Offshoring Tasks, yet Creating Jobs?*

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Abstract

We show that in a Ricardo-Viner-type trade model with unemployment due to search and matching the productivity effect of offshoring emphasized by Grossman & Rossi-Hansberg (2008) emerges as a vehicle of job creation. Improvements in the technology of offshoring causes job losses at the extensive margin where ever more tasks are performed abroad, but it also causes job creation from cost-savings associated with enhanced trade in tasks. We identify conditions under which job creation dominates job destruction. We also show that employment may follow a non-monotonic pattern of adjustment to successive improvements in the technology of offshoring.

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1 Introduction

Economic globalization has reached unprecedented "levels of resolution". Due to advances in the technology of communication and transport, international division of labor affects ever finer slices of the value added chain. Grossman & Rossi-Hansberg (2008) speak of a new paradigm that they call trade in tasks, as opposed to trade in goods. Arguably, staunch believers in gains from trade should welcome the advent of this new form of trade. If trade is good, then more of it – through trade in tasks – is better.

This view is in marked contrast to the widespread anxiety that "high-resolution globalization" meets in the general public and with many policy makers. Typically, offshoring comes with an unbundling of production processes, whereby some workers face low-wage foreign competition on the level of single tasks within their firms, as opposed to competition on the level of finished goods which mainly takes place between firms, and which therefore affects different types of workers on a more equal footing. The common perception in advanced economies of such task-level arbitrage is that some workers may have to accept wage cuts in order to avoid losing their jobs. Indeed, in the aggregate it may even increase both, the degree of inequality and the level of unemployment. As a result, governments who run welfare-state policies will find their policy goals more difficult to achieve, as for instance argued in Keuschnigg & Ribi (2009).

Are higher wage inequality or unemployment inevitable consequences of more "high-resolution globalization"? On an empirical level, the contribution of offshoring to wage inequality and unemployment is very difficult to establish. Some authors point out that the job losses due to offshoring are minuscule, relative to the overall labor market turnover; see Bhagwati, Panagariya & Srinivasan (2004). Others, like Blinder (2006, 2009), point out that the big wave of offshoring is yet to come.[1] On a more general level, other things equal, more open economies do not consistently appear to face more unemployment; see Felbermayr, Pratt & Schmerer (2009). At the same time, however, we do have solid micro-level evidence that offshoring has caused job losses in some countries and periods in time.[2] If this does not show up in aggregate studies of globalization and unemployment, it may be for two reasons. The first is the notorious measurement problem: Offshoring is not a well defined statistical category recorded in trade and employment data. The

[1] See OECD (2007) as well as Bottini, Ernst and Luebker (2007) for a concise survey of empirical studies.

[2] See the NAPA (2006) report for the U.S. and the ERM (2007) report for the European Union.

second is somewhat more subtle. If globalization is mainly driven by lower costs of cross-border transactions, as often argued particularly in the context of offshoring, then economies that already do much of it would seem in a better position to reap benefits from getting even more. Formally, at the initial margin of autarchy, the very first step of globalization does not involve any first-order effect of cost-savings, while subsequent steps do. Conceivably, the relationship between *changes* in offshoring and *changes* in unemployment may for this reason be non-monotonic. If so, then empirical studies that do not control for this type of non-monotonicity will fail to detect the true relationship between globalization and unemployment.

Looking ahead, Blinder (2009) argues that offshoring in industrial countries like the US is likely to become a much "bigger deal" than many sanguine observers appear to expect, with fundamental consequences for domestic labor markets. He sees both, potentials for job creation and job destruction, but expects the adjustment to a broader scope for offshoring to be dominated by job destruction. And he anticipates a significant increase in the scope and magnitude of offshoring from vast future improvements in all sorts of technologies that are relevant for linking different types of tasks involved in manufacturing as well as services.

Surprisingly, despite a sizable body of empirical literature addressing the offshoring-employment nexus, theoretical analysis are relatively scarce. In recent papers, Mitra & Ranjan (2009a, 2009b) model the impact of offshoring on labor markets outcomes in a search and matching environment. The first of these papers seems particularly relevant in the present context. It highlights the potential for an economy wide net job creation through intersectoral reallocation of labor in response to offshoring that is restricted to one of two sectors. Davidson, Matusz and Shevchenko (2008) also adopt a search and matching environment, in order to model the impact of offshoring on low- and high-skilled wages. By way of contrast, Egger & Kreickemeier (2008) provide a theoretical treatment of offshoring in an environment where unemployment stems from a fair wage constraint.

In this paper, we provide a detailed theoretical analysis of the relationship between offshoring and unemployment, relying on the Grossman & Rossi-Hansberg (2008) paradigm of trade in tasks. Intuitively, we should expect cost-savings from offshoring to be reflected in the form of higher factor earnings or enhanced employment perspectives *somewhere* in the economy.[3] It would seem odd, however, to expect that such gains accrue to the type of

[3] Of course, the same does not hold true if offshoring is an integral part of adjustment to some other exogenous shock, say a change in final goods prices.

workers whose tasks have been moved offshore. Yet, this is precisely what happens in the model proposed by Grossman & Rossi-Hansberg (2008): Offshoring of tasks performed entirely by low-skilled labor entails a rise in the wage for domestic low-skilled workers. It does so, because the cost of low- and high-skilled labor are uniquely tied down in general equilibrium by zero-profit conditions, assuming that both types of labor are completely mobile across two industries that differ in the skill-intensity of production. The point is that cheaper offshoring lowers the cost of tasks already performed abroad, thus reducing the cost of low-skilled labor as a whole. With unchanged final goods prices, this needs to be fully offset by a rise in the domestic low-skilled wage rate. Grossman & Rossi-Hansberg (2008) have called this the *productivity effect* of offshoring. Of course, a completely analogous productivity effect obtains if offshoring takes place in tasks performed by high-skilled, instead of low-skilled labor.

But how does the economy absorb the loss in labor demand caused by offshoring? With all cost-savings fully absorbed by a rise in the low-skilled wage rate, the wage for high-skilled labor remains unchanged and firms face no incentive to change their input mix. At the same time, since a larger part of low-skilled labor tasks is now performed offshore, this implies lower demand for domestic low-skilled labor per unit of output in both industries. With perfect labor mobility across industries, factor market equilibrium is restored through a reallocation of both types of labor towards the less skill-intensive of the two industries. This is perfectly analogous to the Rybczynski-type reallocation that takes place when an economy absorbs increased endowment of low-skilled labor. For this reason, Grossman & Rossi-Hansberg call this the *supply effect* of offshoring. Again, a similar effect may arise for high-skilled labor.

However, ruling out any aggregate employment effect by assuming smooth Rybczynski-type reallocation seems questionable. In the short run, workers who lose some of their tasks to offshoring may be specific to the industry. The negative labor demand shock will then have to be absorbed within the industry. In such an environment offshoring surely seems like a much more serious threat to workers, more in line with the anxiety that we observe in the policy debate. Moreover, in the presence of labor market frictions, adjustment will most probably also hold the specter of higher unemployment among the workers affected by offshoring. In a similar vein, assuming that the entire benefit from cheaper foreign tasks accrues to workers who perform these same tasks domestically comes close to taking the entire distributional scorn out of offshoring. Surely, offshoring in the real world entails a much heavier dose of conflict of interest.

In this paper, we place the Grossman & Rossi-Hansberg (2008) paradigm of offshoring in a modeling setup that reflects these criticisms and is less benign. In particular, we allow for unemployment effects due to search and matching frictions in the market for low-skilled labor. Domestic low-skilled workers thus face the specter of competition from foreign low-skilled labor, as well as the threat of unemployment. Moreover, we assume that low-skilled workers are locked in the offshoring sector and cannot move to employment in other sectors. Production in this sector combines low-skilled labor with high-skilled labor to generate a composite labor input which then enters a concave production function, together with a fixed amount of sector-specific capital. Thus, our analysis is in the spirit of a short-run Ricardo-Viner trade model.

We use high- and low-skilled labor as convenient labels for a generic distinction between two types of labor that are, or are not, subject to i) the threat of offshoring and ii) unemployment caused by search and matching frictions on the labor market. As regards low-skilled labor, technology involves different tasks that are more or less impersonal in the sense of Blinder (2009). A task which is completely *im*personal need not be performed by workers in physical presence at the location of all other inputs, but may instead be performed abroad, with relatively little extra cost of linking the task with other tasks and other inputs into the firm's production. Tasks that are less impersonal in nature involve some extra cost. We model this notion of more or less impersonal tasks using an offshoring cost schedule for a continuum of tasks, as suggested by Grossman & Rossi-Hansberg (2008). The margin between tasks performed domestically and abroad is determined by a foreign labor cost advantage.

Contrary to a-priori intuition and wide-spread belief, it turns out that in such an economy enhanced offshoring of tasks need not destroy jobs. Indeed, offshoring of low-skilled tasks may even generate domestic jobs for low- skilled workers. The reason is that with trade in tasks employment of domestic low-skilled labor involves a twin margin of adjustment. At the *extensive margin*, jobs are lost if cheaper offshoring prompts firms to enhance the set of tasks performed abroad. This is the Grossman & Rossi-Hansberg (2008) supply (or endowment) effect. However, at the *intensive margin*, cheaper offshoring means lower cost of low-skilled labor as a whole, which prompts firms to expand employment for the entire set of low-skilled tasks, including the ones for which domestic procurement is still cheaper. In other words, the productivity effect of offshoring translates into higher demand for domestic low-skilled workers. With labor market frictions instead of smooth Rybczynski-type reallocation, offshoring of tasks may thus *reduce* domestic unemployment, provided that the expansionary intensive margin effect is sufficiently strong. In short, in labor markets characterized by search and matching the Grossman & Rossi-Hansberg (2008) productivity effect of offshoring emerges as a vehicle of *potential* net job-creation.

However, job-creation is not a foregone conclusion. It emerges only if the expansionary intensive margin effect is sufficiently strong. We derive sufficient conditions for a positive net job creation effect from an improvement of the technology of linking tasks across distance and borders. Two sets of conditions are emerging. There are "local conditions" relating to the margin that separates domestic from offshore performance of tasks. And secondly, there is what we call the "interval property" of an equilibrium which describes the position of this margin within the interval, as well as integral properties of the aforementioned offshoring cost schedule. We do not present any empirical analysis in this paper, but we emphasize that these conditions are amenable to empirical observation.

As a result of the twin-margin-adjustment, the outcome may be a non-monotonic relationship between movements at the extensive margin, where ever less impersonal tasks become subject to offshoring, and the employment level of domestic low-skilled labor. Starting out with zero offshoring, successive improvements of the offshoring technology will first harm low-skilled labor in terms of both, a wage cut and lower employment. For low levels of offshoring, the extensive margin of job losses dominates the adjustment. But once the economy has reached a critical level of offshoring, the intensive margin of job creation *may* dominate the extensive margin, so that offshoring becomes a vehicle of net job creation. We present numerical simulations that substantiate our theoretical analysis and highlight some important implications. In particular, we identify a principal distinction between two types of industries, separated by a fundamental difference in their offshoring technologies. The distinction can loosely be described as one between "deep" and "shallow" comparative advantage. Our numerical analysis shows that these two types of industries will exhibit different patterns of employment effects as they engage ever deeper into offshoring in a scenario of the type foreseen by Blinder (2009).

Our paper is structured as follows. In the first section we develop a stylized model of offshoring and unemployment. Offshoring is modeled as trade in a continuum of tasks. Unemployment is determined by labor market frictions modeled along the familiar paradigm of search and matching. Our model features a small open economy producing two goods with a Ricardian and a Ricardo-Viner technology, respectively. Balanced trade emerges on both, the task level as well as the level of final goods. Section 3 then presents a complete comparative static analysis of this model, whereby the exogenous shock is an improvement in the offshoring technology. In section 4, we derive two propositions on the employment effect of such a technology shock. The first highlights the role of labor market institutions, as opposed to the offshoring technology. The second proposition identifies sufficient conditions for a non-monotonic pattern of net job creation to emerge in a process of successive improvements of the offshoring technology. Section 5 turns to a numerical treatment, intended to develop a deeper understanding of the detailed properties of the offshoring technology that are responsible for such non-monotonicity.

2 A Model of Offshoring and Unemployment

2.1 Production

The economy produces two traded goods with given prices, whereby good x serves as a numéraire with a unitary price. Good z uses only high-skilled labor with a Ricardian technology and a constant productivity equal to b. The wage rate for high-skilled labor w_H is thus equal to bp_z. Production of good x involves low-skilled labor l as well as high-skilled labor h according to

$$x = F(l,h) := A\left(l^{\alpha}h^{1-\alpha}\right)^{\delta} \quad \text{where} \quad 0 < \alpha, \delta < 1. \tag{1}$$

Denoting the cost per unit of low-skilled labor by W_L, we define $\omega\left(W_L, w_H\right)$ as the minimum unit-cost function corresponding to $y(l,h) := l^{\alpha}h^{1-\alpha}$. Concavity of x in y, for $\delta < 1$, may be interpreted as the presence of a third factor, say capital, which is fixed in supply. It is straightforward to show that profit-maximizing employment levels l and h must satisfy

$$l = \alpha\delta x/W_L \qquad \text{and} \qquad h = (1-\alpha)\,\delta x/w_H, \tag{2}$$

and maximum profits are equal to

$$\pi = (1-\delta)\,x, \tag{3}$$

where x is as given in (1), with input levels satisfying (2). Profits may be interpreted as income to owners of the third factor capital. Given wage-costs per unit of l and h, equations (2) and (1) determine a unique output level x, and profits are then determined by (3). In what follows we denote labor inputs per unit of x as a_L and a_H, respectively.

A unit of the low-skilled labor input l involves performance of many tasks, while high-skilled labor h may be thought of as a single input that cannot be decomposed into separate tasks. Following Grossman & Rossi-Hansberg (2008) we assume a continuum of l-tasks. We index tasks by $i \in [0,1]$, and we assume that for a unit-level of l the same amount of low-skilled labor is required on each of these tasks. The entire measure of tasks required per unit of l is normalized to one. Thus, the amount of low-skilled labor needed for tasks located in the sub-interval $[o, \bar{\imath}]$ in order to secure a level l of the unskilled labor input is given by $l\int_0^{\bar{\imath}} \mathrm{d}i$. Notice that, while high- and low-skilled labor inputs h and l are imperfect substitutes with a unitary elasticity of substitution, the elasticity of substitution between different tasks for a given level of l is zero.

We make no distinction between intra-firm performance or outsourcing of tasks to independent suppliers. However, firms decide on where to perform tasks, based on cost advantage. As in Grossman & Rossi-Hansberg (2008), we assume that tasks may be performed abroad where firms face perfectly elastic supply of low-skilled labor at a wage rate w_L^*.[4] Suppose a firm wants to secure an input level l and it wants to perform the necessary tasks within the sub-range $i \in [0, \bar{\imath}]$ abroad. Then the cost of these offshore activities are equal to $w_L^* l \int_0^{\bar{\imath}} \beta t\,(i)\mathrm{d}i$. The term $\beta t(i)$ denotes the extra cost caused by offshore performance of task i, over and above the amount of labor needed if the task is performed domestically.[5] This is the familiar notion of "iceberg cost". The function $t(i)$ depicts the variation of this cost across tasks, while β measures the overall costliness of offshoring. For obvious reasons, we assume $\beta \geq 1$ and $t(0) = 1$. Moreover, without loss of generality, we may rank tasks

[4] In Kohler (2004b), the unit of offshoring is a task that involves both types of primary inputs, with a perfectly analogous definition of offshoring costs. Within the Grossman & Rossi-Hansberg (2008) framework the results are highly sensitive to the precise definition of a task; see Kohler (2009). Given the purpose of our analysis as motivated in the introduction, the present definition of a task seems like an obvious choice. Grossman & Rossi-Hansberg (2009) apply the same notion of offshoring costs, focusing on a different driving force behind offshoring, viz. external scale economies on the task level.

[5] For example, Blinder (2006, 2007, 2009) has pointed out that the costs for offshoring a task depend on whether the performance of the task requires personal contact to the customer or not. Levy and Murnane (2004) divided tasks into those that can be described by the use of rule-based logic and those where this is impossible. While for the former tasks a remote performance bears only a modest risk of miscommunication the offshore performance of the latter tasks entails substantial communication costs. Finally, Leamer and Storper (2001) emphasized the difference between tasks that require "codifiable" information and those that require "tacit" information. While the former type of information can be transferred easily with the help of some kind of symbol system, the latter type of information require personal contact. Note also that it is easy to imagine a scenario where the costs of transportation differ across tasks.

such that $t'(i) > 0$.

We assume that the domestic low-skilled labor market is characterized by search frictions. Firms have to post a vacancy in order to find suitable workers, and there is a constant cost per vacancy equal to κ, measured in terms of the final good. The rate at which a vacancy is turned into a successful match is denoted by $q(\theta)$, where θ denotes the labor market tightness. Denoting the take-away wage per worker by w_L, the cost per unit-level of a low skilled labor task, if performed domestically, is equal to $w_L + \kappa/q(\theta)$. We shall turn to the determination of w_L as well as the matching rate $q(\theta)$ below. Moving any task offshore, the firm thus saves on both, domestic factor costs w_L and hiring costs $\kappa/q(\theta)$. The cost-savings are the same across all tasks. Cost-minimization requires that these savings be offset, at the margin, by the cost of performing a task abroad. Given our ranking of tasks, it is straightforward to determine a marginal task I which separates tasks $i < I$ performed offshore from tasks $i > I$ that are performed drawing on the domestic labor market. The marginal task satisfies

$$w_L + \frac{\kappa}{q(\theta)} = \beta t(I)\, w_L^*. \tag{4}$$

We assume that $w_L + \kappa/q(\theta) > \beta t(0)\, w_L^*$ in order to arrive at a non-trivial offshoring equilibrium with $I > 0$. Notice that this does not require $w_L^* < w_L$. The foreign cost advantage derives from a lower wage, as well as the absence of hiring cost. The extensive margin of offshoring I decreases with β, the overall costliness of offshoring.

If a firm posts v vacancies, it will end up paying $w_L q(\theta)\, v$ in terms of wage cost, plus hiring cost κv. Given I, profit-maximizing domestic employment levels of high- and low-skilled labor, h and l, then satisfy

$$\max_{l,h} \left\{ F(l,h) - \left[w_L + \frac{\kappa}{q(\theta)} \right] l(1-I) - w_L^* l \beta \int_0^I t(i)\, \mathrm{d}i - w_H h \right\}. \tag{5}$$

Observing the first order condition (4) on I, maximum profits may be rewritten as

$$\pi = \max_{h,l} \left\{ F(h,l) - w_H h - \left[w_L + \frac{\kappa}{q(\theta)} \right] \Omega(I)\, l \right\}, \tag{6}$$

$$\text{whereby} \quad \Omega(I) = (1-I) + \frac{\int_0^I t(i)\, \mathrm{d}i}{t(I)}. \tag{7}$$

The term $\Omega(I)$ is well known from Grossman & Rossi-Hansberg (2008), capturing in a concise way the entire factor cost savings from offshoring. Obviously, $\Omega(I) = 1$ if $I = 0$, and from $t'(i) > 0$ it follows that $\Omega(I) < 1$ if $I > 0$.

Moreover, it can be shown that $\Omega'(I) < 0$ for all $I \in (0,1]$.[6] Notice that the term $\Omega(I)$ makes the entire schedule of offshoring cost $t(i)$ an integral part of the technology. Indeed, it will become evident as we proceed that the precise form of this schedule plays a key role for job creation and job destruction in the process of enhanced offshoring.

We simplify by assuming a static hiring decision. The first order conditions for employment of the two types of jobs are

$$F_l(l,h) = \Omega(I)\left[w_L + \frac{\kappa}{q(\theta)}\right] \quad \text{and} \quad F_h(l,h) = w_H, \tag{8}$$

where F_l and F_h denote the marginal productivity of low-skilled and high-skilled labor, respectively. Solving these equations for l and h, we arrive at equations (2), whereby the cost of low-skilled labor has now been replaced by

$$W_L = \Omega(I)\left[w_L + \kappa/q(\theta)\right]. \tag{9}$$

The first order condition on domestic low-skilled labor may be rewritten as

$$\left[F_l(l,h) - \Omega(I)\,w_L\right] q(\theta) = \Omega(I)\,\kappa. \tag{10}$$

The left-hand side gives the expected job rent from posting a vacancy for an additional unit of l, taking into account that cost-minimizing offshoring reduces the wage cost below the negotiated wage for domestic workers. This must be equal to the cost of posting such a vacancy, whereby this cost is similarly affected by cost-savings through offshoring. Put differently, the recruiting cost applies not to the entire unit of l, but only to the tasks that are performed domestically. Since recruiting cost κ is expressed in terms of the final good (with a unitary price), it must be scaled down on an equal footing with the labor cost through the cost savings term $\Omega(I)$.[7]

[6] Appendix A.1 derives all relevant properties of $\Omega(I)$ that are important for the results of this paper.

[7] In a dynamic model, the firm would maximize the present value of periodic profits, whereby posted vacancies of time t determine the rate of change, at time t, in employment through the filling rate $q(\theta)$ (to be determined below) and a job separation rate, usually assumed exogenous in this setup. The job separation rate λ and the interest rate r raise the steady state "effective" cost of posting vacancies, such that condition (8) is replaced by $F_l(\cdot) = \Omega(I)\{w_L + (r+\lambda)[\kappa/q(\theta)]\}$. The extensive margin of offshoring I is determined through a condition completely analogous to (4), with κ again replaced by $(r+\lambda)\kappa$. Since all results of this paper go through for this dynamic version, it is worth simplifying the analysis to the static version.

2.2 Wage Bargaining

For simplicity, we assume that each firm is matched with a single worker.[8] Given the hiring cost, the firm and the worker find themselves in a bargaining situation, once a match has occurred. We follow the standard approach in assuming a Nash bargaining solution for the wage rate w_L. At this stage, we want to simplify as much as possible, hence we assume a zero outside option for the worker.[9] Denoting the worker's bargaining power by γ, Nash bargaining implies

$$\max_{w_L} \left\{ (w_L)^{\gamma} \left[F_l(l,h) - \Omega\left(I\right) w_L \right]^{1-\gamma} \right\}, \tag{11}$$

whereby h and l satisfy (8). Notice that the overall surplus from filling a low-skilled job is equal to $F_l(l,h)$, whereas $F_l(l,h) - \Omega\left(I\right) w_L$ is the firm's job rent, given cost-savings $\Omega(I)$ from offshoring low-skilled tasks $i \in [0, I]$. The first order bargaining condition reads as $\gamma \left[F_l(l,h) - \Omega\left(I\right) w_L \right] = (1-\gamma)\Omega(I) w_L$. Observing the first-order condition on l in (8), we obtain

$$w_L = \frac{\gamma}{1-\gamma} \frac{\kappa}{q\left(\theta\right)}. \tag{12}$$

It is interesting to note that the same bargaining condition would obtain, if Nash-Bargaining took place in an environment without offshoring, which may appear surprising. But it reflects the simple point mentioned before that offshoring saves on both, the wage cost from employment as well as the hiring cost.

2.3 Jobs for Domestic Low-skilled Workers

We stipulate a simplified version of the standard matching model by Pissarides (2000), in order to determine employment of low-skilled labor. Given a low-skilled labor force with mass 1, the rate at which low-skilled workers find jobs, denoted by e, is determined by the amount of vacancies v according to a matching function $M(1, v)$, which is assumed to be homogeneous of degree 1. Notice that $e = M(1, v)$ and the usual measure of labor market tightness is $\theta \equiv v$.[10] The link between vacancies and the entire employment

[8] This assumption is not entirely innocuous. Given the assumption of a unitary mass of low-skilled labor, it implies a certain corresponding mass of firms.

[9] It would be easy to introduce an unemployment benefit. However, as we do not want to model government policy in this paper, we simplify by setting the benefit equal to zero.

[10] Labor market tightness is usually defined as the ratio between the number of vacancies and the number of unemployed. In this simplified static version of the matching model,

of low-skilled labor is given by

$$\theta q(\theta) = (1 - I)l. \tag{13}$$

The rate at which vacancies are filled is given by $q(\theta) = M/\theta = M(1/\theta, 1)$. To simplify, we write $q(\theta) := M(1/\theta, 1)$, so that

$$e = e(\theta) := \theta q(\theta). \tag{14}$$

Note that $q'(\theta) = -M'_U/\theta^2 < 0$, where M'_U is the partial derivative of the matching function with respect to the number of unemployed searching for a match. Any increase in the number of vacancies raises labor market tightness, thus reducing the rate at which vacancies are filled. At the same time, it raises employment, $e'(\theta) > 0$.[11] Note that this setup implies less than full employment, unless the wage falls all the way down to zero, which is equivalent to a dynamic case where, due to full employment, the outside option in wage bargaining is equal to the ongoing wage.

Following Keuschnigg & Ribi (2009), we introduce an elasticity $\eta := -\theta q'(\theta)/q(\theta) > 0$. Using a caret to denote relative changes, we then have

$$\hat{e} = (1 - \eta)\hat{\theta}. \tag{15}$$

Note that employment of domestic low-skilled workers, evolves at two adjustment margins.[12] At the extensive margin firms decide about the fraction of tasks $1 - I$ they finally want to perform drawing on domestic labor. The intensive margin describes how much low-skilled labor l is used in overall production. Other things equal, any increase in the overall employment of low-skilled labor also increases the number of jobs for domestic workers. As we shall see below, offshoring affects the two margins differently, hence the domestic employment effect depends on the relative strength of the adjustments at the two margins.

2.4 International Trade

For the sake of simplicity, we do not explicitly model the foreign economy on an equal footing. As we have mentioned at the outset, we assume a

since the entire labor force needs to be matched, the *initial* number of unemployed is equal to the entire labor force.

[11]This follows from linear homogeneity of M, which implies that $e(\theta) = M(1, v) = M(1, \theta)$, and hence $e'(\theta) > 0$, with $\hat{e}/\hat{\theta} = 1 - \eta > 0$. This implies that $0 < \eta < 1$.

[12]We make a distinction between domestic employment of low-skilled labor and employment of domestic low-skilled labor, because offshoring allows domestic firms to effectively "employ" foreign labor.

given relative price of the traded good p_z which ties down the domestic high-skilled wage rate w_H, based on a Ricardian technology for good z. Moreover, we assume a given foreign wage rate for low-skilled labor w_L^*, assuming – a priori - that $w_L^* < [w_L + \kappa/q(\theta)]/[\beta t(0)]$. The domestic economy thus imports low-skilled tasks, and it may exhibit net exports or net imports of the final goods x and z, depending on its endowment with the two types of labor and the x-specific capital, as well as on preferences. Suppose, for simplicity that domestic households have uniform Cobb-Douglas preferences with an expenditure share of φ for the final good z and $1-\varphi$ for good x. If H is the high-skilled labor endowment, total household income is equal to

$$Y = w_L(1-I)l + w_H H + (1-\delta)x. \tag{16}$$

With perfect competition, assuming full employment of H, we may write $w_H H = w_H h + p_z z/b$, where b is the constant productivity of high-skilled labor in production of good z. The final term is profit income; see (3). Net imports of the final good x are equal to $(1-\varphi)Y - \{x - [\kappa/q(\theta)](1-I)l\}$, both in value and quantity terms, while net imports of good z are equal to $\varphi Y - p_z b(H-h)$ in value terms. Note that imports of the final good x is demand minus output of good x net of the resource use involved in hiring of domestic low-skilled labor. In turn, imports of low-skilled tasks are equal to

$$w_L^* l\beta \int_0^I t(i)\mathrm{d}i = \left[w_L + \frac{\kappa}{q(\theta)}\right][\Omega(I) - (1-I)]\, l \tag{17}$$

This follows from (5) and (4). The aggregate value of net imports, then, is equal to

$$\begin{aligned} B &= Y - x + [\kappa/q(\theta)](1-I)l - p_z b(H-h) \\ &\quad + \left[w_L + \frac{\kappa}{q(\theta)}\right][\Omega(I) - (1-I)]\, l \end{aligned} \tag{18}$$

Moreover, recognizing that profits $(1-\delta)x$ are equal to $x - W_L l - w_H h$ and $w_H H = w_H h + p_z b(H-h)$, we may write

$$Y = w_L(1-I)l + w_H H + x - W_L l - w_H h, \tag{19}$$

$$\quad = w_L(1-I)l + p_z b(H-h) + x - \Omega(I)[w_L + \kappa/q(\theta)]\, l \tag{20}$$

This, in turn, implies that $B = 0$. As expected, given all equilibrium conditions are satisfied, trade is balanced.

There is one additional condition, though, that needs to be satisfied for an economically meaningful equilibrium. Skilled labor endowment H needs to be large enough for $H - h$ to be positive.

3 Comparative Statics of Globalization

Our model determines six endogenous variables. These are the extensive margin of offshoring I, the two input levels l and h, and the domestic low-skilled wage rate w_L as well as domestic low-skilled employment e (with a rate of unemployment equal to $1-e$) and the labor market tightness θ. The corresponding equilibrium conditions are the cost-minimization condition for offshoring (4), the two labor demand equations (8), the bargaining condition (12), and the two conditions relating production to labor market tightness (13) and employment of low-skilled labor (14). Note that in all of these equations $q(\theta) = M(\theta)$. We now explore the comparative static properties of this equilibrium with respect to the general costliness of offshoring β. Unless indicated otherwise we use the hat notation to denote relative changes. We focus on employment of domestic low-skilled labor.

Differentiating the first order condition (8) on both inputs l and h yields

$$\hat{l} = -\frac{1-\delta(1-\alpha)}{1-\delta}\hat{W}_L. \tag{21}$$

In what follows, we shall use $\Delta := [1-\delta(1-\alpha)]/(1-\delta)$ for the elasticity of labor demand l, incorporating equilibrium adjustment of high-skilled labor h, given a constant w_H. Differentiating the first order condition on offshoring (4), we obtain

$$\eta\hat{\theta} = \hat{\beta} + \zeta(I)\hat{I}, \tag{22}$$

On the right-hand side we define $\zeta(I) > 0$ as the elasticity of the offshoring-cost-schedule $t(i)$, evaluated at $i = I$. Less costly offshoring, $\hat{\beta} < 0$, implies adjustment through an extension of offshoring into more costly types of tasks, $\hat{I} > 0$, or a lower cost of performing such tasks which may come about through a lower negotiated take-away wage w_L and a lower labor market tightness θ (and thus easier recruiting). On the left-hand side of equation (22), wage adjustment and labor market tightness are brought together through the bargaining condition (12) which requires that

$$\hat{w}_L = -\hat{q}(\theta) = \eta\hat{\theta}. \tag{23}$$

Returning to the labor demand function (21) and remembering the definition of W_L in (9), which – together with the offshoring arbitrage condition (22) – implies $\hat{W}_L = \eta\hat{\theta} + \xi(I)\hat{I}$, we arrive at

$$\hat{l} = -\Delta\left[\hat{\beta} + [\xi(I) + \zeta(I)]\,\hat{I}\right] \tag{24}$$

In this equation, we have defined $\xi(I) < 0$ as the elasticity of the cost-savings factor $\Omega(I)$. In appendix A1, we show that $\xi(I) + \zeta(I) = \zeta(I)(1-I)/\Omega(I)$. Hence, for interior offshoring equilibria, $I < 1$ and $I > 0$, we have $\xi(I) + \zeta(I) > 0$. Employment of domestic low-skilled labor $e = (1-I)l$ then adjusts according to

$$\hat{e} = -\frac{I}{1-I}\hat{I} - \Delta\left[\hat{\beta} + [\xi(I) + \zeta(I)]\,\hat{I}\right] \tag{25}$$

The first term on the right-hand side of this equation represents what we call the extensive margin of low-skilled labor demand which reflects job losses or gains through more or less tasks being performed offshore. The second term reflects the intensive margin, following from adjustment of overall low-skilled labor input in line with changes in low-skilled labor cost. Note that (25) incorporates a cost-minimizing adjustment of I. This equation also highlights the ambiguity which is at the core of this paper: An increase in the extensive margin of offshoring caused by $\hat{\beta} < 0$ leads to higher cost-savings from offshoring and, thus, to lower cost of low-skilled labor causing an expansion of low-skilled labor in production. This is the employment side of what Grossman & Rossi-Hansberg (2008) call the productivity effect of offshoring. At the same time, however, the very increase in I that is at the heart of this effect also implies a direct loss of jobs since low-skilled tasks are moving offshore. We thus have two opposing forces, with an ambiguous net effect on domestic low-skilled jobs.

However, we need not stop here, since we know how $\hat{I}$ and $\hat{\beta}$ are related to one another from the arbitrage condition of offshoring (22). But the change in the domestic labor market tightness on the left-hand side of (22) also implies a change in domestic employment. To take account of this interdependency, we express $\hat{I}$ as a function of $\hat{e}$, using (15)

$$\hat{I} = \frac{\tau\hat{e} - \hat{\beta}}{\zeta(I)}, \tag{26}$$

where we define $\tau := \eta\,/(1-\eta)$. Remember that the conventional specification of the matching function implies $1-\eta > 0$; see above.

Putting all pieces together, we now arrive at our core equation

$$[1 + \lambda(I)\tau]\,\hat{e} = \psi\,(I)\,\hat{\beta}. \tag{27}$$

In this equation we have defined $\lambda(I)$ and $\psi\,(I)$, respectively, as follows

$$\lambda(I) \;:=\; \frac{I}{(1-I)\zeta\,(I)} + \Delta\frac{\xi\,(I) + \zeta\,(I)}{\zeta\,(I)} > 0, \tag{28}$$

$$\psi\,(I) \;:=\; \frac{I}{(1-I)\zeta\,(I)} + \Delta\frac{\xi\,(I)}{\zeta\,(I)}. \tag{29}$$

In the appendix we show that $[\xi(I)+\zeta(I)]/\,\zeta(I)\equiv(1-I)\,/\Omega\,(I)\,>0$, hence $\xi(I)/\zeta(I)\equiv(1-I)\,/\Omega\,(I)\,-1<0$. All other endogenous variables follow in a straightforward way from the relevant equations above. In particular, labor market tightness θ and the domestic low-skilled wage rate w_L are positively tied to employment e through (15) and the wage bargaining condition in (23). The term $1+\lambda(I)\tau>0$ reflects a mitigation effect reflecting wage adjustment on the domestic labor market. Moreover, as long as less costly offshoring, $\hat{\beta}<0$, enhances employment of low-skilled labor at the intensive margin l, we observe a rise in output x and an increase in profits $\pi=(1-\delta)x$. If one assumes that such profits accrue to high-skilled labor, as we do in this paper, high-skilled labor is always at the winning side of offshoring.[13] In contrast, the effect on domestic low-skilled labor is ambiguous. In the next section we take a closer look at this ambiguity.

4 Offshoring and Net Job Creation

Blinder (2009) argues that offshoring will likely gain impetus from further enhancement of IT and become a "big deal". Moreover, in his view "offshoring per se will lead to far more job destruction than job creation in the United States". However, he states that this is a mere belief, subject to the verdict of time. Equation (27) offers a theoretical perspective on what may happen in countries like the US. It is a formal expression that highlights the net effect of job destruction at the extensive margin of offshoring and job creation at the intensive margin, due to the productivity effect. In this section we state two theoretical propositions. In the next section we turn to some illustrative simulations.

A first noteworthy result relates to the role of labor market institutions for the employment effect of enhanced trade in tasks.

Proposition I: *i) In qualitative terms the employment effect of enhanced trade in tasks, $\hat{I}>0$ caused by $\hat{\beta}<0$, does not depend on domestic labor market institutions related to matching and wage bargaining. ii) In quantitative terms, the effect is dampened by a high value of the elasticity of matching with respect to labor market tightness. iii) The wage bargaining condition as such is unaffected by trade in tasks, but the wage for low-skilled labor is indirectly affected through labor market tightness.*

[13]This seems in stark contrast to the thrust of Blinder (2009). However, we should remind the reader that "high-skilled" is a nothing but a convenient, though perhaps a bit misleading, label for whatever type of labor is "safe from offshoring" – in Blinder's terminology: labor that delivers personal (as opposed to impersonal) services.

Part i) of this statement is directly evident from equation (27) and the definitions of $\lambda(I)$ and $\psi(I)$. It means that the direction of employment adjustment is entirely a matter of technology. There are two key elements of this model that capture labor market institutions. The first is the matching function $M(1, v)$, and the second is the relative bargaining power of workers and firms, respectively. Part ii) follows from $\tau := \eta/(1-\eta)$ in the term $1+\lambda(I)\tau$, where η is the matching elasticity mentioned in the proposition. Other things equal, a higher η implies a lower absolute value of $\hat{e} = [1 + \lambda(I)\tau]^{-1} \psi(I) \hat{\beta}$, for any given value of $\hat{\beta}$. The reason for this mitigation effect is the dampening role of wage adjustment to the labor demand shock from trade in tasks. The matching elasticity determines how a shock gets transmitted into a change in employment on the one hand, and wage adjustment on the other; see equation (23). Part iii) is directly evident from equation (12). This result may seem a bit surprising, as we have assumed frictionless hiring in offshoring. Contrary to speculative arguments often brought up, the possibility to perform low-skilled tasks through cheap offshore labor does not play a direct role in wage bargaining. The intuition is that at the stage of wage bargaining the possibility of moving tasks offshore does not constitute any valuable outside option for the firm, because it is already at the cost-minimizing extensive margin I of offshoring. Hiring a worker must generate a job rent for the firm that equals the cost of recruiting, whereby both, the job rent and the recruiting cost are appropriately adjusted for the savings effect from offshoring; see (10).

Although the relative bargaining power of the worker thus plays no direct role in the wage and employment effects of offshoring, it does of course determine rent sharing between firms and workers.[14] Specifically, the relative share of the job surplus going to the firm and the worker, respectively, does change upon $\hat{\beta} < 0$. But this comes about, not because offshoring alters wage bargaining as such, but because it affects the equilibrium labor market tightness θ.

A closer examination of $\psi(I)$ in equation (27) allows us to trace out the evolution of net job creation for domestic low-skilled labor along the entire Blinderian way of offshoring becoming a "big deal", i.e., as successive reductions in β lead to ever larger values of I. It is instructive to start out at the zero-offshoring margin where (4) is satisfied with $I = 0$. Then, if $\hat{\beta} < 0$ leads to incipient offshoring, there is zero job creation. Since there are no inframarginal tasks that could benefit from less costly offshoring, there is no

[14] Of course, the fundamental assumption of an exogenous bargaining power γ may be questioned as such. Admittedly, one can certainly imagine ways in which β affects γ directly.

cost-savings effect that could lead to expansion of l. Formally, in $\psi(I)$ we have $\xi(I)/\zeta(I) \equiv (1-I)/\Omega(I) - 1$ equal to zero if $I = 0$. Adjustment is entirely dominated by job destruction from a loss of tasks to foreign low-skilled workers. More specifically, we have $\hat{e} = \hat{\beta}/[(1+\lambda(0)\tau)\, t'(0)]$, where we have replaced $I/[(1-I)\zeta(I)] = t(I)/[(1-I)t'(I)]$, observing additionally that by assumption $t(0) = 1$ and $t'(I) > 0$ for[15] all $I \in [0,1]$. Note that $\lambda(0) = 1/t'(0) + \Delta$.

As we move into interior offshoring equilibria with values of $I > 0$, the offsetting intensive margin adjustment of low-skilled labor employment l sets in, as further technological improvements cause further reductions of β. Throughout the entire range of $I \in [0,1)$, we have $I/[(1-I)\zeta(I)] > 0$ and $\Delta\xi(I)/\zeta(I) < 0$ for the extensive and intensive margins of adjustment, respectively. As indicated by the title of our paper, and contrary to Blinder's conjecture, there is the distinct possibility of positive net job creation resulting from $\hat{\beta} < 0$, as I moves through certain subranges of the interval $(0,1)$ where the intensive margin dominates the extensive margin.

While an equilibrium with $I = 0$ is obviously relevant, an equilibrium at the other extreme with $I = 1$ seems doubtful, as it involves zero employment of domestic low-skilled labor. Indeed, it can be shown that such an equilibrium does not exist. Zero employment of domestic labor would imply zero recruiting, $v = 0$ and thus zero labor market tightness, with a "filling rate" $q(\theta) \to \infty$.[16] But according to the wage bargaining condition (12), this implies $w_L \to 0$, which is the *full-employment-level* of wages and therefore contradicts the *zero employment* as implied by $I = 0$.[17] Looking at (4), we also recognize that in such a situation the term $\beta t(1) w_L^*$ would exceed $\kappa/q(\theta)$, with $q(\theta) \to \infty$, thus leaving room for a positive domestic wage rate with positive employment. Note that this holds true even if $t(1)$ is finite, meaning – in Blinder's terminology – that all tasks are potentially *im*personal for realistically low levels of β. But this seems somewhat odd, hence an equilibrium with $I = 0$ would seems questionable also on economic grounds.[18]

But what is it that determines whether non-monotonicity, with positive net job creation over certain subranges of I, does arise along the Blinderian

[15] We shall return to the question of the limiting behavior of $t(i)$ in section 5 where we present a numerical treatment.

[16] In dynamic terms, the duration of a vacancy would be zero. Hiring becomes costless.

[17] Of course, an equilibrium value of $I = 1$ is perfectly possible in a multi-sectoral model if low-skilled labor is mobile across sectors. However, for reasons emphasized in the introduction, we want to focus on the case of intersectoral immobility.

[18] We shall address the limiting behavior of $t(I)$ as $I \to \infty$ in the next section.

"big-deal-journey" of offshoring? As indicated above, the answer lies in the term $\psi(I)$. Non-monotonicity requires that the job loss effect at the extensive margin, $I/\left[(1-I)\zeta\left(I\right)\right]>0$, eventually becomes dominated by the intensive margin, $\Delta\xi\left(I\right)/\zeta\left(I\right)$, as $\xi(I)/\zeta(I)\equiv\left(1-I\right)/\Omega(I)-1$ takes values below zero, for $I>0$. Obviously, the offshoring cost schedule $t(i)$ plays a key role. We have already emphasized above that this schedule in its entirety becomes an integral part of a domestic firm's technology. It now emerges as the key to the possibility of job creation with offshoring of tasks.

Intuitively, the extensive margin is driven by $t'(I)$: A steeper cost-schedule for offshoring additional tasks implies that – other things equal – the arbitrage condition (4) will be restored with a lower measure of *additional* task-offshoring. At the same time, the intensive margin is driven by the cost-savings reaped from offshoring tasks up to $i=I$, which depends on the entire curvature of $t(i)$ up to $i=I$. In addition, it is driven by the elasticity of labor demand Δ. Sharp insights seem difficult to obtain without venturing a functional form of $t(i)$, which allows us to simulate $\hat{e}/\hat{\beta}$ for the entire span of possible values $I\in[0,1]$. However, we can state the following general proposition.

Proposition II: *If we denote the wage cost for domestic low-skilled labor per unit of low-skilled labor input l as $d:=\left[w_L+\kappa/q\left(\theta\right)\right](1-I)$, and the cost of imported tasks per unit of output as $m:=w_L^*\beta\int_0^I t(i)di$, then, at any interior equilibrium level of offshoring $I\in(0,1)$, the elasticity of employment of domestic low-skilled labor with respect to the costliness of offshoring is negative, $\hat{e}/\hat{\beta}<0$, if and only if $\Delta\zeta(I)$ is larger than $\left(d/m+1\right)I/(1-I)$.*

We relegate the proof of this proposition to appendix A2. Note that $\hat{e}/\hat{\beta}<0$ implies a positive net job creation with enhanced offshoring sparked by a reduction in the costliness of trade in tasks. A positive net job creation from enhanced offshoring requires a large enough labor demand elasticity, reinforced by a large elasticity of the cost of offshoring further tasks. In addition, it requires a relatively low ratio of initial domestic labor cost to cost of imported tasks. In the proposition, the term $\Delta\zeta(I)$ captures "local conditions" at the equilibrium extensive margin of offshoring I. By way of contrast, the $\left(d/m+1\right)I/(1-I)$ depicts the "interval properties" of this margin, meaning the position of I in the interval, as well as the infra-marginal curvature of the $t(i)$-schedule which is reflected in m. The numerical analysis below will shed further light on this distinction.

5 A Numerical Treatment

In this section, we provide a numerical analysis to substantiate proposition II and to highlight some important implications. Much of the literature on offshoring insinuates that the wage and/or employment effects of offshoring does not systematically vary across stages of production. Our preceding analysis strongly suggests it does. Should Blinder turn out to be right and offshoring becomes a "big deal", as the costs of linking tasks across long distances undergo successive rounds or reductions, then it is likely that the associated employment effects will vary greatly, as industries move from incipient trade in tasks to "high-volume-offshorers". As indicated above, employment may well react in a non-monotonic way. In this section we provide a numerical analysis that highlights this potential non-monotonicity.

Toward this end, we must calibrate the schedule $t(i)$. Our approach is not to calibrate it to a specific real world data set. Instead, we want to highlight relevant ways in which industries may differ in their offshoring technologies. It is important to be clear about the meaning of the schedule $t(i)$. Three points need to be observed. First, the schedule does not involve any notion of technological sequencing in which tasks need to be performed.[19] It represents what Blinder (2009) calls a varying degree to which jobs are of a *personal*, or *impersonal* nature. In the present context it is a variation across tasks. To reiterate, $i = 0$ indicates the least personal of all tasks, where the *additional* cost deriving from offshore performance, measured in "iceberg-terms" through $\beta t(i)$, is lowest. In contrast, $i = 1$ indicates the least *im*personal (or most personal) of all tasks, where the additional cost arising from offshore performance is largest. In the above analysis, we have already normalized $t(0) = 1$, and we have treated $\beta \geq 1$ as a cost-shifter that affects all tasks.

Second, the derivative $t'(i)$ does not represent the marginal cost of offshoring, which is equal to $\beta t(i) w_L^*$, but is a cost-equivalent measure of the extent to which increasing the margin of offshoring leads into less impersonal types of tasks. It is relatively obvious that the shape of the entire schedule $t(i)$ should vary significantly across industries. Our numerical analysis in this section reveals that this variation may imply vastly different patterns of employment reactions as industries travel along the interval $I \in [0, 1)$.[20] Accepting the notion of a continuum of tasks, and the absence of any technological sequencing requirement, assuming $t'(i) > 0$ implies no restriction

[19]Sequencing issues are discussed in Harms, Lorz & Urban (2009).

[20]We acknowledge that a well-behaved equilibrium with $I = 1$ does not exist by specifying the relevant interval as an open interval $[0, 1)$.

whatsoever. Indeed on our level of generality, assuming monotonicity also of the second derivative appears entirely innocuous as well.

The third point relates to the limiting behavior of $t(i)$ as $i \to 1$. Our analysis suggests that a fundamental distinction must be drawn between industries where this limit is a finite number, henceforth called "type-f industries", and industries where it is equal to infinity. We label such industries "type-i". This distinction has clear economic meaning. Type-f-industries are somewhat akin to what Bhagwati (2006) has called industries with "shallow" or "thin" comparative advantage.[21] In such industries, a relatively moderate improvement in the technology of linking tasks performed in different locations may lead to a complete dislocation of all tasks, in our case tasks performed by low-skilled labor. The industry need not disappear altogether, but as regards low-skilled labor it may degenerate to a mere "offshoring agency". As we have shown above, in the context of our stylized model an f-type industry seems somewhat implausible, since an equilibrium with $I = 1$ does not exist, but in a more general context, particularly one with labor mobility between several sectors, it certainly commands some relevance. By way of contrast, a type-i industry would be one with a somewhat deeper entrenchment of domestic viability, at least as far as offshoring low-skilled labor is concerned.[22] As the margin of offshoring rises toward $I = 1$, the additional cost deriving from offshore performance of the marginal task approaches infinity. Hence, some tasks will always be retained domestically, even if β falls right down to 1. Given the assumptions made up to this point, and adding twice-differentiability of $t(i)$, type-i industries feature a strictly convex schedule $t(i)$.

From the figure 4 in appendix A1, it is clear that for any given margin I, and a given $t(I)$, the cost savings already achieved through offshoring is larger for a convex schedule $t(i)$ than for a concave schedule. Larger cost-savings imply a lower value of imported tasks (the term m in proposition II), which in turn implies a lower leverage for further cost-savings to be reaped from further $\hat{\beta} < 0$, particularly if the industry is at an "early stage" of offshoring, i.e., at a low value of I. All of this is summarized by the "interval property" of proposition II.

Given the "interval property" of any given equilibrium, the labor market

[21] In the present context, comparative "advantage" means viable domestic *production*, not necessarily *exporting* the good in question.

[22] Of course, comparative advantage of the entire industry may still be lost due to other changes unrelated to β. The difference between type-f- and type-i-industries also resembles the difference between strong- and weak-comparative-advantage-industries in Kohler (2007).

effect of a β-induced further increase in the margin I is determined by the "local conditions". Other things equal, a steeper schedule $t(I)$ implies a muted reaction of I to a given $\hat{\beta} < 0$, which in turn limits the job loss at the extensive margin. At the same time, the labor demand effect deriving from *further* cost-savings is governed by the labor demand elasticity, which is governed by the degree of concavity δ, and the share of low-skilled labor α in, production of the final good. From the definition of Δ subsequent to equation (21), it can be seen that both α and δ magnify the expansion of labor demand at the intensive margin. A large low-skilled labor share in production implies that the unit-cost of l is determined to a large extent by the cost of low-skilled labor, W_L, hence cost-savings from offshoring have a larger effect on W_L. In turn, with a large value of δ, even small changes in the unit-cost of l translate into a sizable increase in the entire demand for low-skilled labor. All of this is captured in a simple way by $\Delta\zeta(I)$ in proposition II.

Armed with this intuition, we can now turn to a numerical view on the aforementioned two types of industries. In the following, we trace out values of $\psi(I)$ throughout the entire interval $I \in [0, 1)$ for alternative functional forms representing type-f and type-i industries, respectively. Remember that the sign of $\psi(I)$ determines the sign of the elasticity $\hat{e}/\hat{\beta}$ and, thus, a positive sign implies net job destruction from offshoring, and vice versa.

5.1 Type-i Industries

Given what we have said above, the schedule $t(i)$ of type-i industries may be described by a strictly convex function of the form[23]

$$t(i) = \frac{1}{(1-i)^{\mu}}, \tag{30}$$

where $\mu > 0$. It should be noted that the parameter μ governs both, the steepness and the degree of convexity of the function $t(i)$. A larger value of μ implies a larger slope at any given I, as well as a higher degree of convexity. Given this functional form, the decisive term underlying proposition II emerges as[24]

$$\psi(I) = \begin{cases} 1 + \Delta \frac{\ln(1-I)}{1-\ln(1-I)} & \text{if } \mu = 1 \\ \frac{1}{\mu} - \Delta \frac{1-(1-I)^{1-\mu}}{1-\mu(1-I)^{1-\mu}} & \text{if } \mu \neq 1. \end{cases} \tag{31}$$

[23]This case is also briefly considered in Grossman & Rossi-Hansberg (2008).

[24]See appendix A3 where we derive equation (31) and some useful properties of the function $\psi(I)$.

Taking limits, we find that $\lim_{I\to 0}\psi(I) = 1/\mu > 0$, while $\lim_{I\to 1}\psi(I) = (1-\mu)/\mu - (\alpha\delta)/(1-\delta)$ for $\mu < 1$, and $\lim_{I\to 1}\psi(I) = -(\alpha\delta)/(1-\delta)\,\mu$ for $\mu \geq 1$.

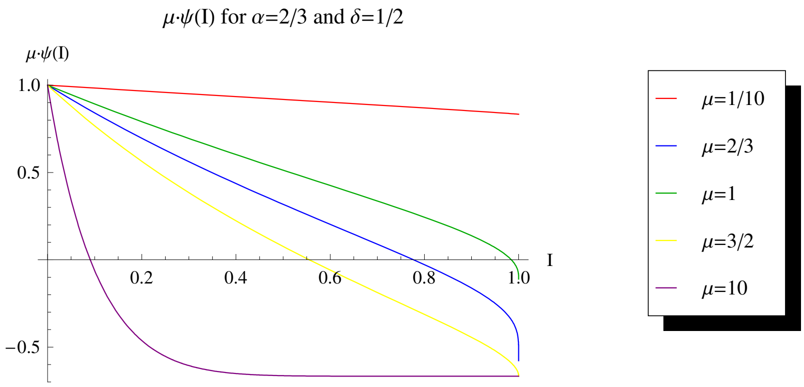

Figure 1: *Employment effects of offshoring for type-i industries*

Figure 1 depicts the general equilibrium impact of falling offshoring costs on employment for $\alpha = 2/3$, $\delta = 1/2$ and different values of μ. For the sake of illustration, we plot $\mu\psi(I)$, thus anchoring all lines at a common unitary value for $I = 0$. Obviously, this type of scaling leaves the horizontal intersection points unaffected. These mark the turning points where the Grossman & Rossi-Hansberg (2008) productivity effect of offshoring gets turned into a vehicle of net job creation. For low values of I, i.e., for for "early" improvements in the technology of linking tasks across countries, offshoring comes with net job losses. But once the industry reaches a critical level of I, measured by the horizontal intersection points in figure 1, further improvements will lead to enhanced offshore performance of tasks, coupled with an increase in employment of domestic labor on account of the "interval property" of proposition II.

However, one must be cautious when interpreting the lines in figure 1. They do not depict the size of the employment effects as the industry moves from low to high values of I. These are governed by the elasticity $\hat{e}/\hat{\beta} = [1+\lambda(I)\tau]^{-1}\psi(I)$. But still, the principal message is simple, clear and important. If the offshoring technology of a type-i industry features a large enough value of μ, then the domestic employment level of this industry features a non-monotonic pattern of adjustment. Initial imports of tasks will be at the expense of domestic jobs, but if further technological improvements take the industry beyond a critical level of offshoring, employment and wages will pick up again. To put it somewhat bluntly, the relationship between domestic jobs and offshoring may be subject to a "curse of small steps": A little bit of offshoring may hurt employment, while a large dose might be a boon. Alas, economies and industries cannot arbitrarily decide about the dose: It is endogenous to β.

From the above discussion and proposition II, one might expect that the extensive margin eventually starts dominating again once the industry approaches very high values of I. However, for type-i industries the prevalence of "infinitely personal" tasks shields domestic low-skilled labor from such a scenario. Indeed, it is interesting to note from figure 1 that the employment effect, once turning positive — or, equivalently, $\mu\psi(I)$ turning negative – does not turn negative again, even for very large values of I.[25] However, whether or not such a pattern emerges depends on the value of μ. Figure 1 reveals that for sufficiently small values, the term $\psi(I)$ converges to a positive number, in which case the adjustment pattern of the industry is monotonic, with job losses throughout the entire Blinderian "big-deal-journey" of offshoring.

5.2 Type-f Industries

The same does not hold true for type-f industries, which for the present purpose may be characterized by the following specification of $t(i)$:

$$t\left(i\right)=1+\phi i^{\epsilon},\tag{32}$$

with $\phi, \epsilon > 0$. Even though the slope of this line is jointly determined by both ϕ and ϵ, we may still view ϕ as the slope parameter, as it uniquely pins down $t\left(1\right) = 1 + \phi$. In turn, $\epsilon < 1$ ($\epsilon > 1$) makes the schedule a concave (convex) function, while $\epsilon = 1$ implies the knife edge case of linearity. It follows from our discussion of the interval property above that the degree of concavity is important for the employment effect of offshoring. We therefore provide two separate illustrations of $\psi\left(I\right)$, in order to highlight the local conditions and the interval conditions, respectively, for offshoring-induced job creation and job destruction in type-f industries.

The term $\psi\left(I\right)$ now emerges as

$$\psi\left(I\right)=\left\{\frac{1}{1-I}-\Delta\frac{\left(1+\frac{\phi}{1+\epsilon}I^{\epsilon}\right)\phi\epsilon I^{\epsilon}}{\left(1+\phi I^{\epsilon}\right)^{2}-\left(1+\phi I^{\epsilon}\right)\left(\frac{\phi\epsilon}{1+\epsilon}I^{\epsilon+1}\right)}\right\}\left(\frac{I^{1-\epsilon}}{\epsilon\phi}+\frac{I}{\epsilon\phi^{2}}\right)\tag{33}$$

As before, we want to anchor our illustration such that $\psi\left(0\right) = 1$. It is straightforward to see that for any functional form of $t(i)$ we have $\lim_{I\to 0}[t'\left(I\right)$

[25] For reasons pointed out above, in the present model the very far extreme of $I = 1$ is devoid of any economic significance, since an equilibrium with $I = 1$ does not exist.

$/t(I)]\psi(I) = 1$, hence we scale our plots accordingly.[26] Again, caution must be exercised in judging the magnitude of employment effects, but the qualitative adjustment pattern is conveniently captured by figures 2 and 3. Figure 2 highlights variations in the steepness of $t(i)$, while figure 3 highlights different degrees of convexity/concavity. Both figures use values $\alpha = 2/3$ and $\delta = 1/2$, as in figure 1.

A steeper schedule (higher value of ϕ) means – loosely speaking – that for, any value of I, the next candidate task for offshoring involves, not just a larger dose of personal elements, but also a larger *increase* in such elements. For reasons familiar by now, this favors job creation. To understand the role of concavity, one may look at the maximum inframarginal cost savings over the entire range of tasks $I \in [0, 1)$. A higher degree of convexity (higher value of ϵ) entails a higher potential for inframarginal cost savings. However, there is a second effect. With a more convex (less concave) schedule the relative importance of a single task for the overall cost savings shifts from less personal to more personal tasks.

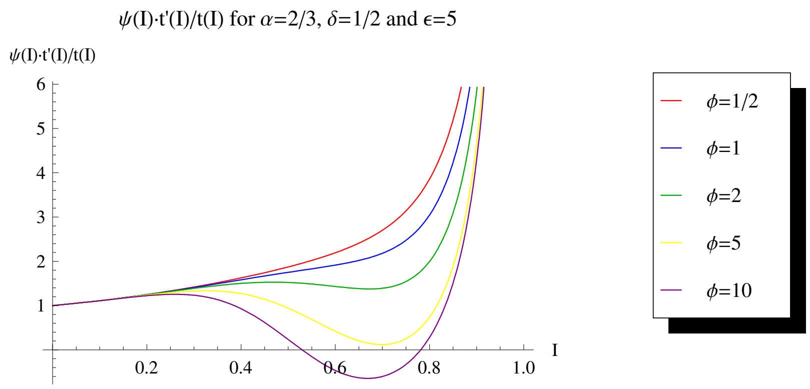

Figure 2: *Employment effects of offshoring for type-f industries varying steepness of cost*

As before, no adjustment at the intensive margin arises from an equilibrium without offshoring where $I = 0$. At the other extreme, for reasons now familiar, job destruction at the extensive margin again dominates when $I \rightarrow 1$. For $I = 1$, the second term in the curly bracket of (33) equals a finite number.[27] With $\lim_{I\rightarrow 1}(1 - I)^{-1} \rightarrow \infty$, we thus obtain $\lim_{I\rightarrow 1}\psi(I) \rightarrow \infty$. But it should be remembered that, even though $t(1)$ is finite for type-f industries, within the confines of our model an equilibrium with $I = 1$ does

[26]This implies that we ignore $I/\zeta(I) = I^{1-\epsilon}/\epsilon\phi + I/\epsilon\phi^2 > 0$ for $I > 0$ on the right hand side of equation (33). But this is inconsequential for our qualitative analysis.

[27]To be precise $\Omega'(1)/\Omega(1) = (\phi\epsilon)/(1 + \phi)$, which is always larger than zero.

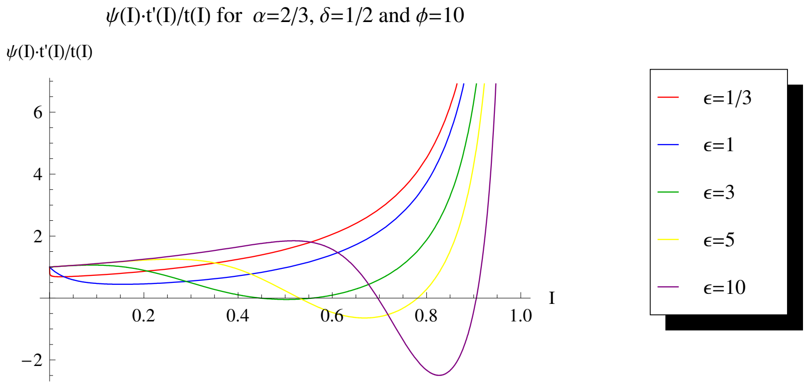

Figure 3: *Employment effects of offshoring for type-f industries varying convexity of cost*

not exist.

The irrelevance of $I = 1$ notwithstanding, there is a significant difference between type-f and type-i industries. For type-i industries, although the *level* of employment of low-skilled labor may follow a non-monotonic pattern of adjustment to successive improvements of the offshoring technology, the employment *changes* fall monotonically as I increases. By way of contrast, given the dominance of the extensive margins both at $I = 0$ and as $I \to 1$, type-f industries necessarily exhibit a non-monotonic pattern of adjustment also in employment levels, as evidenced by figures 2 and 3. However, as with type-i industries, a range of I where offshoring comes with net job creation is no foregone conclusion. As with figure 1, it requires a minimum steepness of the cost schedule also for type-f industries; see figure 2. In other words, in an environment where the tasks affected are almost equally impersonal (or personal), offshoring is unlikely to cause net job creation. On the other hand, for a given steepness of cost at the margin I, net job creation from an enhanced import of tasks requires a minimum degree of convexity, as evidenced from figure 3. But it follows from the interval conditions of proposition II that any increase in the convexity shifts the relevant range of I where job creation dominates job destruction to the right. Loosely speaking, while convexity may guarantee net job creation from offshoring, it does so at the expense of a longer road where the loss of tasks is first associated with job losses. Witness the line for $\epsilon = 10$ in figure 3 rising for low values of I. More generally, a convex cost-schedule $t(i)$ means that the "meaty" gains from offshoring only arise toward the upper end of the task range where the level of offshoring cost is already relatively high.

We may summarize this numerical exercise as follows. For both, type-i and type-f industries, if the tasks affected by offshoring are almost equally impersonal in nature, then the employment level of low-skilled labor will fall monotonically as technological improvements enhance the scope of offshoring. This corresponds to the case highlighted in Keuschnigg & Ribi (2009). However, if the offshoring cost schedule is rather steep, reflecting a large variation in the costliness of offshore performance across different tasks, and if the cost differentials are also unequally distributed across tasks, then there is a distinct possibility that offshoring comes with net job creation, albeit only after the industry has surpassed a threshold level of offshoring. Generally, this outcome is more likely to arise in type-i industries, where comparative advantage is more deeply entrenched, than in type-f industries with shallow comparative advantage.

For both types of industries, a higher value of δ, implying a less concave production technology, and a higher value of α, indicating a larger share of offshorable labor in the wage bill, tend to brighten the picture. In terms of figures 1 through 3, lower values of these parameters would amount to downward shifts of the $\psi(I)$-lines, thus increasing likelihood and relevance of sub-ranges of job-creation ranges within the range of offshorable tasks $[0, 1)$.

6 Conclusion

In the general public, offshoring is associated, first and foremost, with job losses. This is mirrored by a corresponding rhetoric and attitude of policy makers. Empirical studies have produced mixed results, but it is probably fair to say that overall the evidence does not suggest a strong macroeconomic impact of offshoring on the level of unemployment. Yet, micro-level evidence clearly shows that industrial restructuring often involves a fair dose of offshoring which is associated with domestic job losses.

Existing theoretical models of offshoring shed little light on this issue. With very view exceptions, they rely on general equilibrium trade models that assume full employment. In this paper we present a theoretical model that allows us to juxtapose job destruction and job creation as a result of offshoring. Job destruction happens whenever firms broaden the set of tasks performed offshore, because of an improved technology of linking tasks across distance. Job creation is caused by the cost-savings deriving from such technological improvements, which induce firms to expand their entire production. Modeling both in a unified framework, we are able to identify conditions where job creation dominates job destruction.

Our model envisages a process of "high-resolution globalization", whereby profit maximizing decisions about sourcing of tasks lead to a steady increase in the share of tasks performed offshore. This process involves a systematic variation in the relative importance of job destruction and job creation. We have traced out this variation theoretically, as well as through a numerical analysis. The conclusion is that for certain types of industries, identified by particular characteristics of their offshoring technology, the conditions for net job creation will be met. However, they will typically be met only at relatively late stages of offshoring, where technological improvements dictate offshoring also of tasks that are relatively personal in nature, with less personal tasks already having fallen victim to offshoring due to earlier improvements. We identify something like the "curse of small steps", meaning that a small dose of incipient offshoring is likely to hurt in terms of job losses and wage cuts, whereas further doses may lead to jobs and wage gains.

However, such non-monotonicity is not a foregone conclusion, but it is a distinct possibility. Whether or not it arises depends on both, the slope and the degree of convexity of the offshoring cost schedule. Loosely speaking, the larger the variation across tasks in the degree to which they are personal or impersonal, the stronger the job creation effect in later stages of offshoring. In a similar vein, the more equally dispersed the differences in the degree of personality across tasks, the more likely a net job gain at later stages of offshoring.

7 Appendix

A1 Properties of $\Omega(I)$

Since offshoring provides a possibility to save on low-skilled labor costs, one should expect that $\Omega(I) < 1$. This inequality can be rewritten as

$$\int_0^I t(i)\,\mathrm{d}i < I t(I) \tag{A.1}$$

which holds true for all $I \in (0,1]$ if $t'(i) > 0$ for all $i \in [0,1]$. Hence, $\Omega(I) < 1$ for all $I \in (0,1]$. It is instructive to depict this term graphically. Thus, in

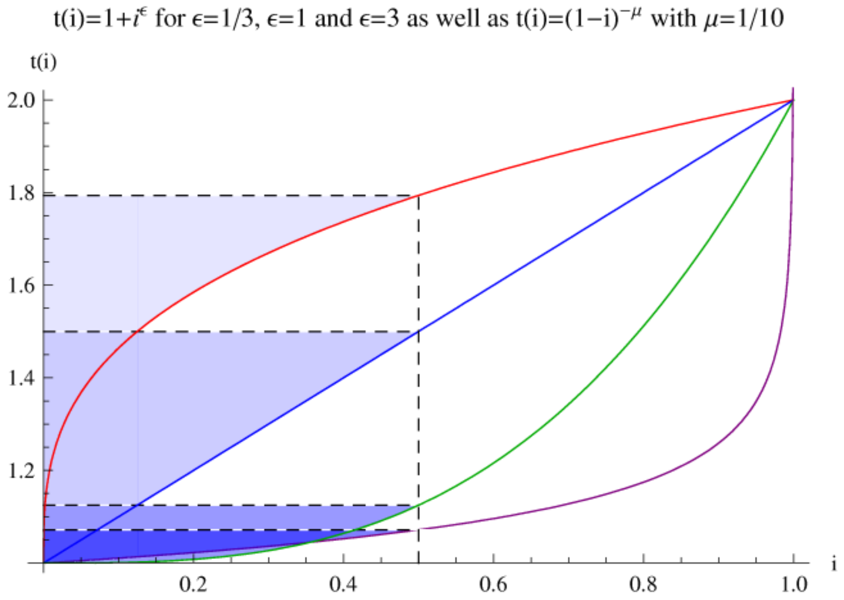

Figure 4: *Inframarginal factor cost savings for f- and i-industries*

figure 4 the shaded areas are measures of the cost-savings from offshoring, i.e., $t(I)\,[1-\Omega(I)]$, at $I = .5$ for alternative functional forms of $t(i)$. The diagram nicely highlights the inframarginal nature of $\Omega(I)$.

The first derivative of $\Omega(I)$ with respect to I equals

$$\frac{\mathrm{d}\Omega(I)}{\mathrm{d}I} = -\frac{\int_0^I t(i)\,\mathrm{d}i\, t'(I)}{[t(I)]^2}. \tag{A.2}$$

Note that $\Omega'(I) < 0$ for all $I \in (0,1]$ while $\Omega'(I) = 0$ if $I = 0$. Moreover, defining the elasticities $\xi(I) := \Omega'(I)\, I/\Omega(I)$ and $\zeta(I) := t'(I)\, I/t(I)$, we have

$$\frac{\xi(I)}{\zeta\,(I)} = \frac{-\int_0^I t\,(i)\,\mathrm{d}i}{t(I)\Omega(I)} < 0. \tag{A.3}$$

In addition, we have

$$\begin{aligned}\xi(I) + \zeta\,(I) &= -\frac{\int_0^I t\,(i)\,\mathrm{d}i\, t'\,(I)}{[t\,(I)]^2}\frac{I}{\Omega(I)} + \frac{t'(I)I}{t(I)} \\ &= \left[-\frac{\int_0^I t\,(i)\,\mathrm{d}i}{t\,(I)\,\Omega(I)} + 1\right]\frac{t'(I)I}{t(I)} > 0,\end{aligned} \tag{A.4}$$

and

$$\frac{\xi(I) + \zeta\,(I)}{\zeta(I)} = \left[\frac{-\left[\Omega(I) - (1-I)\right]}{\Omega(I)} + 1\right] = \frac{1-I}{\Omega(I)} > 0. \tag{A.5}$$

A2 Proof of Proposition II

Taking equation (27), and observing that $[1 + \lambda(I)\tau] > 0$, it follows that $\hat{e}/\hat{\beta} < 0$, if and only if

$$\psi\,(I) = \frac{I}{1-I}\frac{1}{\zeta(I)} + \Delta\frac{\xi(I)}{\zeta(I)} < 0, \tag{A.6}$$

which may be rewritten as

$$\frac{\Omega(I)}{1-I} + \Delta\Omega'(I) < 0. \tag{A.7}$$

Inserting $\Omega'(I)$ from the appendix, we obtain

$$\int_0^I t(i)\mathrm{d}i\left[\frac{1}{1-I} - \Delta\frac{t'(I)}{t(I)}\right] < -t(I). \tag{A.8}$$

Multiplying both sides by βw_L^*, and using (4), we may write

$$m\left[1 - \Delta\frac{t'(I)}{t(I)}(1-I)\right] < -\beta w_L^* t(I)(1-I) = -d. \tag{A.9}$$

Rearranging terms and multiplying out by -1, we finally obtain

$$\Delta\zeta(I) > \left(\frac{d}{m} + 1\right)\frac{I}{1-I}, \tag{A.10}$$

which completes the proof.

A3 Derivation of $\psi(I)$ for $t(i) = (1-i)^{-\mu}$

Given the offshoring cost schedule $t(i) = (1-i)^{-\mu}$ the aggregated offshoring costs for the range of tasks I can be calculated as

$$\int_0^I t(i)\,\mathrm{d}i = \begin{cases} -\ln(1-I) & \text{if } \mu = 1 \\ \frac{1-(1-I)^{1-\mu}}{1-\mu} & \text{if } \mu \neq 1. \end{cases} \tag{A.11}$$

Inserting these expressions into equation (7) and (A.2) yields

$$\frac{\Omega'(I)}{\Omega(I)} = \begin{cases} \frac{\ln(1-I)}{[1-\ln(1-I)](1-I)} & \text{if } \mu = 1 \\ -\frac{\mu-\mu(1-I)^{1-\mu}}{\left[1-\mu(1-I)^{1-\mu}\right](1-I)} & \text{if } \mu \neq 1. \end{cases} \tag{A.12}$$

Finally the equations above can be combined with $I/\zeta(I) = (1-I)/\mu$ in order to obtain equation (31). The first order derivative of equation (31) with respect to I can be written as

$$\frac{\partial\psi(I)}{\partial I} = \begin{cases} -\left(1+\frac{\alpha\delta}{1-\delta}\right)\frac{(1-I)^{-1}}{[1-\ln(1-I)]^2} & \text{if } \mu = 1 \\ -\left(1+\frac{\alpha\delta}{1-\delta}\right)\frac{(1-\mu)^2(1-I)^{-\mu}}{\left[1-\mu(1-I)^{1-\mu}\right]^2} & \text{if } \mu \neq 1, \end{cases} \tag{A.13}$$

which is strictly negative for $I \in (0, 1]$.

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