through a Dixit-Stiglitz-type utility function for varieties of a single final good. We assume varieties to be fully symmetric in both, demand and production. Producing any variety requires hiring f *managers* as a *fixed input*. In addition to managerial input, production requires a *continuum of different tasks*, indexed by $i \in [0,1]$, to be performed by *production workers*. We use a function $z(i)$ to denote the amount of task i that needs to be performed per unit of the final good.

By definition, firms are headquartered in the country where they hire their managers.[16] We make no distinction between firms hiring managers and managers setting up their own firm. In equilibrium, a manager must earn the same income, whether in terms of entrepreneurial profit, if self-employed, or through a perfect contract with a firm. For simplicity, our entire argument will be framed in terms of managerial wages, denoted by s and s^* for the home and the foreign economy. The equilibrium value of managerial wages is determined by free entry and perfect competition for managers,

[15] Our model bears a resemblance to Helpman's (1984) theory of the multinational enterprise. In his terminology, we would say that managers are headquarter inputs, while production work is used in the production line, either in the headquarter country or the foreign economy. However, the new element that we borrow from Grossman & Rossi-Hansberg (2010) is that trade in tasks is governed by external scale economies of the type described above.

[16] As indicated in the introduction, this is a useful first step. An obvious next step would be to allow for managerial workers to be mobile across countries and to analyze potential agglomeration along the lines of "new economic geography".

whence pure profits are zero.

Given Dixit-Stiglitz preferences, producers of differentiated varieties have price-setting power, and they charge a markup over marginal cost equal to $\sigma/(\sigma-1) > 1$, where $\sigma > 1$ is the elasticity of substitution between any two varieties of the good.[17] Assuming free entry, the number of firms is given by

$$n = H/f \quad \text{and} \quad n^* = H^*/f \tag{1}$$

and competitive managerial wages denoted by s and s^*, are determined from the condition that all profits end up in managerial income:

$$s = \frac{cx}{\sigma-1}\Big/ f \quad \text{and} \quad s^* = \frac{c^*x^*}{\sigma-1}\Big/ f \tag{2}$$

where c and c^* are marginal cost from production workers employed by a firm headquartered in the domestic and the foreign economy, respectively, selling amounts x and x^* of their respective final-good-variety.[18] We assume no trade costs for final goods, hence the total amounts sold by the two types of firms on the world market satisfies the following goods market equilibrium condition:

$$\frac{x^*}{x} = \left(\frac{c^*}{c}\right)^{-\sigma} \tag{3}$$

Marginal costs c and c^* depend on wages for production workers, and on a firm's organization of production. Firms face given wage rates w and w^* for workers located in the domestic and the foreign economy, respectively. We compare two trading arrangements. With final goods trade alone, a firm headquartered in the domestic economy must draw exclusively on domestic production workers, and similarly for foreign firms. With trade in tasks, a firm need not have all tasks performed in its headquarter-country, but may freely decide to locate some of the tasks in the other country. It then becomes a multinational firm in the sense of Helpman (1984). However, doing so involves an additional cost which varies across tasks; see below.

We use $1/A(i)$ to denote the amount of labor needed per unit of task i, if performed in the domestic economy. Analogously for the foreign economy. External economies of scale imply that $A(i)$ depends on the entire amount of task i performed in the domestic economy, which we denote by $X(i)$. Following Grossman & Rossi-Hansberg (2010), we model external scale economies in constant elasticity form, such that $A(i) =$

[17] This assumes a neglible influence of a single firm's pricing policy on the overall price index of varieties, which implies a relatively large numer of firms. We assume that the overall endowment of $H + H^*$ is sufficiently large for a sufficiently large number of firms.

[18] Equations (2) follow from setting $px - cx - sf = x[\sigma/(\sigma-1) - 1] - sf = 0$. This replaces the zero-profit condition found in conventional models of monopolistic competition.

$A[X(i)] := [X(i)]^{\theta}$, with $0 < \theta < 1$. By analogy, $A^*(i) = [X^*(i)]^{\theta}$. Note that these scale economies, while *external to the firm*, do not extend beyond country borders. They are *national* in scope.

The external nature of scale economies in production tasks has two implications. First, it is consistent with the assumption of perfect competition in an institutional environment where individual tasks are performed at arms length through market transactions. Secondly, if we allow for task trade (offshoring), the equilibrium location of tasks depends on firms' beliefs about what other firms will do. From existing literature on external economies of scale, one would expect multiple equilibria; see Ethier (1982b). This is true here as well. However, as shown by Grossman & Rossi-Hansberg (2010), if any one firm has the option of performing tasks for other firms at arms length (outsourcing), then the scope for multiple equilibria is significantly reduced. We shall return to this below.

We define $\tilde{c}(w)$ as the unit cost function for a final-good that arises for a firm headquartered in the home country, if trade is possible only for *final goods*, meaning that the entire continuum of all tasks for all domestic firms (and only domestic firms) are performed domestically. Analogously for $\tilde{c}^*(w^*)$. We have

$$\tilde{c}(w) = \int_0^1 w \frac{z(i)}{A[z(i)nx]} \mathrm{d}i \quad \text{and} \quad \tilde{c}^*(w^*) = \int_0^1 w^* \frac{z(i)}{A[z(i)n^*x^*]} \mathrm{d}i \tag{4}$$

Notice that the entire amount of task i performance in the domestic economy is $X(i) = z(i)nx$. Given our specification of $A[X(i)]$, the amount of production work on task i that is required per unit of the final good is equal to $[z(i)]^{1-\theta} \Big/ (nx)^{\theta}$. We now assume that $z(i)$ is uniform across the entire range of i, such that $[z(i)]^{1-\theta} = z$. Moreover, we assume that the entire amount of all tasks required per unit of the final good is of measure 1, meaning $\int_0^1 z \mathrm{d}i = 1$. This leads to

$$\tilde{c}(w) = w/A(nx) \quad \text{and} \quad \tilde{c}^*(w^*) = w^*/A(n^*x^*) \tag{5}$$

Given these assumptions, $w/A(nx)$ and $w^*/A(n^*x^*)$ may also be interpreted as the cost of performing a unit of any task, respectively, in the domestic and the foreign economy.

If trade is possible also for *production tasks*, then the minimum marginal cost in each of the two countries depends on both wages, w and w^*, since each country potentially has some of these tasks performed abroad. Instead of equations (4), we then have relatively complex expressions involving endogenous subranges of the task continuum that represent central or decentralized task performance. More details will follow below.

Trade in final goods implies that $c = \tilde{c}(w) = w/A(xn)$ and $c^* = \tilde{c}^*(w^*) =$

$w^*/A(x^*n^*)$. Commodity market clearing according to (3) thus requires

$$\frac{x^*}{x} = \left[\frac{w^*/A(x^*n^*)}{w/A(xn)}\right]^{-\sigma} \tag{6}$$

Moreover, managerial wages satisfy

$$s = \frac{w}{A(nx)}\frac{x}{\sigma-1}\Big/ f \quad \text{and} \quad s^* = \frac{w^*}{A(n^*x^*)}\frac{x^*}{\sigma-1}\Big/ f \tag{7}$$

Labor market equilibrium for production workers requires

$$L = \frac{nx}{A[X(i)]} = (nx)^{1-\theta} \tag{8}$$

$$\text{and} \quad L^* = \frac{n^*x^*}{A[X^*(i)]} = (n^*x^*)^{1-\theta} \tag{9}$$

whereby the second equality in each line follows from the above assumption of externally increasing returns to scale.[19] Replacing $n = H/f$ and $n^* = H^*/f$ from equilibrium conditions (1) for the managerial labor market, we thus have 5 equilibrium conditions to determine the equilibrium levels of four wage rates $\{w, w^*, s, s^*\}$ and the two output levels $\{x, x^*\}$.

Choosing the foreign wage rate as our numéraire, $w^* = 1$, we have $s^* = [x^*/A(x^*n^*)]\, f^*/(\sigma - 1)$, and replacing x from the above labor market clearing conditions (1) and (8), we obtain the foreign managerial wage as

$$s^* = \frac{L^*}{H^*(\sigma-1)} \tag{10}$$

Given $w^* = 1$, the domestic wage is governed by commodity market clearing (6), which leads to $w = (x/x^*)^{-1/\sigma}(xn)^{\theta}(x^*n^*)^{-\theta} = (x/x^*)^{\theta-1/\sigma}(n/n^*)^{\theta}$. Taking into account equilibrium in the two labor markets for production workers, $x/x^* = (L/L^*)^{1/(1-\theta)}(n^*/n)$, and using $n^*/n = H^*/H$, we arrive at

$$w = \left(\frac{H}{H^*}\right)^{1/\sigma}\left(\frac{L}{L^*}\right)^{(\theta\sigma-1)/[(1-\theta)\sigma]} \tag{11}$$

Substituting back into (10) gives $s = w(nx)^{1-\theta}/H(\sigma-1)$, and we thus obtain

$$s = \frac{H^{*-1/\sigma}H^{1/\sigma-1}L^{*-(\theta\sigma-1)/[(1-\theta)\sigma]}L^{(\sigma-1)/[(1-\theta)\sigma]}}{\sigma-1} \tag{12}$$

[19] It is perhaps worth pointing out that these scale economies to not translate into scale economies on the final goods level. Final goods producers do not act under the belief that increasing their output lowers marginal cost on account of a larger task performance. They take marginal cost c and c^* as given parametrically.

We are now in a position to explore the comparative statics of wages.

Pure size effects: In the sequel, we shall refer to the ratio s/w or s^*/w^* as the *managerial wage premium*. Remember that the two types of labor are in different positions regarding economies of scale. The scale effect from the fixed managerial input is internal to the firms producing final goods, while the scale economies in production tasks are external to the firms specializing on certain tasks. This fundamental asymmetry notwithstanding, the benefit from a balanced increase in a country's labor force trickles down in equal proportions to both types of labor. The managerial and the production wage increase equiproportionally. For the foreign economy, this is obvious from (10), for the home economy it is best seen from equations (11) and (12) by letting relative changes $\hat{H} := \mathrm{d}H/H = \hat{L} := \mathrm{d}L/L$:

$$\left.\frac{\hat{w}}{\hat{H}}\right|_{\hat{L}=\hat{H}} = \left.\frac{\hat{s}}{\hat{H}}\right|_{\hat{L}=\hat{H}} = \frac{\theta(\sigma-1)}{(1-\theta)\,\sigma} > 0 \tag{13}$$

Perhaps surprisingly, the managerial wage premium is independent of country size and depends only on relative endowments.

Unbalanced growth - more managers: The wage effects of unbalanced growth of the labor force are less straightforward. Intuitively, other things equal, a larger size of the production work force might be considered a good thing for the individual worker, since there are external scale economies in the use of production work. At the same time, we would not expect that managers should benefit from a larger size of the managerial work force, since the economies of scale involved in managerial input are internal to the firm or manager. We first look at managers. Given that we have normalized the foreign production wage w^* to unity, it seems natural to explore the wage effects of a varying domestic managerial work force by setting $\hat{H} > 0$ and setting $\hat{L} = \hat{H} = \hat{L} = 0$. From (12) it is immediately clear that this depresses the domestic managerial wage rate, since we have $\sigma > 1$. For the same reason, it raises the home production wage w; see (11). The intuition is quite straightforward. More managers raise the number of domestic firms at the expense of lower firm output. However, with a constant production work force L, the amount of aggregate output xn must remain constant; see (9). The increased scarcity of each home variety, relative to foreign varieties, implies that each home firm charges a higher price and, thus, pays a higher wage to its production workers. The standard results prevail: A larger endowment with managers has a negative own-effect and a positive cross-effect on wages.

Unbalanced growth - more workers: Things look different for a variation in the production work force. Holding all other endowments constant, an enhanced supply

of domestic production workers L has an ambiguous effect on the domestic production wage w. From (11), the relevant elasticity is equal to $(\theta\sigma - 1)/[(1-\theta)\sigma]$, which is positive if and only if $\theta > 1/\sigma$. This is intuitive. The degree of scale economies needs to surpass a critical level, which is in turn the higher, the lower the degree of substitutability between different varieties of the final good. A lower σ gives rise to more market power for final goods producers, resulting in higher final goods prices. This implies that domestic producers, who now produce a higher aggregate output and need to sell more in both markets, reduce their prices by a greater extent than with a higher σ. Other things equal, this works against reaping the external economies of scale in the use of production labor. On the other hand, an increase in L unambiguously benefits home managers. This is witnessed by the term $(\sigma - 1)/[(1-\theta)\sigma]$, which is positive. The cross effect on managerial wages unambiguously increases in both θ and σ, for the reasons just mentioned. Hence, managerial labor participates in the external scale economies present in production labor. The standard complementarity relationship is upheld in this model of double economies of scale.

Cross-country effects: Remember that we have normalized the domestic wage for production workers to unity, $w^* = 1$. Given this normalization, we see from (11) and (12) that a balanced increase in the size of the foreign labor force works against home wages. Both, the domestic managerial and production wage must fall. In contrast, an unbalanced increase in the foreign production work force has an ambiguous cross-country effect. It lowers both, the home managerial and production wage rate if and only if $\theta > 1/\sigma$. The intuition is as mentioned above. As regards the production wage rate, we observe the mirror image of what happens in the foreign economy. If foreign production workers lose, then home production labor gains, and vice versa. On the other hand, home managers always lose from a higher foreign pool of production workers, while it always works to the benefit of foreign managers.

All of these *relative* wage effects may be interpreted as relative welfare effects for the respective group of workers, provided that trade in final goods is free and costless, as assumed. Consumers in both countries then pay identical prices for final goods, and they also face the same degree of variety. However, one needs to be cautious when considering *real* wage effects. Two additional channels need to be taken into account for real wages. The first is a change in variety that follows from any change a country's endowment with managers; see the managerial labor market equilibrium condition (1) above. With "love for variety", such changes are of direct relevance for real wages. The second channel runs through final goods prices, which are related to marginal cost through a constant markup. From (2), marginal costs in the domestic and the foreign economy are related to endowment changes according to

$$\widehat{\tilde{c}} = \hat{w} - \theta\hat{L}/(1-\theta) \quad \text{and} \quad \widehat{\tilde{c}}^* = -\theta\hat{L}^*/(1-\theta) \tag{14}$$

Based on these considerations, it is relatively straightforward to extend the above analysis to real wages. We leave this to the reader.

4 Extension: trade in production tasks

Remember that $w/A(nx)$ and $w^*/A(n^*x^*)$ is the cost of performing a unit-level of any task, respectively, in the domestic and the foreign economy. If a task is concentrated for the entire world in the domestic economy, the cost is equal to $w/A(nx + n^*x^*)$, if it is concentrated in the foreign economy, then the cost is equal to $w^*/A(nx + n^*x^*)$. However, if a certain task is performed in a different country from where a firm's headquarter is located, then the amount of this task required per unit of the final good is $\beta t(i)z$ instead of z. Moreover, we assume that the additional labor required from offshoring is labor from the country where the task is located, not where the headquarter is located. This formulation is completely analogous to the familiar "iceberg cost" of transport. Naturally, we have $\beta t(i) \geq 1$, and we order tasks according to the ease with which they can be dislocated, whence $t'(i) > 0$. Moreover, we normalize $\beta t(0) = 1$.

Intra-firm task trade: We first look at cases where all task trade takes place within a firm's boundary. This means that a final goods producer does not consider performing tasks for other final goods producers, or outsourcing a certain task to be done by another firm. Moreover, we first look at equilibria where a location decision by any one firm is matched by the same decision of all other firms headquartered in the same country. Outsourcing and deviant behavior across firms will be considered below.

As a first step we address the border line between tasks that may be concentrated in either the domestic or the foreign economy. Obviously, it is tasks with low i-values that are prime candidates for concentration in one of the two countries. Thus, if

$$\beta t(i) < \frac{w^*/A(n^*x^*)}{w/A(nx + n^*x^*)} \tag{15}$$

then task i is a candidate for concentrated performance in the domestic economy. Foreign firms would find no incentive to relocate this task back to their headquarters. Given the numbers of firms and output levels, as well as the wage rates in either country, the condition

$$\beta t(I) = [w^*/A(n^*x^*)] \,/\, [w/A(nx + n^*x^*)] \tag{16}$$

implicitly determines a cut-off-value I, separating tasks $i < I$ that *may* in equilibrium be concentrated in the domestic economy from those that may either be concentrated in the foreign economy, or else not be concentrated in any country, but performed where

the respective firm's headquarter is located. A corresponding condition identifies tasks $i < I^*$ that *may* be concentrated in the foreign economy:

$$\beta t(I^*) = [w/A(nx)] \,/\, [w^*/A(nx + n^*x^*)] \tag{17}$$

Obviously, if the two countries are completely symmetric, then $I = I^*$. However, countries may be asymmetric either in absolute size, or in their relative endowments. Intuitively, a larger country should have a larger range of tasks that it may end up performing for the entire world. On the other hand, a higher endowment with managers relative to simple labor has an ambiguous effect. Other things equal, it does increase the number of firms headquartered there, which contributes to its size advantage. However, it also tends to increase the equilibrium wage paid to simple labor, which reduces its cost competitiveness.

The pattern of task specialization supported by this type of *coordinated* location decision is ambiguous. For tasks $i < \min(I, I^*)$ equilibrium requires concentration of a task in either the domestic or the foreign country. Tasks $i > \max(I, I^*)$ will be located at the respective firms' headquarter location. If $I^* < I$, then tasks indexed $i \in [I, I^*]$ will be concentrated domestically, and conversely for $i \in [I^*, I]$ if $I < I^*$.

Outsourcing and deviant behavior: Grossman & Rossi-Hansberg (2010) show that this indeterminacy of equilibrium task location is reduced, if one allows for single firms to perform tasks for others. When considering where to locate a certain task, a firm may then invest in the capacity of becoming an attractive outsourcing partner for other firms. Whereas in the equilibrium considered above tasks are never traded across firms, although potentially located offshore, we now have tasks being contracted out to independent suppliers. This raises two issues. First, since firms produce different varieties, tasks may be specific to varieties and, thus, relationship-specific. As emphasized by Antràs (2003) and Antràs & Helpman (2004), this may generate a holdup problem, if complete and enforceable contracts cannot be written. For the sake of simplicity, we rule this out.

The second issue relates to pricing. If a firm expects other firms to make similar location decisions regarding the capacity to perform certain tasks, then a reasonable assumption is that they charge prices equal to costs of serving other firms, inclusive of the cost for offshore provision of tasks. However, a firm may also consider a single, isolated deviation from a common location decision. For instance, if a common decision to locate capacity for some task i in the domestic economy is an equilibrium in the sense described above, a firm may consider the profit potential of an isolated deviation strategy, setting up task-i capacity in the foreign economy and trying to attract all demand for this task through outsourcing relationships. Such a deviant firm is then

assumed to set different prices to different buyers, depending on whether the buyer's own capacity of task performance is offshore, or sited at its headquarter location. By construction of the argument, they all have their own capacity of task provision in the same location. But for some of them, that will be an offshore location, which allows the deviant firm to charge them a higher price. We follow Grossman & Rossi-Hansberg (2010) in assuming that a potential deviant charges task-prices just an ε below the respective buyer's cost of in-house provision, given the buyer's own task location. This price discrimination is possible, because tasks are specific to the final goods.

Allowing for such outsourcing relationships, we may reinterpret the condition (16) above as separating tasks $i < I$, where a common decision to place task performance in the domestic economy is immune to what Grossman & Rossi-Hansberg call *local deviation*, from the rest where domestic task concentration is subject to a deviation threat. By local deviation we mean a foreign firm deviating from this common choice of location by placing its task capacity in the foreign economy, hoping to make a profit through serving foreign firms from a foreign base, thus saving on offshoring cost. It would have a per unit cost equal to $w^*/A(n^*x^*)$, thus forgoing global scale, but would be able to charge a price just below $w\beta t(i)/A(nx + n^*x^*)$, which is what foreign firms have to pay when procuring task i from offshore (i.e., the domestic economy). A similar reinterpretation for a world with outsourcing relationships obtains for I^* as defined in (17) above. The above ranges of task concentration receive further substantiation through allowing for contractual outsourcing.

But deviation may take a second form, where the deviant firm tries to attract task demand from the entire world. Grossman & Rossi-Hansberg (2010) call this *global deviation*. Suppose, again, that all firms have to locate their capacity of performing a certain task $i < \min(I^*, I)$ in the domestic economy. With intra-firm task offshoring, domestic firms would then obtain these tasks for a "price" equal to $w/A(nx + n^*x^*)$, while foreign firms have bear the dislocation cost $\beta t(i)$ and, thus, pay a "price" equal to $\beta t(i)w/A(nx + n^*x^*)$. New consider a deviant firm setting up task-i capacity in the foreign economy and trying to make a profit by selling this task for just an ε below these prices to the two types of firms. It seems natural to consider such a deviation. If successful in attracting the entire world demand for this task, the deviant would have costs equal to $w^*/A(nx + n^*x^*)$ and would have the advantage of being able to sell to foreign firms at a price $\beta t(i)w/A(nx+n^*x^*)-\varepsilon$, and to domestic firms at a price equal to $w/A(nx+n^*x^*)-\varepsilon$. Obviously, whether this generates a positive profit depends on the difference in the wage gap $w^* - w$ and on the size of the two countries, measured through nx and n^*x^*. In turn, the wage gap will depend on both, country size and relative endowments. We first look at the case where relative endowments are the same in both countries. The case of endowment asymmetry will be dealt with below.

Given the aforementioned price discrimination, a deviant firm's total revenues from

selling task i is equal to $w\left[nx+\beta t(i)n^*x^*\right]/A(nx+n^*x^*)$.[20] The deviant firm's own aggregate cost in the outsourcing case (inclusive of the offshoring cost) would be equal to $w^*\left[n^*x^*+\beta t(i)nx\right]/A(nx+n^*x^*)$. Hence, the profit from a deviation strategy, relative to a concentration of any task $i<\min(I^*,I)$ in the domestic economy, emerges as

$$\pi_d(i):=\frac{w\left[nx+\beta t(i)n^*x^*\right]-w^*\left[n^*x^*+\beta t(i)nx\right]}{A(nx+n^*x^*)} \tag{18}$$

If this profit from deviation is negative, then a concentrated location of task i in the domestic economy is the only equilibrium. If $\pi_d(i)>0$, then a deviation strategy would ultimately lead to an equilibrium where all firms locate task i in the foreign economy and where no contractual outsourcing actually takes place.

We may now define a task J that yields a zero profit for the deviant firm, which means $\pi_d(J)=0$. This condition can be written as

$$\beta t(J)\left(wn^*x^*-w^*nx\right) = w^*n^*x^*-wnx \tag{19}$$

$$\text{or}\quad \beta t(J) = \frac{w^*n^*x^*-wnx}{wn^*x^*-w^*nx} \tag{20}$$

Suppose there is a solution to (20) with $J\in\,]0,1[$. Suppose, moreover, that $J<\min(I,I^*)$. This cut-off value separates tasks with positive deviation profits from those with negative deviation profits. Then, the right-hand side of (20) must have equal signs for the denominator and the numerator. If it is negative, essentially meaning that the domestic economy larger than the foreign economy, then it must be true that $\pi_d(i)>0$ for $i<J$, and conversely for $i>J$. In the opposite case of a relatively domestic economy, the deviant's profit is positive for $i>J$ and negative for $i<J$.

Let us look at the first of these cases where the domestic economy is relatively large. Obviously, for tasks $i>J$ and $i<\min(I,I^*)$, meeting world-wide demand for the task from concentrating all capacity in the domestic economy is immune to global deviation cum outsourcing. The same is not true for tasks $i<J$. But let us assume that firms can relocate their own production capacity at no cost. Then any attempt by the deviant with a foreign production base to charge foreign firms a price above here own task cost $w^*/A(nx+n^*x^*)$ would be futile, since these firms would then be prompted to relocate to a foreign production base. The important point to bear in mind here is that these firms would fully benefit from size advantage, if that advantage is external to the firm as assumed. Consequently, the deviant's positive profit would then rely in charging domestic firms a price above $\beta t(i)w^*/A(nx+n^*x^*)$. But again, such an attempt would be frustrated by domestic firms shifting their production base for task i to the smaller foreign economy.

Hence, global deviation from coordinated concentration of tasks $i<J$ in the end

[20] To be pricese, revenues are an ε belos this magnitude.

does not lead to any outsourcing.[21] What it does, instead, is tie down the location of tasks $i < J$ to the smaller of the two countries, which in our argument is the foreign economy, and of tasks $i > J$ and $i < \min(I, I^*)$ in the domestic economy. It is relatively obvious that a perfectly analogous reasoning leads to concentration of all tasks $i > J$ and $i < \min(I, I^*)$ in the foreign economy, provided that it is the larger of the two economies. For tasks $i > \min(I, I^*)$, the equilibrium allocation of task capacity will be in the domestic economy, if $I^* < I$, and vice versa. And for tasks i above $\max(I, I^*)$, decentralized location of task performance is the only equilibrium outcome, as we have seen above.

The remaining question now is what happens if $J > \min(I, I^*)$. Suppose that $I < I^*$, effectively meaning that the home economy is relatively small. Then, by the above logic we have tasks $i > J$ and $i < I^*$ concentrated in the foreign economy, and all tasks $i < \min(I, I^*)$ - and thus $i < J$ - we have a safe concentration of tasks in the (smaller) domestic economy. But suppose, instead, that $I^* < I$.

Task trade with identical relative endowments: We are now able to fully describe the pattern of task trade between two countries that differ only in size. We have five different possibilities separated by whether $I > I^*$ or $I^* < I$ and by whether or not $J < \min(I, I^*)$. In all of these cases, tasks with low offshoring costs are concentrated in the low-wage country which is also the smaller of the two countries. Tasks with intermediate offshoring costs are concentrated in the larger country high-wage country. And tasks at the upper end of the scale of offshoring costs are performed in a decentralized way, with each firm locating its task capacity in its headquarter country.

However note that each of these sets of tasks might be empty. Grossman & Rossi-Hansberg (2010) show that in this case wages and aggregate output always go hand in hand. In other words, the high-wage country will always have a higher aggregate output than the low-wage country. Intuitively for most parameter values the country that is endowed with a higher amount of both factors of production will obtain a higher aggregate output. However note that with low offshoring costs and the two countries being sufficiently equal three equilibria are possible, the second equilibrium having the country that is endowed with *less* of both production factors achieving a *higher* aggregate output and therefore a *higher* wage for production workers, while in the third equilibrium both countries have an equal aggregate output, equal wage and the offshoring structure cannot be determined.

Task trade with different relative endowments: In the asymmetric case we assume that both countries are of equal size. Size in this context has to be measured

[21] More precisely, final goods producers are indifferent between in-house procurement of tasks and outsourcing, but the location of task capacity is unambiguous.

by the amount of task i performance for domestic and foreign firms respectively, which is equivalent to aggregate output. This can be written as $nx = n^*x^*$. We do this to isolate the effect of relative endowment differences and changes thereof on the offshoring equilibrium. As a side effect, this assumption improves the analytic tractability of our result. Proceeding as above and assuming an equilibrium with $w \neq w^*$ we obtain the only possible ordering of the marginal tasks, that has tasks with low offshoring costs concentrated in the low-wage country while tasks with high offshoring costs are performed dispersedly in both countries. In analogy to Grossman & Rossi-Hansberg (2010) it is now possible to prove that relative factor endowments and production workers' wages always go hand in hand. The country with a higher relative endowment with managers always has a higher wage for its production workers. We state this result in the following proposition1

Proposition 1. *In two countries of identical size* $nx = n^*x^*$, $w \geq w^*$ *if and only if* $\frac{H}{L} > \frac{H^*}{L^*}$

A proof is offered in a separate appendix, available upon request. The intuition is as follows. In this model tasks that might be performed offshore only require production labor to be accomplished. However, by assumption production workers are equally productive in both countries. With very low offshoring costs and wages "almost" equal the external economies of scale lead to a situation where, in principle, concentration of tasks in both countries is possible. But as we know that in the domestic economy production labor is relatively scarce, the equalization of production workers' wages is only possible if there is at least one task concentrated in the foreign country. In addition, we know that with unequal wages the marginal tasks I, I^*, and J are always in an order such that only offshoring is possible only in one direction. This, in turn, implies offshoring from the high-wage-country towards the low-wage country. Summarizing this intuition, we can conlude that, with $\frac{H}{L} > \frac{H^*}{L^*}$ and $w \neq w^*$, it must be true that $w > w^*$.

However we cannot rule out a possible equilibrium with $w = w^*$, which implies $I = I^*$ and equal aggregate production cost in both countries. This means that offshoring in both directions might take place and no structure is imposed on the sets of tasks that are concentrated in the two countries. In such a case we only know that the set concentrated in the foreign country must be larger than the set of tasks domestically concentrated, but we cannot determine the exact offshoring pattern.

5 Simulation Results

In the following we illustrate some results obtained by a numerical simulation of the model. There are two reasons to use simulation methods in this context. First, as GR (2009) point out, the equilibrium parameter values depend on integrals over the

set of tasks concentrated in each economy or performed in both countries. But these sets themselves are functions of the parameters in question. Furthermore the external nature of the economies of scale might give rise to multiple equilibria. This implies only little scope for analytical tractability. An additional benefit of the numerical simulation is that it allows us to present non-monotonic outcomes of offshoring pattern and factor payments.

We choose parameter values such as to ensure comparability with GR (2009). Offshoring cost is linear with $t(i) = i + 1$ and the external scale economy takes the form $[X(i)]^{\theta}$ with $\theta = 0.8$, while $f = 1$ and $\sigma = 2$. GR (2009) demostrate that the choice of $\sigma = 2$ implies for the symmetric case offshoring in both directions whenever there is offshoring. As we show in section 3 this choice has the additional advantage of yielding equal remuneration for managers and workers in the symmetric case whenever there is no offshoring.

We analyze inequality in two dimensions: Inequality *between* countries measured by the average wage and inequality *within* countries measured by the managerial wage premium. For each of these dimensions we differentiate between two cases: First we have a look at a symmetric case (North-North Offshoring). Following GR (2009) it is characterized by a proportional endowment of both countries with both factors $H/L = H^*/L^* = 0.5$ and a constant world endowment $H + H^* = 2$ and $L + L^* = 2$. We look at cases where the domestic economy is endowed with more of both types of labor $H = L > H^* = L^*$ Second we analyze the asymmetric case (North-South Offshoring), in which the domestic economy is assumed to be relatively more endowed with managers $H/L > H^*/L^*$. Focusing on the relative endowment effect and shutting down the country size channel is done by assuming $nx = n^*x^*$.

5.1 Cross-country Inequality

The relative average wage that we use to measure the effect on the inequality between the two countries is given by

$$\frac{s\theta_H + w\theta_L}{s^*\theta_H + \theta_L} \tag{21}$$

since $w^* = 1$ is the numeraire and where θ_H and θ_L is the share of high- and low-skilled workers in the economy. For the symmetric case with $H/L = H^*/L^* = 0.5$ this simplifies to

$$\frac{s + w}{s^* + 1} \tag{22}$$

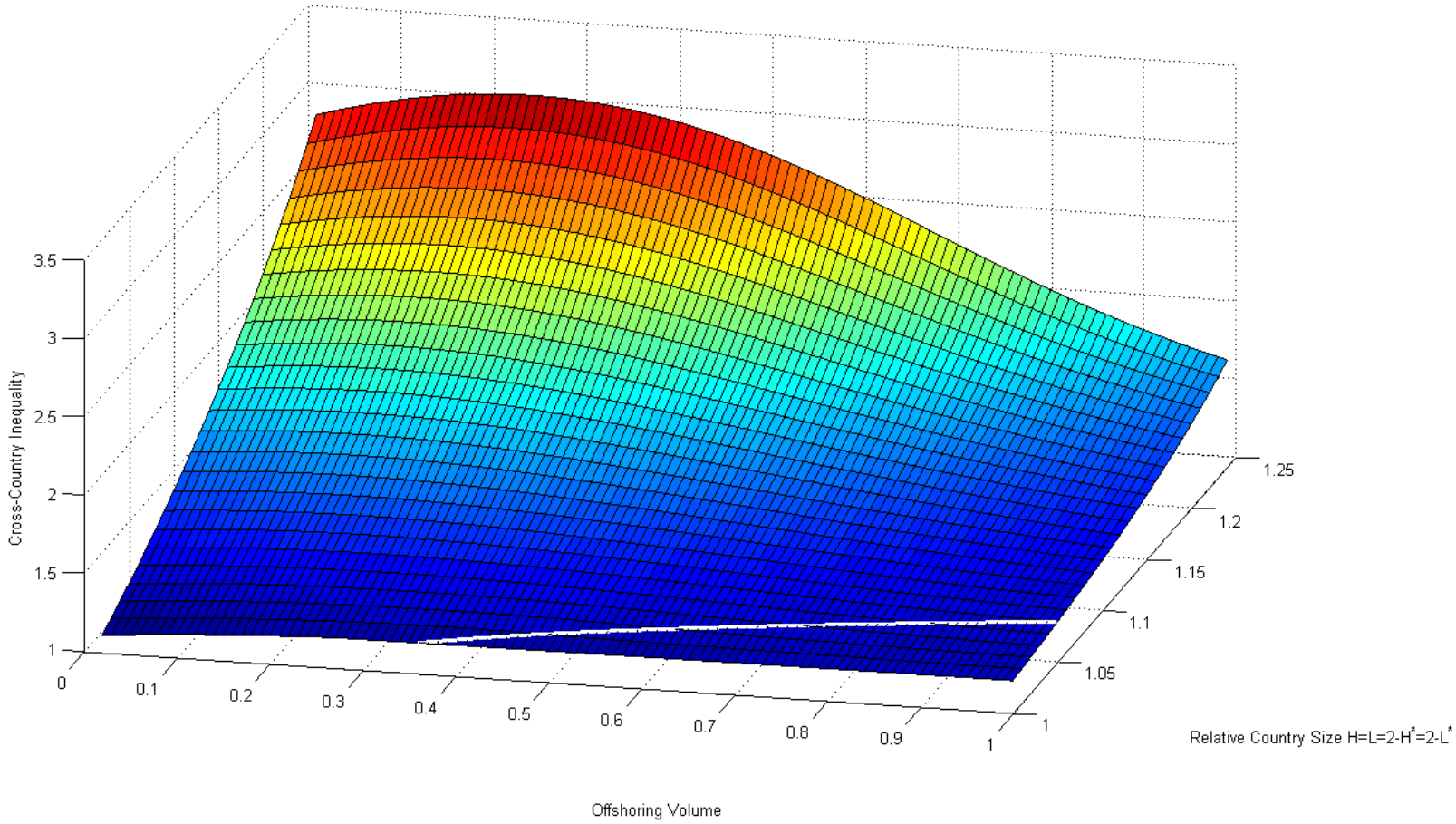

Figure 1. Symmetric Case: Cross-country inequality
Independent Variables: $H = L = 2 - H^* = 2 - L^*$ and $VOL = \mathcal{D} + \mathcal{F}$
$\sigma = 2$, $\theta = 0.8$, $f = 1$

First we turn to the results of the symmetric case. Figure 1 shows the domestic average wage relative to the foreign one. It clearly indicates that in the absence of relative endowment differences the economies of scale work to the benefit of both types of labor in the large country. Not only the average wage of domestic labor is higher than the wage of their foreign counterpart, but the same result holds for managerial and production workers seperately.

Another general insight is that for very similar countries, offshoring has only a negligible effect on the relative average wage. For example with $H = L = 1.01$ a jump from zero offshoring to complete specialization in tasks increases the gap in the average wage from 1.05 to 1.14. For more differing countries, however, the average wage gap is highest for medium levels of offshoring. This means that very high and very low levels of offshoring work to the benefit of the smaller (poorer) country. With an endowment of $H = L = 1.1$ and offshoring autarky the wage gap is 1.5. Opening up to offshoring it reaches its maximum of 1.55 at an offshoring volume of 0.2 and subsequently declines until it reaches 1.24 at the point of complete specialization in tasks.

The intuition for this non-monotonicity is that with low levels of offshoring, the domestic country benefits more from the first tasks moved to the respective other country, since tasks with low offshoring costs are concentrated in the small country while tasks with higher offshoring costs are concentrated in the large country, so that the large country has to spend less on transport costs. This effect is further strenghtened since it is obvious that even though offshoring in both directions occurs, a higher share of tasks is concentrated in the large country than in the small country. This means that production workers' productivity in the large country rises more than in the small country due to the scale effect. If there already is a substantial amount of infra-marginal tasks, however, a further decrease in the offshoring costs that induces a higher level of offshoring brings higher benefits to the small country since their producers save on transport costs for the high share of tasks already concentrated in the large, whereas this savings for domestic producers are smaller.

Besides it can be shown that in an equilibrium without offshoring, the relative average wage is identical to the inverse of the relative production cost for the varieties of the two countries. As the offshoring volume increases this relationship break down since more and more foreign production workers are employed in the manufacturing of the domestic good and vice versa.

There is only a small caveat: As mentioned above, imagine both countries to be of relative similar size and globalization having gone very far—meaning a high volume of offshoring and. This case, which corresponds to parameter values in the south of the white line, implies the possibility of multiple equilibria and the larger country may end up producing less aggregate output and having a lower average wage. We restrict, however, the figures to only depict the equilibrium where the larger country produces

a higher aggregate output and has higher wages.

Now let us move on to the asymmetric case where the domestic country is relatively manager-abundant while the foreign country is abundantly endowed with production workers. First it can be seen that in this specification opening up to offshoring gives rise to an opposite pattern. Here offshoring only takes place in one direction. When the first tasks are concentrated in the production-worker-abundant country it are the workers there who can raise their productivity and wage. When more offshoring is induced by a fall in offshoring costs this pattern changes. Decreasing offshoring costs for the infra-marginal tasks only work to the benefit of the manager-abundant country, so that with more and more specialization it can achieve an ever higher average wage.

Another insight is that the backlog from which the manager-abundant country starts is larger the more extrem the relative distribution of factors is. This is due to the fact that the income distribution *within* this country changes more rapidly to the factor that becomes increasingly scarce than the income distribution *within* the production-labor-abundant country does.

In this model again there is a caveat. For very similar countries and high levels of offshoring domestic production workers, although being the scarce production factor, can even end up with an identical wage as their foreign counterparts, which implies $I = I^*$. In such an equilibrium, offshoring of *some* tasks from the domestic to the foreign economy equalizes wages in both countries. However, the set of tasks that yields equal wages when performed offshore in the foreign country might be smaller than the set of tasks for which offshoring is feasible as implied by I and I^*. If this is the case then for all tasks i with $C < i \leq I = I^*$ there is nothing to determine the location of production, we only know that there exists a non-empty set of tasks concentrated in the foreign economy and that this set is larger than the set of tasks concentrated in the domestic economy. Since this indeterminacy influences wages and salaries due to the differing offshoring costs we do not report results for the parameter values for which this indeterminacy arises.

5.2 Within-country inequality

In this section we do not look at an aggregate of the two factor remunerations but on their ratio. We call this ratio the managerial wage premium. We report results for the domestic economy, that is the large country in the symmetric case and the manager-abundant country in the asymmetric case. Again, first we have a look at the symmetric case.

From a rapid glance at figure 3 we already learn two things. Generally it seems that a more diverse distribution of labor between the two countries works to the advantage

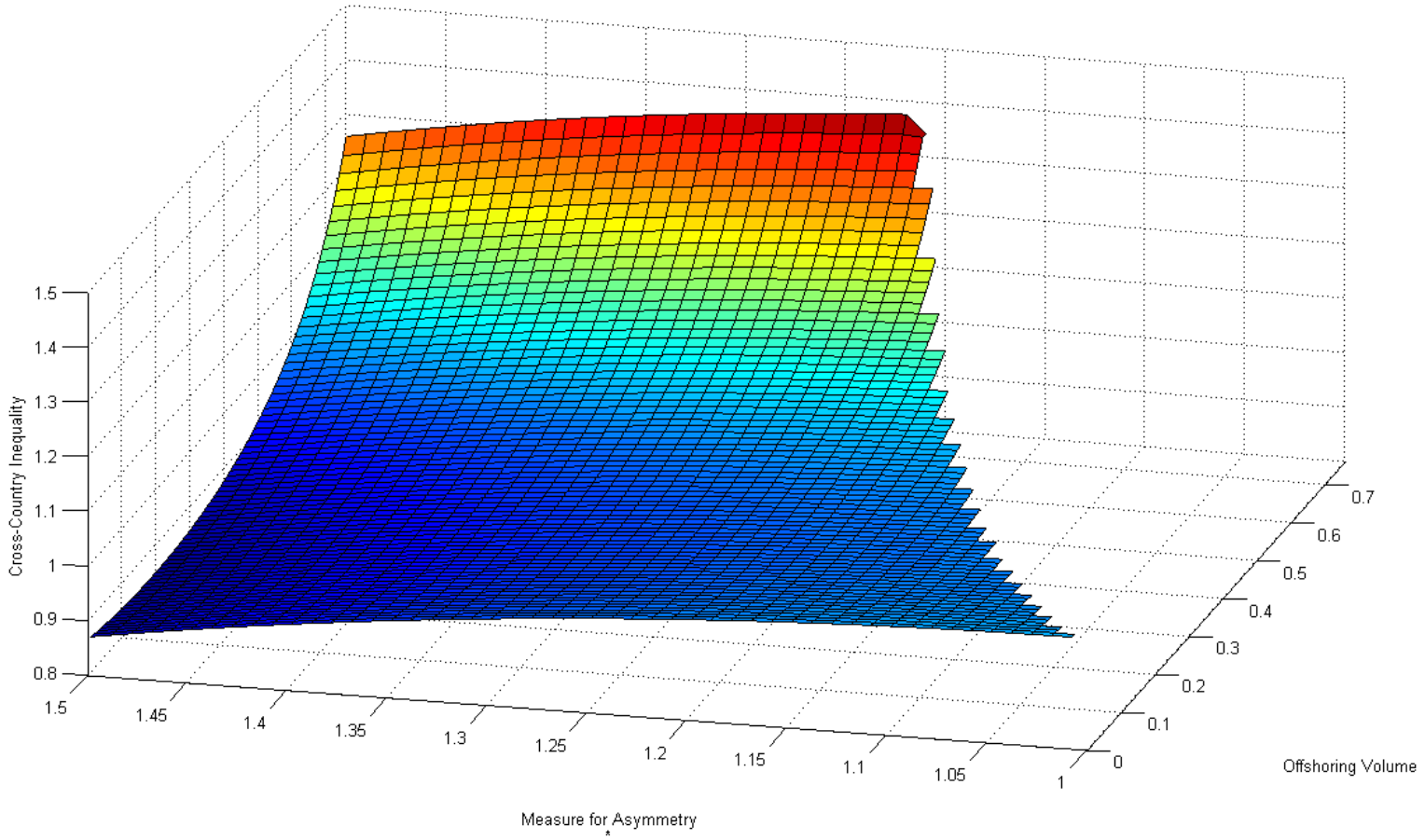

Figure 2. Asymmetric Case: Cross-country inequality
Independent Variables: $H = 2 - L = 2 - H^*$ and $VOL = \mathcal{D} + \mathcal{F}$
$\sigma = 2$, $\theta = 0.8$, $f = 1$

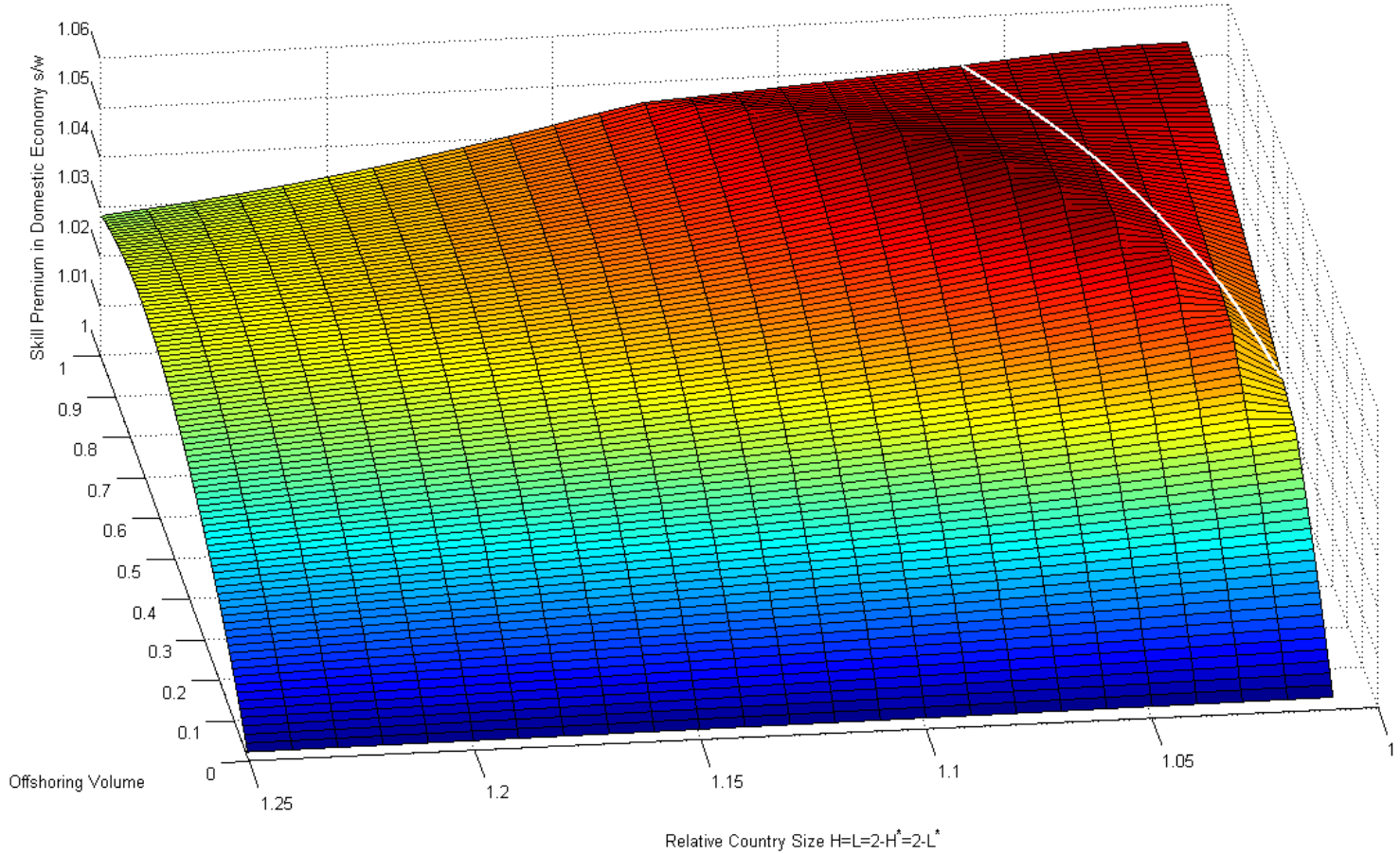

Figure 3. Symmetric Case: Within-country inequality
Independent Variables: $H = L = 2 - H^* = 2 - L^*$ and $VOL = \mathcal{D} + \mathcal{F}$
$\sigma = 2$, $\theta = 0.8$, $f = 1$

of production workers whereas this effect is negligible for very little offshoring. This is due to the fact that keeping the overall offshoring volume constant for a more diverse distribution implies that less tasks are concentrated in the small country whereas more tasks are concentrated in the large (domestic) country. This means that in the domestic economy more workers now perform concentrated high-productivity tasks which means that their wage rises. Intuitively, the higher the offshoring volume, the stronger this productivity increase due to concentration and the stronger this wage effect.

Second we see that globalization—that means higher levels of offshoring— works to the advantage of managers. This effect is smaller for highly unequal endowments. This is because higher levels of offshoring imply a higher productivity and a higher output for each fixed manager input. Workers' wages rise due to the increased productivity in tasks concentrated *domestically*. However, managers' salaries move proportionally with output, which is a function of the *total* volume of offshoring and therefore rises even faster and leads to an increase in the managerial wage premium. Clearly, if the domestic country is larger, a larger share of total offshoring is concentrated in the domestic economy so that workers benefit almost as much as managers and the increase in the managerial wage premium is less eminent.

A closer look reveals that the highest managerial wage premium does result with complete specialization only for intermedium values of relative size at about $H = L = 1.15$. For more unequal countries the maximum manager premium occurs with an offshoring volume of about 0.75, while for more equal countries it heavily depends on the exact level of country size. We find it hard to come up with a convincing explanation for this pattern.

In figure 3 the parameter combinations for which a second equilibrium with higher wages in the small country might occur is indicated by a white line.

In the asymmetric case we can identify a similar pattern of the managerial wage premium in the manager-abundant country. Intuitively, at every level of offshoring, if managers become more numerous in an economy it has a negative on their salary. This is the standard result that we expect from Heckscher-Ohlin-Theory.

Additionally, an increase in the offshoring volume again has a positive effect on the managerial wage premium. Clearly, since offshoring only means concentration of tasks in the production-labor-abundant economy, domestic workers do not become more productive. However, domestic managers benefit from the increased productivity of their firms due to the offshoring possibility and receive higher wages. In contrary to the above case, the rising managerial wage premium due to globalization is then independent from the factor endowments.

Comparing the size of these two channel it is intuitive that offshoring in the asymmetric model has a larger effect than in the symmetric model. In the asymmetric

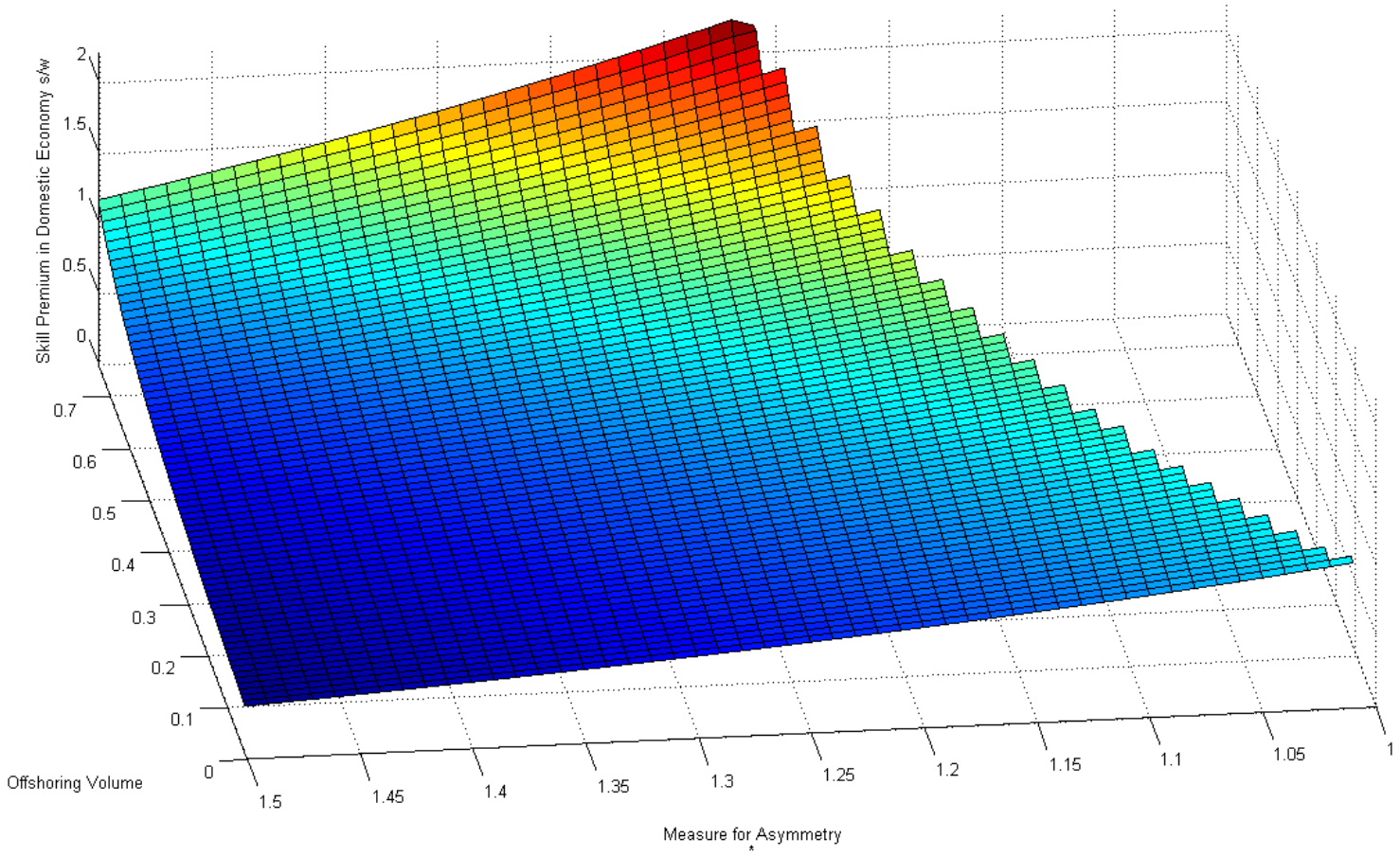

Figure 4. Asymmetric Case: Within-country inequality
Independent Variables: $H = 2 - L = 2 - H^*$ and $VOL = \mathcal{D} + \mathcal{F}$
$\sigma = 2$, $\theta = 0.8$, $f = 1$

case, moving from no offshoring to a substantial amount of offshoring while holding endowments fixed can increase the wage premium by a factor of around 2.5. In the symmetric model, where we look at offshoring between countries with an identical relative labor endowment, moving from no offshoring to a substantial amount of offshoring only increases the wage premium by a factor 1.05.

6 Conclusion

In this paper we analyze the impact of offshoring on between-country inequality and within-country inequality. The further we measure by the relative average wage of two countries, while the latter is measured by the wage premium. By wage premium we mean the relative wage of managers to production workers, where managerial labor is characterized by being a fixed production input while production labor is a variable input. Trade takes the form of offshoring and only production workers face the risk of their jobs being offshored, whereas a constant amount of managers is needed to work in the firm headquarters.

In recent literature there is a consensus that, other things equal, larger countries can pay higher real wages. This result is usually derived from models with monopolistic competition and increasing returns to scale à la Krugman (1980). On the other hand it is well known that relative scarcity of a production factor drives up the relative wage of this factor. This paper is an attempt to unite two strands of literature, combining the theory of increasing returns to scale with relative endowment effects to explore their interaction.

We draw upon recent work by Grossman & Rossi-Hansberg (2010) where trade in final varieties is costless but trade in tasks (offshoring) is costly and only affects production labor. Within their model framework we calculate wages and salaries and analyze how they are influenced by technological shocks that reduce the technological offshoring cost parameter. We compare factor remunerations between countries as well as within countries and find that a decrease in offshoring costs generally leads to a rising managerial wage premium. The scope of this increasing inequality within a country, however, depends crucially on the assumptions on factor endowments in the two countries. On the other hand we find that inequality between the two countries is reduced by globalization. Factors in a formerly small economy can now exploit increasing returns to scale by concentrating on a subset of tasks and formerly scarce factors face harder competition from abroad lowering their remuneration.

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