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Abstract

The policy debate views offshoring as job destruction. Theoretical models of offshoring mostly assume full employment. We develop a model of task trade that allows for equilibrium unemployment. In this model, there are two margins of adjustment. At the extensive margin, moving tasks offshore destroys jobs. At the intensive margin, due to higher productivity of labor in domestic tasks it creates jobs. Exploring these conditions in detail, we identify the potential of non-monotonic adjustment: Early stages of offshoring always lead to higher unemployment, while later stages may entail net job creation. We highlight this potential through numerical simulations.

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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. Increasingly, firms literally place bits and pieces of their value added processes in foreign labor markets that offer a cost advantage. While economists tend to view this as a positive development that “leverages” the gains from trade, the public debate on offshoring is characterized by contention. During the past decade, offshoring has been perceived primarily as a cause of worker displacement and job losses.¹ Workers view it as competition head on from foreign labor to perform single tasks within their firms. Working for a viable firm does not mean much in terms of job security, if the firm actively pursues international arbitrage through offshore performance of individual tasks. Moreover, job losses that form an integral part of profitable firm strategies seem more difficult to accept politically than job losses that come with the decline of firms, or whole industries, brought about by international competition on goods markets.

Economists’ reaction to this debate has been to point out that, whatever the concomitant circumstance of a job loss, if its domestic opportunity cost is larger than the cost of obtaining the service from offshore, then keeping the job would be forgoing efficiency gains from international division of labor.² However, this message is difficult to get across to people whose presumption is that the opportunity cost of the job is zero since the alternative is unemployment. And it appears difficult to sound credible with the message, if it draws on models that rule out all unemployment. Indeed, given the public’s preoccupation with *worker displacement effects* of offshoring, it must appear somewhat surprising that mainstream theoretical models of offshoring mostly assume full employment of a constant labor supply. In such a modeling environment, all labor set free through offshoring of certain production or non-production tasks is smoothly reallocated to employment elsewhere in the economy, with no change in aggregate employment or unemployment. Arguably, this assumption makes existing literature appear

¹An excellent account of the tension between the academic view and the public and political debate on offshoring is found in [Mankiw & Swagel \(2006\)](#).

²See again [Mankiw & Swagel \(2006\)](#).

somewhat disconnected from practical concerns. For the sake of credibility, we should therefore address offshoring with models that allow for unemployment, duly taking into account the direct displacement from offshoring, even if this seems unlikely to contribute much to the overall rate of unemployment.³

Arguably, the most direct job displacement occurs when a certain task of a production process is no longer performed by domestic labor, but is replaced by offshore provision through foreign labor. Grossman & Rossi-Hansberg (2008) have developed a general equilibrium model in the spirit of standard trade theory where a given type of labor input is composed of a continuum of tasks and where the job displacement appears as an endogenous variation of the margin that separates domestic tasks from offshore tasks. The authors frame job displacement from offshoring as an equivalent increase of labor supply, assuming that this is smoothly absorbed through a Rybczynski-type reallocation, with zero unemployment. In this paper, we place the paradigm of task trade in a modeling environment that is less benign in two ways. First, it rules out reallocation across sectors, and secondly, it features labor market frictions with equilibrium unemployment. We thus directly address the concerns raised in the policy debate about offshoring.

The model also highlights a second effect that stands against this fear of worker displacement. This is the cost advantage, often called the *productivity effect* of offshoring. From an economy-wide perspective, this amounts to a better exploitation of comparative advantage, facilitated by an expansion of the set of tradable goods to formerly nontradable activities or tasks. Therefore, in a distortion-free world with full employment offshoring should be beneficial for the economy as a whole, at least for constant terms of trade.⁴ However, it need not constitute a

³For descriptive micro-level evidence of job losses due to offshoring, see NAPA (2006) and ERM (2007) and the evidence reported in Mankiw & Swagel (2006). For a survey see OECD (2007). On the limited contribution of offshoring to the overall labor market turnover, see Bhagwati et al. (2004) and Mankiw & Swagel (2006). However, Blinder (2009) calculates that in the future as much as a quarter of the US manufacturing work force might be affected by offshoring. The general case for trade models with equilibrium unemployment is argued forcefully by Davidson & Matusz (2009, ch.1). The case seems particularly pressing, if we look at trade in the form of offshoring.

⁴Intuitively, offshoring means uncoupling certain pieces of value-added where an economy has a stronger comparative advantage from other pieces where this advantage is weaker, or where the economy even has a (latent)

Pareto improvement. Indeed, the bulk of existing theoretical literature addresses the redistribution effects of offshoring. In a competitive general equilibrium setting with full employment the factor price changes arising in a certain scenario of offshoring may be derived from the zero profit conditions of a competitive equilibrium, once we know how this scenario disturbs these conditions.⁵ Very often, the disturbance may equivalently be described as a certain form of technological improvement. As demonstrated by [Grossman & Rossi-Hansberg \(2008\)](#), the equilibrium adjustment of factor prices then depends on the factor- or sector-biasedness of this technological improvement.⁶ In this paper, instead of investigating how the *productivity effect* of offshoring is distributed across factors in a full employment world, we assume a world with equilibrium unemployment and explore conditions under which it is strong enough to offset the *worker displacement effect*.

We thus respond to the aforementioned need to address the concerns raised in the policy debate on offshoring. However, our analysis also responds to the need of an improved guidance for empirical work. Attempts to use large scale cross-section and time series evidence in order to quantify the labor market effects of offshoring typically focus on variations in aggregate employment (or unemployment) or wages.⁷ These are the joint outcome of both, the immediate comparative disadvantage; see [Jones \(2000\)](#). For an extension of the gains from trade theorem to offshoring, see [Markusen \(2010\)](#) and [Baldwin & Robert-Nicoud \(2010\)](#).

⁵Depending on details related to assumptions about intersectoral factor mobility, the full employment conditions may come into play as well. Most of the literature focuses on Heckscher-Ohlin-type models with perfect mobility of factors across sectors. See [Jones \(2000\)](#) and [Feenstra \(2010\)](#). For a model assuming specific factors, see [Kohler \(2004a\)](#).

⁶Their task trade model features two perfectly competitive industries using two types of labor. If lower offshoring costs lead to enhanced offshoring of tasks performed by low-skilled labor, the *productivity effect* is equivalent to a Harrod-neutral technological improvement in the use of low-skilled labor. Provided the two industries use the two types of labor in different proportions, a zero profit equilibrium with unchanged prices of final goods then requires a higher wage for low-skilled labor. By assumption, the worker displacement is fully absorbed by reallocation of both types of labor between the two industries.

⁷For empirical studies, see [Egger & Egger \(2003, 2006\)](#), [Amiti & Wei \(2005\)](#), [Görg, Hijzen & Hine \(2005\)](#) and [Geishecker & Görg \(2008\)](#). For an attempt to disentangle the *productivity effect* of service offshoring in the US, see [Amiti & Wei \(2009\)](#). A recent paper by [Wright \(2011\)](#) looks at sectoral employment effects of offshoring through the lens of a log-linear version of the [Grossman & Rossi-Hansberg \(2008\)](#). However, the analysis is based on the usual full employment assumption.

worker displacement as well as the *productivity effect* of offshoring, and of the labor market institutions governing the equilibrium adjustment to these “shocks”. As will become evident below, the results that we derive in this paper should be helpful also for improving specifications of employment and/or wage equations that permit disentangling the *displacement* and *productivity effects* also in empirical work.

Before we proceed with our theoretical model, we must briefly mention a further effect of offshoring that has caused quite a bit of attention in the literature. In one way or another, offshoring is likely to affect the output pattern. Therefore, a large country must also expect a *terms of trade effect*. Grossman & Rossi-Hansberg (2008) have demonstrated that this feeds back into factor prices via the well-known Stolper-Samuelson theorem. In addition, it has welfare consequences. Indeed, the *terms of trade effect* may even wipe out the entire *productivity effect*, so that the economy becomes worse off through the technological improvement that drives offshoring.⁸ However, as pointed out by Bhagwati et al. (2004), the empirical relevance of the *terms of trade effect* of offshoring seems rather limited.⁹ At any rate, it certainly does not dominate the public debate nearly as much as the direct *worker displacement effect* and the *productivity effect* of offshoring. In this paper, we therefore focus on the *worker displacement effect* and the *productivity effect*, allowing for labor market frictions that lead to equilibrium unemployment.

Our analysis of offshoring is not the first to allow for equilibrium unemployment. The first to do so is Egger & Kreickemeier (2008), where international fragmentation is based on endowments with two types of labor, with wages subject to a fair wage constraint that leads to unemployment. More directly related to this paper, Keuschnigg & Ribi (2009) look at offshoring in a model

⁸This is an instance of “immiserizing growth”; see Johnson (1955) and Bhagwati (1958). The conditions for offshoring to be beneficial are identified, using standard gains from trade logic, in two recent papers by Markusen (2010) and Baldwin & Robert-Nicoud (2010).

⁹An alleged negative *terms of trade effect* has entered the center stage of public debate as a result of an article by the late Paul Samuelson (2004). That paper was partly seen as pointing out the specter of harmful offshoring due to an adverse *terms of trade effect*. However, while the scenario envisaged by Samuelson did involve a deterioration of the US terms of trade, this was not caused by offshoring as such; see Bhagwati et al. (2004) as well as Mankiw & Swagel (2006). “Trade Disputes” in *The Economist*, Sept 16, 2004 and Farrell & Rosenfeld (2005) exemplify the broad attention received by this argument.

where unemployment is due to costly search and matching. At the firm level, offshoring is modeled as a discrete choice between domestic or cheaper foreign provision of a specific input, which requires only low-skilled labor. The choice is governed by a fixed cost of offshoring. The *worker displacement effect* appears as a continuous margin between firms that choose offshore provision and firms relying on domestic employment. Any reduction in the cost of offshore input provision thus comes at the expense of domestic employment through an increase in the share of offshoring firms, driving up unemployment of low-skilled labor. Importantly, by assumption offshoring firms hire no domestic labor at all, hence there is no way in which the *productivity effect* of offshoring would ever lead to domestic job creation. All it does is enhancing earnings perspectives of the other factor, i.e., high-skilled labor.

In Mitra & Ranjan (2010) a single type of labor is employed subject to search and matching in two sectors, each producing a nontradable good. Technology is assumed to be Ricardian, although in one of the sectors it involves two intermediates, each produced with labor and assembled to the final good according to a CES aggregate. Domestic labor is equally suitable for production of either type of input. However, by assumption only one of these inputs is amenable to offshore procurement. Since output is linear in the input aggregate, the job surplus generated by an optimal mix of employment is independent of total employment. Wage bargaining determines the equilibrium labor market tightness as well as the wage rate paid in either of the two sectors as functions of output prices, but leaves relative sector size indeterminate. This is determined through an arbitrage condition for the unemployed who must decide in which sector to search for employment. Offshoring reduces the minimum unit cost for CES input assembly. For a given price of the final output, firms find domestic hiring more attractive, which increases labor market tightness as well as the wage paid in the offshoring industry. This is the *productivity effect* of offshoring.

The important point to note here is that the model by Mitra & Ranjan (2010) rules out any *worker displacement effect* of offshoring. Offshoring per se never causes firms to shed domestic labor, but simply leads them to post more vacancies upon realizing that the *productivity effect* enhances the job surplus on domestic employment which is smoothly reoriented towards the non-offshorable input. The downside of offshoring comes only through the equivalent of a *terms*

of trade effect. Given that offshoring is restricted to one of two sectors, it affects outputs in the two industries asymmetrically, and market clearing requires adjustment of prices in the two industries. This counteracts the job creation associated with the *productivity effect*. Depending on the assumption about intersectoral factor mobility, it may even overcompensate the job creation associated with the *productivity effect*.

Obviously, the models by [Keuschnigg & Ribi \(2009\)](#) and [Mitra & Ranjan \(2010\)](#) are at opposite extremes. The former rules out any job creation on account of the *productivity effect* of offshoring, which seems overly pessimistic. The latter rules out the sort of direct worker displacement that preoccupies the practical debate on offshoring. Given that output price effects of offshoring seem somewhat far-fetched, it thus risks being overly optimistic. In this paper, we therefore explore the middle ground defined by the coexistence of a *worker displacement* and a *productivity effect* of offshoring, while ignoring the *terms of trade effect*. Given what we have said above, this seems the most relevant case. Our analysis adopts the task trade paradigm of [Grossman & Rossi-Hansberg \(2008\)](#) where these two effects are in sharp focus. Empirical observations suggest that offshoring depends on task characteristics which are more or less orthogonal to the usual distinction between jobs requiring low-skilled and high-skilled labor.¹⁰ By the same token, almost all sectors of the economy employ labor that performs offshorable tasks. We therefore assume a single sector employing a single type of domestic labor, alongside unspecified other inputs. The economy is assumed to be small, importing labor tasks against exports of the final good for given terms of trade.

Adopting this view of offshoring allows us to go beyond existing literature in that we explore the relative strengths of the job displacement and job creation effects along the process of globalization, as firms move from low levels of offshoring, directed at tasks with low offshoring cost, to ever higher levels affecting tasks which are more costly to move offshore. Intuitively, the balance of job destruction and job creation is likely to undergo significant changes as this process unfolds. We shall demonstrate that this may generate a *non-monotonic relationship* between the level of offshoring and the level of domestic employment (or the rate of unemployment) and

¹⁰See [Spitz-Oener \(2006\)](#) and [Becker et al. \(2009\)](#) for empirical studies that look at tasks performed by labor with different skill content.

domestic wages. We also explore properties of the offshoring technology that are responsible for the relative strengths of the two effects and for whether or not this non-monotonicity arises.¹¹

We proceed in three steps. *First*, we derive what we call a “task-trade-adjusted” labor demand curve which incorporates an endogenous adjustment of the extensive margin of task trade in response to changes in the wage rate. The technology of offshoring appears as a shifter in this demand curve. In a *second step*, we then confront this extended labor demand curve with a wage curve that represents labor market frictions in order to determine the equilibrium wage rate and the equilibrium rate of unemployment. We derive this wage curve for two distinct paradigms of equilibrium unemployment, search and matching as well as efficiency wages due to shirking. This second step allows us to identify the precise condition under which the *job displacement effect* is dominated by the *productivity effect*, meaning that offshoring of tasks generates domestic jobs. With a view on the aforementioned empirical literature, we also translate our theoretical insight into a statement that relates to observable magnitudes, and we discuss income distribution effects. The *third step* then turns to a numerical simulation that highlights the potential of a non-monotonic relationship between the level of offshoring and the level of domestic employment. In doing so, we make a distinction between two types of industries based on certain characteristics in their offshoring technologies. With respect to the cost of offshoring, we call these “deep cost advantage” and “shallow cost advantage” industries, respectively.

2 Offshoring with Equilibrium Unemployment

2.1 Task-Trade-Adjusted Inverse Labor Demand

Our model economy produces a single good using labor input, l . Output is generated according to a production function, $F(l)$, with $F''(l) < 0 < F'(l)$. For a constant returns to scale technology, concavity of $F(l)$ may be interpreted as the presence of a second factor, say capital, which is fixed in supply. A unit of l requires the performance of many tasks according to a Leontief-type technology. Following Grossman & Rossi-Hansberg (2008), we assume a continuum of tasks,

¹¹Another model featuring a non-monotonic adjustment to increased offshoring is the one proposed by Rodríguez-Clare (2010). In this framework the rich country, which offshores certain tasks, may suffer in the short run, but then gains in the long run, when research effort is adjusted optimally.

indexed by $i \in [0, 1]$. Without loss of generality, we assume that for a unit-level of l the same amount of labor is required on each of these tasks. Units are scaled such that the measure of tasks required per unit of l is equal to unity. Thus, in order to secure a level l of the labor input, a firm has to employ an amount of labor equal to $l \int_0^1 di$. The labor required to perform a subset of tasks, $i \in [0, j]$ with $j < 1$, is equal to $l \int_0^j di$.

Firms decide on where to perform tasks based on cost advantage. Tasks may be performed abroad where firms face perfectly elastic supply of labor at a wage rate, $w^* > 0$, or by domestic labor with a labor cost equal to W . We make no distinction between intra-firm performance and outsourcing of tasks to independent suppliers. Suppose a firm wants to secure an input level l and it wants to perform tasks within the sub-range $i \in [0, \bar{i}]$ abroad. Then the cost of these offshore activities is equal to $w^* l \int_0^{\bar{i}} \beta t(i) di$, and the cost of tasks performed domestically is equal to $W l \int_i^1 di$. 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. 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 such that $t'(i) > 0$. The offshoring cost of a task is determined by several characteristics, but for the sake of easy reference we follow [Blinder \(2009\)](#) in calling tasks with low (high) values of $t(i)$ impersonal (personal) tasks.¹²

For reasons emphasized in the introduction, we want to allow for domestic cost of labor, W , to be influenced by labor market frictions and unemployment. One would expect that, up to a point, the balance between the job displacement and job creation effect of offshoring does not depend on the details of these frictions. It turns out that this is, indeed, the case. We demonstrate this by first deriving a relationship between the domestic labor cost, W , and the profit maximizing level of domestic employment, subject to the condition that firms engage in cost minimizing task trade. We call this a “*task-trade-adjusted inverse labor demand curve*” (TTLD), although the presence of labor market frictions implies that W may not be interpreted in a conventional way as the wage rate received by domestic workers (and assumed given from

¹²See [Leamer & Storper \(2001\)](#) and [Levy & Murnane \(2004\)](#) for broader descriptions of the underlying characteristics that determine the magnitude of $t(i)$.

an individual firm's perspective).¹³ Subsequently, we specify two types of labor market frictions that we may see behind W . The first is the search and matching paradigm due to [Pissarides \(2000\)](#), and the second is the paradigm of shirking and efficiency wage setting, due to [Shapiro & Stiglitz \(1984\)](#). We first proceed with our TTLD and turn to the two labor market frictions below.

Cost minimization determines a marginal task, I , which separates tasks $i < I$ that are performed offshore from tasks $i > I$ that are performed domestically. The marginal task satisfies

$$W = \beta t(I) w^*. \quad (1)$$

In order to arrive at a non-trivial offshoring equilibrium with $I > 0$, we assume $W > \beta t(0) w^*$.¹⁴ We shall henceforth call I the (endogenous) extensive margin of offshoring. Thus, moving tasks $i < I$ offshore saves on domestic labor costs, W , and at the margin I these cost-savings are offset by the extra cost of offshoring. Obviously, the extensive margin of offshoring, I , decreases with β , which measures the overall costliness of offshoring.

Given I , firms maximize periodic profits by choosing the optimal amount of labor input l according to

$$\max_l \left[F(l) - Wl(1 - I) - w^* l \beta \int_0^I t(i) di \right]. \quad (2)$$

Observing condition (1) on I , maximum profits may be rewritten as

$$\pi = \max_l [F(l) - \Omega(I) Wl], \quad (3)$$

$$\text{whereby } \Omega(I) := (1 - I) + \frac{\int_0^I t(i) di}{t(I)}. \quad (4)$$

The term $\Omega(I)$ is well known from [Grossman & Rossi-Hansberg \(2008\)](#). It captures 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 $I \in (0, 1]$. The term

¹³See [Kohler \(2004b\)](#) for a similar approach where trade takes place in tasks that draw on two types of labor, and where the focus lies on a *task-trade-adjusted factor price frontier*.

¹⁴The assumption of a cheap and perfectly elastic foreign labor supply is meant to reflect, albeit in a stylized way, the doubling of the world labor force through the "entry" of China and India, as well as the ex-Soviet bloc countries; see [Freeman \(2009\)](#).

$\Omega(I)$ makes the entire schedule of offshoring cost, $t(i)$, an integral part of the technology. The corresponding first order condition is

$$W = \frac{F'(l)}{\Omega(I)}. \quad (5)$$

Denoting domestic labor demand by E , we may write $E = (1 - I)l$, and substituting this into equation (5) allows us to write the TTLD as

$$W = F' \left(\frac{E}{1 - I} \right) / \Omega(I). \quad (6)$$

The right hand side of this equation expresses the cost savings term, $\Omega(I)$, as a positive effect on the marginal productivity of domestic labor. Concavity of the production function implies that for a given level of I the marginal product of labor is falling in E .

Now suppose that, in line with the scenario addressed in [Grossman & Rossi-Hansberg \(2008\)](#), offshoring becomes less costly, $\hat{\beta} := d\beta/\beta < 0$. The first order condition on I in (1) then implies that there is an increase in the extensive margin, $\hat{I} > 0$, such that offshoring now affects additional tasks. Introducing elasticities $\xi(I) := I\Omega'(I)/\Omega(I) \leq 0$ and $\Delta := -[lF''(l)/F'(l)]^{-1} > 1$, we may derive the following Lemma:¹⁵

Lemma 1: *A lower cost of offshoring, $\hat{\beta} < 0$, leads to a upward shift in the task-trade-adjusted inverse labor demand curve, provided that $-\Delta\xi(I) > I/(1 - I)$.*

The proof of this Lemma simply uses proportional differentiation of equation (6), setting $\hat{W} = 0$, and solving for \hat{E} . In economic terms the interpretation is as follows. Holding the domestic labor cost, W , constant means that the entire reduction in the cost of offshoring is absorbed by locating additional tasks abroad that are more costly to offshore, until at the margin the relevant no-arbitrage condition (1) is again satisfied. Introducing an elasticity $\zeta(I) := It'(I)/t(I) > 0$, this implies $\hat{I} = -\hat{\beta}/\zeta(I) > 0$, if $\hat{\beta} < 0$ as assumed. The *worker displacement effect* then emerges as $-[I/(1 - I)]\hat{I} < 0$. We may also call this the *extensive margin* adjustment of labor demand, a *worker displacement effect* sparked off by less costly offshoring. But in line with the elasticity $\xi(I) < 0$, a higher margin I also entails a positive *productivity effect*, which translates into higher

¹⁵While the term $\Omega(I)$ measures the *productivity effect* deriving from offshoring tasks $i < I$, the elasticity $\xi(I)$ measures the *productivity effect* of an *increase* in the margin of offshoring. It is straightforward to show that $\xi(I) < 0$ for all $I \in (0, 1]$ and $\xi(I) = 0$ for $I = 0$. The term Δ corresponds in absolute value to the elasticity of a standard labor demand curve. Assuming constant returns to scale of the underlying technology, we have $\Delta > 1$.

labor demand according to $-\Delta\xi(I)\hat{I} > 0$. We refer to this as the *intensive margin* adjustment of labor demand. Lemma 1 states the condition under which the *productivity effect* dominates the *displacement effect*.

Of course, $\hat{W} = 0$ is notional. The domestic cost of labor will typically change as a result of less costly offshoring. Depending on the frictions on the domestic labor market, the change in W involves a change in both the wage rate received by domestic workers and the rate of unemployment. We now turn to a detailed analysis of labor market frictions, first taking up the search and matching paradigm and then assuming a shirking environment with efficiency wage setting. In either case, we shall derive a “*labor market equilibrium*” (LME) locus, which may then be combined with the TTLD schedule, in order to tie down the labor market effects of offshoring. It turns out that for our purposes we may use a single LME locus representing both types of labor market frictions in order to trace out the wage and unemployment effects of globalization in the form of a lower offshoring cost, β .

2.2 Search and Matching

Suppose the labor force is equal to L , with an unemployment rate denoted by u and a rate of vacancies denoted by v . Following Pissarides (2000), we assume that unemployed workers, $U = uL$, are matched with vacancies, $V = vL$, according to a standard Cobb-Douglas matching function. Specifically, the number of matches is determined as $M(U, V) = Lm(u, v) = Lu^\eta v^{1-\eta}$. The parameter $\eta \in [0, 1]$ denotes the so-called matching elasticity. It is a key measure of the labor market distortion in this model. Note that for $\eta = 1$ all unemployed would instantly be matched without the need of costly vacancies. Given this functional form, we can compute the rate at which firms are able to fill their vacancies, $q(\theta)$, and the rate at which unemployed workers find a new job, $\theta q(\theta)$, as follows

$$q(\theta) = \frac{m(u, v)}{v} = \left(\frac{v}{u}\right)^{-\eta} = \theta^{-\eta}, \quad (7)$$

$$\theta q(\theta) = \frac{m(u, v)}{u} = \left(\frac{v}{u}\right)^{1-\eta} = \theta^{1-\eta}. \quad (8)$$

In these expressions the term θ measures labor market tightness, $\theta := v/u$. The flow equation describing labor market turnover follows as $\dot{E} = \theta q(\theta)(L - E) - \lambda E$, where \dot{E} measures the

instantaneous net flow from unemployment into employment. The number of employed increases by the unemployed who find a job, $\theta q(\theta)(L - E)$, while it decreases by λE , where $\lambda \in [0, 1]$ is an exogenous rate of job separation. Setting $\dot{E} = 0$, we derive an equation that describes the steady state relationship between the labor market tightness and the level of employment:

$$\theta = \left(\frac{\lambda E}{L - E} \right)^{\frac{1}{1-\eta}}. \quad (9)$$

As usual, there is a positive relationship between labor market tightness and total employment.¹⁶

Once a match occurs, the worker and the firm find themselves in a bargaining situation. We follow the standard literature in assuming Nash bargaining between each individual worker and the firm. We leave the number of firms unspecified, hence we allow for more than one worker being matched to any one firm.¹⁷ Nash bargaining requires derivation of the value of filling a vacancy, which is the discounted stream of future profits from the match. The periodic profit of a representative firm is the excess of output, $F(l)$, over the entire labor cost, which is composed of wage cost and the cost of hiring. The wage cost of domestic employment is $lw(1 - I)$, and the foreign wage cost is equal to $lw^*\beta_0^I t(i)di$. The hiring cost is equal to κV , whereby κ denotes the cost (in terms of output produced) per vacancy posted. Vacancies and employment are related through an equation of motion which takes into account that offshore employment is not subject to costly search and matching

$$(1 - I)\dot{l} = q(\theta)V - \lambda(1 - I)l. \quad (10)$$

In this equation \dot{l} denotes the instantaneous change in total employment, both domestic and offshore. Dividing by $1 - I$, it becomes clear that frictionless offshoring is taken into account through a suitably scaled-up matching rate, $q(\theta)/(1 - I)$.

In the appendix we show that maximization of the firm value with a real interest rate, r , implies

$$\frac{F'(l)}{\Omega(I)} = w + \frac{(r + \lambda)\kappa}{q(\theta)} = W. \quad (11)$$

¹⁶Equation (9) can be seen as a standard Beveridge curve, but focusing on employment, E , instead of unemployment, U .

¹⁷An interpretation of this assumption is that each worker negotiates with a different representative of the firm, aiming at wages that are consistent with simultaneously maintaining all matches; see Rotemberg (2006).

The second equality derives from comparison with (6). This equation thus reveals the details behind the domestic labor cost, W , if labor market frictions are as in the search and matching model of Pissarides (2000). The representative firm's rent that derives from filling a vacancy with a worker earning a wage rate w is equal to

$$R = \frac{\frac{F'(l)}{\Omega(I)} - w}{r + \lambda} = \frac{\kappa}{q(\theta)}. \quad (12)$$

Intuitively, the asset value that corresponds to a filled domestic job equals the firm's marginal product of labor minus the wage paid, discounted by the interest rate, r , plus the separation rate, $\lambda \in [0, 1]$. With free entry this must be equal to the hiring cost per matched worker, $\kappa/q(\theta)$.

Turning to the value equations for the two states of employment or unemployment, V_E or V_U , and assuming risk neutral workers, we have

$$rV_E = w + \lambda(V_U - V_E), \quad (13)$$

$$rV_U = z + \theta q(\theta)(V_E - V_U), \quad (14)$$

where $z > 0$ denotes the outside option of workers, e.g. the money-equivalent of leisure. The wage rate, w , is now determined by (generalized) Nash bargaining. Denoting the bargaining power of workers by $\gamma \in [0, 1]$, we have

$$w = \arg \max \left[(V_E - V_U)^\gamma R^{1-\gamma} \right]. \quad (15)$$

The first order condition corresponding to (15) states that

$$V_E^j - V_U = \frac{\gamma}{1-\gamma} R = \frac{\gamma}{1-\gamma} \frac{\kappa}{q(\theta)}. \quad (16)$$

where the second equality follows from (12). Substituting back into the workers' value equations, we finally arrive at an equilibrium relationship between the domestic wage rate and labor market tightness

$$w = z + \frac{\gamma}{1-\gamma} \left[\theta \kappa + \frac{(r + \lambda) \kappa}{q(\theta)} \right]. \quad (17)$$

We call equation (17) the *labor market equilibrium* (LME) locus. Together with the *task-trade-adjusted inverse labor demand* (TTLD) schedule in equation (6), it determines the equilibrium wage rate, w , as well as labor market tightness, θ . Replacing for the domestic labor

cost, $W = w + \frac{(r+\lambda)\kappa}{q(\theta)}$, and using the steady state relationship between labor market tightness and the level of employment, E , given in (9), we may describe the labor market equilibrium as follows:

$$\text{TTLD: } w = \frac{1}{\Omega(I)} F' \left(\frac{E}{1-I} \right) - (r + \lambda) \kappa \left(\frac{\lambda E}{L - E} \right)^{\frac{\eta}{1-\eta}}, \quad (18)$$

$$\text{LME: } w = z + \frac{\gamma}{1-\gamma} \left[\left(\frac{\lambda E}{L - E} \right)^{\frac{1}{1-\eta}} \kappa + (r + \lambda) \kappa \left(\frac{\lambda E}{L - E} \right)^{\frac{\eta}{1-\eta}} \right]. \quad (19)$$

It is easy to verify that the TTLD schedule is falling in w . As firms expand employment, the marginal product of labor is falling, while at the same time the requirement of a higher number of vacancies inflates hiring costs. Equilibrium thus requires that, other things equal, more employment comes at the expense of a lower wage rate. Conversely, the LME locus is upward sloping, with the following intuition: Higher levels of employment require posting additional vacancies, leading to a tighter labor market and thus a higher cost of filling a vacancy. This, in turn, implies a higher job rent for the firm. But with Nash wage bargaining workers and firms capture constant fractions of the job surplus, and workers will thus receive a higher wage. Figure 1 illustrates both equilibrium conditions. Interestingly, the level of offshoring, I , enters the picture only through the demand side shifting the TTLD curve up or down, in line with Lemma 1 above.

2.3 Efficiency Wage Setting

Framing our model of offshoring with equilibrium unemployment with the aid of a TTLD schedule and an LME locus has an advantage in terms of generality. In particular, it allows for interpretations of the LME locus along other lines than the search and matching paradigm. In this subsection, we demonstrate that an alternative possible interpretation is efficiency wage setting in a shirking environment, as proposed by [Shapiro & Stiglitz \(1984\)](#). We briefly restate the core relationships of this model that lead to an LME locus which is completely analogous to (19) above. As will become evident, although it has a different interpretation regarding the underlying labor market frictions, in qualitative terms the labor market effects of offshoring are the same in both models of the labor market.

As before, workers are assumed to be risk neutral, with an instantaneous utility that depends

positively on the wage rate, w , and negatively on the effort level, ε . The effort undertaken by the worker determines the effective labor input per physical unit of employment. For simplicity it is assumed that the effective labor delivered by a worker is equal to her effort level, ε . Moreover, the worker can choose to provide either full effort, $\varepsilon = 1$, or else spend her work time shirking, in which case $\varepsilon = 0$ and the firm has zero output. To prevent workers from shirking, firms can monitor their workers, with a probability, $p \in (0, 1)$, of detecting a worker who is shirking. A worker can lose her job for two reasons. The first is to be caught when shirking, in which case the worker is fired. The second is that the firm is hit by a negative shock, in which case it shuts down. This happens with a given probability, $b \in (0, 1)$, independently on workers' shirking. In the state of joblessness, a worker faces a constant instantaneous probability, $a \in (0, 1)$, of finding a new job.

Under these assumptions, the value functions of employed workers (E) when shirking (S) and not shirking (N), respectively, are given by

$$rV_E^S = w + (b + p)(V_U - V_E^S), \quad (20)$$

$$rV_E^N = w - 1 + b(V_U - V_E^N). \quad (21)$$

Note that we have set $\varepsilon = 1$. In these equations, V_U denotes the asset value of being unemployed (U), and r again denotes the real rate of interest. Workers refrain from shirking, if and only if $V_E^N \geq V_E^S$. This no-shirking condition translates into the following condition for an efficiency wage

$$w \geq \tilde{w} = rV_U + \frac{(b + p + r)}{p}. \quad (22)$$

The term rV_U is the instantaneous (flow) utility that a worker enjoys while being unemployed. This consists of the unemployment benefit (if any)¹⁸ plus the utility (in present value terms) that derives from an expected change in status, $a(V_E - V_U)$. In equilibrium, of course, V_E must be equal to V_E^N . Writing z for the unemployment benefit, we use $rV_U = z + a(V_E - V_U)$ together with (21), setting $V_E = V_E^N$, in order to solve for V_E and V_U . Inserting the solutions for V_U into

¹⁸In Shapiro & Stiglitz (1984), this benefit is interpreted as a minimum payment that firms need to pay workers who are fired upon being caught.

(22), we obtain the final no-shirking condition

$$w \geq \tilde{w} = z + \frac{a + b + p + r}{p}. \quad (23)$$

The model is closed by setting a so as to guarantee a stationary level of employment in a state where there is no shirking. Observing that $\dot{E} = a(L - E) - bE$ and setting $\dot{E} = 0$ yields $a = bE/(L - E)$. Inserting into (15) gives rise to a *labor market equilibrium* (LME) locus. The two curves describing the labor market now emerge as

$$\text{TTL D: } w = \frac{1}{\Omega(I)} F' \left(\frac{E}{1 - I} \right). \quad (24)$$

$$\text{LME: } w \geq \tilde{w} = z + 1 + \frac{1}{p} \left(\frac{bL}{L - E} + r \right). \quad (25)$$

Note that the TTL D schedule now simplifies, since the labor cost, W , coincides with the wage rate, w . Moreover, the meaning of z is now somewhat different from its meaning in the search and matching paradigm. Obviously, this locus is upward-sloping, and the reason is as follows. A higher employment level implies a higher steady state rate of job finding, a , which increases the worker's reservation wage and therefore also the efficiency wage that rules out shirking behavior.

3 General Equilibrium

We assume a representative household earning all domestic labor income, wE , and receiving all profits, π , made by domestic firms. Substituting from (2) and (11), household income then emerges as

$$Y := wE + \pi = F \left(\frac{E}{1 - I} \right) - \frac{(r + \lambda) \kappa}{q(\theta)} E - w^* l \beta \int_0^I t(i) di. \quad (26)$$

The household is assumed to spend all of this income on the final good. Adding final goods demand from firms' hiring activity, $\frac{(r + \lambda) \kappa}{q(\theta)} E$, we may identify export supply of the final good as the difference between output and demand

$$X = F \left(\frac{E}{1 - I} \right) - \left[Y + \frac{(r + \lambda) \kappa}{q(\theta)} E \right]. \quad (27)$$

Inserting for Y from above, we realize that the economy exports the final good against imports of tasks, and that trade is balanced: Final goods exports, X , are equal in value to imports of tasks, $w^* l \beta \int_0^I t(i) di$.

We describe general equilibrium in terms of the extensive margin of offshoring, I , and domestic employment, E , as well as the domestic wage rate, w . These three variables are uniquely determined by the first order condition on offshoring (1), with the labor cost replaced from (11), and the TTLD curve in (18) as well as the LME locus, which in turn appears either in its search and matching version (19) or its efficiency wage version (24).¹⁹ A remarkable property of the model is that either version of the LME locus is independent of the extensive margin of offshoring. Lemma 1 thus gives rise to the first core proposition of our model.

Proposition I: *For search and matching frictions as well as for efficiency wage setting, equilibrium adjustment to less costly offshoring, $\hat{\beta} < 0$, holds a rise in both, the domestic wage rate and domestic employment, provided that $-\Delta\xi(I) > I/(1 - I)$.*

Figure 1 illustrates this result, combining the downward-sloping TTLD schedule with an upward-sloping LME locus. The figure may represent either type of labor market frictions, although strictly speaking the TTLD curve for search and matching is subject to a downward-shift, relative to its position for the efficiency wage paradigm; see equations (18) and (24). However, what matters here is a vertical shift that arises as a consequence of $\hat{\beta} < 0$, and this shift is identical for either type of labor market friction. The figure includes a schedule FOCO which depicts the first order condition on offshoring in (1), with the labor cost replaced in line with (11). For the search and matching environment, this schedule is downward sloping but has a flatter slope than the TTLD curve (at the intersection point). For the efficiency wage environment, the FOCO locus is flat. Of course, general equilibrium requires that all three curves have a common intersection, whereby the necessary adjustment runs through the extensive margin, I , which shifts both the TTLD curve and the FOCO locus.

Let us briefly look at a scenario $\hat{\beta} = (\beta_0 - \beta_1)/\beta_0 < 0$. On impact, the change of β shifts the FOCO locus but leaves the TTLD unchanged. Note that $\Omega(I)$ does not depend on β . But the initial intersection point A now violates the first order condition for offshoring. The marginal task I_0 is cheaper to obtain from offshore than through domestic labor. A cost minimizing response requires shifting the margin to a task $I_1 > I_0$ which is more costly to offshore than

¹⁹It is relatively obvious that existence and uniqueness of such an equilibrium is ensured by the continuity and curvature assumptions of the model. We assume that, given $F(l)$, the offshoring technology $w^*\beta t(i)$ is such that a non-trivial equilibrium with an interior solution for I arises.

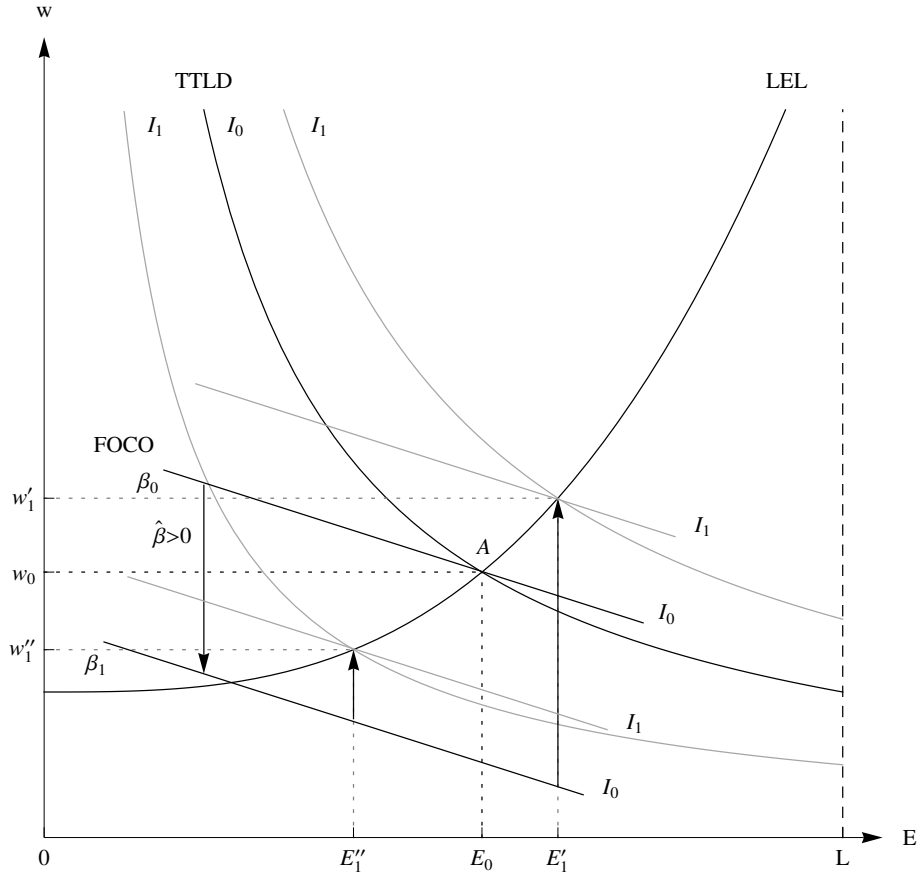


Figure 1: Labor market equilibrium with lower cost of offshoring

I_0 , but which is equally expensive with foreign labor as with domestic labor. This shifts up the FOCO locus, depending on the slope $t'(I)$. And it shifts the TTLD curve, depending on $\Omega'(I)$ as well as on $F''[E/(1-I_0)]$. If the condition of proposition I is fulfilled, then TTLD shifts up, and vice versa. Figure 1 depicts the two possible cases. Of course, since $\Omega'(0) = 0$, the condition can be fulfilled only for $I_0 > 0$. Notice, however, that the level of $\Omega(I_0)$ is immaterial for the adjustment. What matters are the derivatives of the cost schedule $t(i)$ and the marginal productivity schedule for labor in production of the final good.

In order to obtain a better understanding of the driving forces of adjustment, we now proceed towards an explicit derivation of the comparative statics of employment, E , with respect to β . In doing so, we focus on the search and matching version of labor market distortions. In this

case, the labor cost may be written as $W = W(w, \theta)$, whereas the LME locus may be described as $w = w(\theta)$; see equations (11) and (17). For simplicity, we now set $z = 0$. Combining, we write $W = \tilde{W}(\theta) := W[w(\theta), \theta]$, and we denote the elasticity of the function \tilde{W} by ω . It is easy to show that $\omega = \mu + (1 - \mu)\eta$, whereby $\mu := \gamma\theta q(\theta) / [\gamma\theta q(\theta) + r + \lambda]$.²⁰ Given $0 < \eta < 0$ and $0 < \mu < 1$, we have $0 < \omega < 1$. the equilibrium may be now described by the following two equations:

$$F' \left(\frac{E}{1 - I} \right) / \Omega(I) = \tilde{W}(\theta), \quad (28)$$

$$w^* \beta t(I) = \tilde{W}(\theta). \quad (29)$$

The first equation combines the TTLD curve and the LME locus, whereas the second expresses the relationship between the extensive margin of offshoring I and labor market tightness. Remember that labor market tightness is related to employment as expressed in equation (9). For simplicity, we now normalize the labor endowment, $L = 1$. We then have $\hat{\theta} = [1/(1 - \eta)] [1/(1 - E)] \hat{E}$. Thus, the above two equations determine a general equilibrium relationship between changes in β and changes in domestic employment, E . Proportional differentiation of the two equations yields

$$\Delta\omega\hat{\theta} + \hat{E} = - \left[\frac{I}{1 - I} + \Delta\xi(I) \right] \hat{I}, \quad (30)$$

$$\hat{I} = \frac{\omega\hat{\theta} - \hat{\beta}}{\zeta(I)}. \quad (31)$$

Replacing for $\hat{\theta}$, we obtain

$$\hat{E} = \frac{\psi(I)}{1 + \vartheta(I)\alpha} \hat{\beta}. \quad (32)$$

In this equation, we have used the following definitions

$$\alpha := \frac{\omega}{(1 - \eta)(1 - E)} > 0, \quad (33)$$

$$\psi(I) := \frac{I}{(1 - I)\zeta(I)} + \Delta \frac{\xi(I)}{\zeta(I)}, \quad (34)$$

$$\vartheta(I) := \frac{I}{(1 - I)\zeta(I)} + \Delta \frac{\xi(I) + \zeta(I)}{\zeta(I)} > 0. \quad (35)$$

²⁰For the efficiency wage case, we have $W = w$.

It is easy to see that $\xi(I) + \zeta(I) = (1 - I)\zeta(I)/\Omega(I) > 0$ and, hence, $\vartheta(I) > 0$. Notice the interpretation of the parameter α which is the elasticity of the overall cost of labor, W , with respect to domestic employment, $\alpha := \hat{W}/\hat{E}$.

Given the solution for \hat{E} , the remaining endogenous variables are determined in a straightforward fashion. First, the labor market tightness is tied to employment through (9) above, whence $\hat{\theta} = \hat{E}/[(1 - \eta)(1 - E)] = (\alpha/\omega)\hat{E}$. Thus, the ambiguity with respect to \hat{E} carries over to labor market tightness, θ . The extensive margin of offshoring follows in line with (31), which implies $\hat{I} = -\hat{\beta}(\alpha/\omega)/[\zeta(I)(1 + \vartheta(I))]$. Unsurprisingly, $\hat{\beta} < 0$ unambiguously raises the offshoring margin, I . And finally, the wage rate adjusts according to $\hat{w} = \tilde{\omega}\hat{\theta}$, where $\tilde{\omega} := \tilde{\mu} + (1 - \tilde{\mu})\eta$, whereby $\tilde{\mu} := \theta q(\theta)/[\theta q(\theta) + r + \lambda]$ is a share parameter which is closely related to μ as defined above in relation to labor cost, W . All of this implies that $\hat{w} = (\tilde{\omega}\alpha/\omega)\hat{E}$. Note that $\tilde{\omega}$ is the elasticity of the negotiated wage, w , with respect to labor market tightness, while ω measures the same elasticity for labor cost, W , inclusive of the hiring cost. Both, the total labor cost, W , and the wage rate, w , move in line with employment and thus share the same ambiguity with respect to changes in β .

It might be argued that the elasticity $\xi(I)$, which plays a key role in the above propositions, is a somewhat arcane concept which seems quite remote from empirical quantification. However, the following proposition shows that it may be related in a relatively straightforward way to observable magnitudes.

Proposition II: *If we denote the domestic labor cost per unit of labor input l as $d := W(1 - I)$, and the cost of imported tasks per unit of l as $m := w^*\beta \int_0^I t(i)di$, then at any interior equilibrium level of offshoring, $I \in (0, 1)$, an increase in the extensive margin of offshoring, brought about by a reduction in the cost of offshoring β , entails net domestic job creation, if and only if $\Delta t'(I) > (d/m + 1)[t(I)/(1 - I)]$.*

The proof is as follows. Taking equation (32), and observing that $1 + \vartheta(I)\alpha > 0$, it follows that net domestic job creation will arise upon $\hat{\beta} < 0$, if and only if $\psi(I) < 0$. This condition may, in turn, be written as

$$\frac{\Omega(I)}{1 - I} + \Delta\Omega'(I) < 0. \quad (36)$$

Inserting $\Omega'(I)$ and $\Omega(I)$ we obtain

$$\int_0^I t(i) di \left[\frac{1}{1-I} - \Delta \frac{t'(I)}{t(I)} \right] < -t(I). \quad (37)$$

Multiplying both sides by βw^* , and using (1), we may write

$$m \left[1 - \Delta \frac{t'(I)}{t(I)} (1-I) \right] < -\beta w^* t(I) (1-I) = -d. \quad (38)$$

Rearranging terms and multiplying out by minus one, we finally arrive at the condition $\Delta t'(I) > (d/m + 1) [t(I)/(1-I)]$, which completes the proof.

Proposition II is illustrated in figure 2 which depicts the key magnitudes involved, looking at the entire continuum of tasks with some initial interior equilibrium, I_0 , determined by an underlying value of β_0 . For simplicity the figure assumes a linear schedule $t(i)$. There are two types of magnitudes involved. The left-hand side of the condition in proposition II captures local “*slope-properties*”, meaning the elasticity of labor demand, Δ , and the slope of the offshoring schedule at the extensive margin I_0 , $t'(I_0)$. The right-hand side captures what might be called an “*interval-property*” of the offshoring technology, meaning areas m and d which are determined by the entire shape of the offshoring technology over the sub-range $i \in [0, I_0)$. The magnitude of m , the cost of imported tasks per unit of labor input, is depicted by the shaded area $DCBE$, while d , the labor cost of domestic employment, is depicted by the dotted area $EBGF$. Notice also that the area ABC measures inframarginal cost savings from offshoring tasks $i \in [0, I_0)$: $W_0 [1 - \Omega(I_0)]$. Proposition II is, of course, closely related to proposition I, but it formulates a crucial additional insight in that it establishes a relationship between the interval condition of net job creation and observable magnitudes. It thus also establishes a potential for improvements of empirical approaches towards estimating labor market effects of offshoring.

How does offshoring affect the *distribution of income* between labor and the other factor used in production who receives profit income? Let us assume, for the sake of concreteness, that there is a single second factor, viz. capital. Since a lower β unambiguously leads to a larger overall labor input l , it increases profit income π . Therefore, if the condition of proposition I is violated, then offshoring unambiguously increases the capital rental relative to the wage rate. However, if this condition is satisfied, then both the capital rental and the wage rate are increasing. In the appendix, we derive necessary and sufficient conditions for an increase in

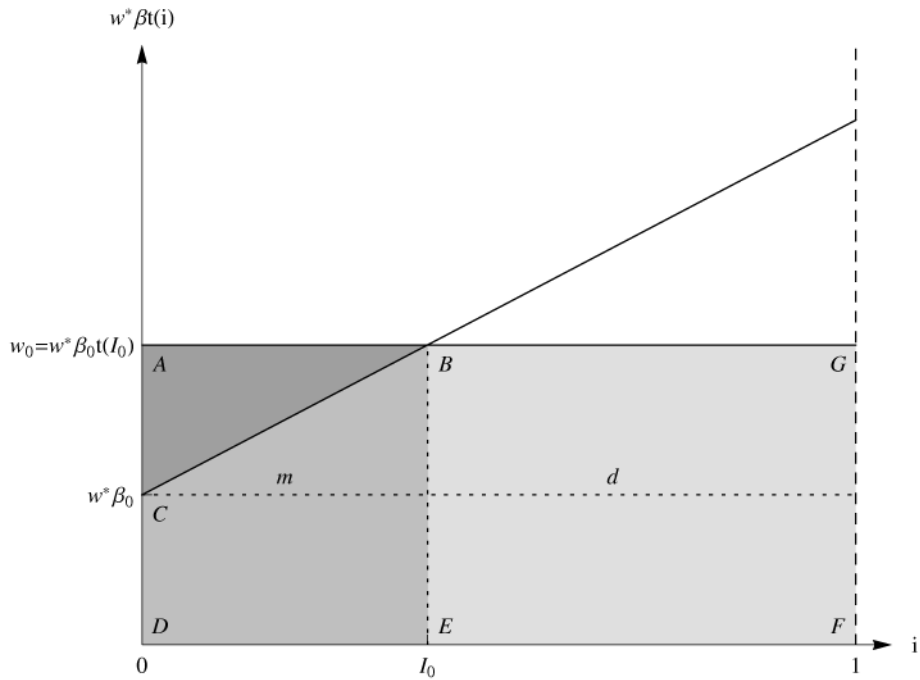


Figure 2: *Illustration of Proposition II*

the extensive margin of offshoring to change the relative income position of domestic workers, either looking at profit income relative to aggregate income accruing to employed domestic labor, i.e., $\pi/[w(1-I)l] = \pi/(wE)$, or at the rental-wage ratio, π/w . As perhaps expected, these conditions are more likely to be fulfilled at later stages of offshoring where I is large. Moreover, a large elasticity of labor demand is similarly conducive to a distributional effect which favors labor. Finally, such an effect is more likely for a high value of $\tilde{\omega}$, the elasticity of the wage rate, w , with respect to labor market tightness, θ , and a low value of ω , the elasticity of labor cost, W , with respect to labor market tightness.

Before we turn to a more detailed analysis of this relationship, it is worth considering a few generalizations. A first relates to a multi-sector case with possible *terms of trade effects*. What we have said so far may be taken as characterizing any one out of several sectors of an economy. The sectors are related to each other through goods market clearing as well as through some form of labor mobility across sectors. For instance, in [Mitra & Ranjan \(2010\)](#) households are heterogeneous regarding their underlying preference for working in two sectors, which governs

their search behavior. Equilibrium requires a no-arbitrage-condition in terms of the two sectors' labor market tightness.²¹ This, in turn, determines a sector-specific labor force and a certain output level for each sector, given final goods prices. If the economy is large, or even closed on final goods markets as in [Mitra & Ranjan \(2010\)](#), goods market clearing will require goods price adjustments, which may run counter to the initial adjustments. But as we have argued in the introduction, significant *terms of trade effects* are an unlikely ingredient of an offshoring scenario. Within the present model, we may reinterpret the elasticity Δ , which captures the concavity of production as capturing the *terms of trade effect*, lowering the marginal *value* product of labor over and above what concavity of production alone would imply.

Whatever the assumption about endogenous final goods prices, an economy facing offshoring scenarios that differ across sectors which, in turn, differ in terms of the severity of search frictions, the effect on the aggregate rate of unemployment will typically be ambiguous, even if the sectoral adjustment is unambiguously positive in terms of employment. This was pointed out by [Mitra & Ranjan \(2010\)](#), and the reason is that the overall labor adjustment may imply reallocation from low-unemployment- to high-unemployment-sectors.

A further generalization might relax the assumption of zero frictions in employment of foreign labor for task performance in the domestic value added chain. Within the present single sector model, this would be equivalent to introducing a *terms of trade effect* in that any increase in the extensive margin of offshoring would lower the price of the (exported) final good, relative to foreign labor embodied in imported tasks. We may thus generalize the interpretation of our rising $t(i)$ schedule as incorporating search frictions present in hiring foreign labor when extending the tasks performed offshore.

4 Numerical Treatment

An important insight from the preceding analysis is that the relationship between domestic employment and the extensive margin of offshoring *may be* non-monotonic, meaning that for low levels of I we have $\hat{E}/\hat{\beta} > 0$ (a net job loss through $\hat{\beta} < 0$), while for a high enough level of I we may observe $\hat{E}/\hat{\beta} < 0$. Whether or not such a non-monotonicity arises depends on how

²¹A similar condition can be envisaged for the shirking and efficiency wage paradigm.

the local and the interval properties of the schedule $t(i)$, highlighted in proposition II above, vary as the economy moves from $I = 0$ to $I \rightarrow 1$, driven by ever lower values of β . For easier wording, we subsequently refer to this as the economy’s adjustment to globalization. Resorting to numerical simulation, we want to shed further light on the potential of non-monotonicity.

Notice the difference between β and $t(i)$ which capture different aspects of the offshoring technology. While β measures the overall costliness of offshoring across all tasks, the schedule $t(i)$ measures how the cost of offshore performance *varies* between different tasks. What is of interest here is not the level of $t(i)$ as such, but its slope and its shape in the sense of the above mentioned *local* and *interval property*, respectively. 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 successively lower values of β drive industries from lower to higher values of $I \in [0, 1)$.²²

Numerical analysis requires that we parameterize the schedule $t(i)$. Accepting the notion of a continuum of tasks and positive monotonicity of $t(i)$, i.e., $t'(i) > 0$, it would seem relatively innocuous to assume monotonicity also of the first derivative. In this section, we make this assumption. However, the sign of $t''(i)$ certainly seems ambiguous. Indeed, this is where industries or countries will likely differ. Perhaps more importantly, differences across industries must be expected in the limiting behavior of $t(i)$ as $i \rightarrow 1$. Our analysis suggests a fundamental distinction between industries where this limit is a finite number, and industries where it is equal to infinity. This distinction is of clear economic significance. The former type of industry bears a close resemblance to what [Bhagwati \(2006\)](#) calls “shallow” or “thin” cost advantage.²³ In such industries, successive reductions in β may eventually lead to a complete dislocation of all tasks. In other words, the industry as a whole loses viability in the domestic economy and moves all its operations offshore.²⁴ By way of contrast, a case where $t(i)$ approaches infinity

²²We acknowledge that a well-behaved equilibrium with $I = 1$ does not exist by specifying the relevant interval as an open interval $[0, 1)$.

²³We deliberately abstain from using the term *comparative* advantage which does not fit a single-sector general equilibrium model.

²⁴As we have argued above, in our stylized single-sector-model 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.

might be called “deep” cost advantage. Due to the highly personal nature of a sub-range of tasks, domestic viability of this industry is more deeply entrenched, so that less costly offshoring as such will never wipe out the industry as a whole. In the following, we trace out values of $\psi(I)$ throughout the entire interval $I \in [0, 1)$ for alternative functional forms representing “deep” or “shallow” advantage industries.

4.1 “Deep” Cost Advantage

The case of “deep” cost advantage is described by a strictly convex function of the form²⁵

$$t(i) = (1 - i)^{-\sigma}, \quad (39)$$

where $\sigma > 0$. Notice that a larger value of σ implies a higher slope as well as a higher degree of convexity for the entire schedule. Given this functional form, the crucial term determining the sign of the employment effect of offshoring emerges as

$$-\psi(I) = \begin{cases} -1 - \Delta \ln(1 - I) / [1 - \ln(1 - I)] & \text{if } \sigma = 1 \\ -\sigma^{-1} + \Delta [1 - (1 - I)^{1-\sigma}] / [1 - \sigma(1 - I)^{1-\sigma}] & \text{if } \sigma \neq 1. \end{cases} \quad (40)$$

Taking limits, we find $\lim_{I \rightarrow 0} -\psi(I) = 1/\sigma > 0$, while $\lim_{I \rightarrow 1} -\psi(I) = (\sigma\Delta - 1)/\sigma \geq 0$ for $\sigma \leq 1$, and $\lim_{I \rightarrow 1} -\psi(I) = (\Delta - 1)/\sigma > 0$ for $\sigma > 1$. Figure 3 looks at how the term $-\psi(I)$ behaves as the extensive margin of offshoring increases from low to high values of I . Remember that $-\psi(I) > 0$ means net job creation through $\hat{\beta} < 0$ at the margin I . To anchor all lines at a common unitary value for $I = 0$, we scale the plot to $\sigma\psi(I)$. Obviously, this does not affect the horizontal intersection points which mark the turning points where the *productivity effect* of offshoring turns into a vehicle of net job creation.

The principal message of figure 3 is simple, clear and important. If the offshoring technology features a large enough value of σ , then, monotonicity of $t(i)$ notwithstanding, an industry with “deep” cost advantage exhibits a non-monotonic adjustment to globalization, with job losses at the beginning and net job creation at later stages.²⁶ Notice that a high value of σ means a high *overall level of “task diversity”*, meaning that the continuum of tasks spans activities

²⁵This case is also briefly considered in Grossman & Rossi-Hansberg (2008).

²⁶In passing, it is worth pointing out that this pattern of adjustment may also lie behind the ambiguities that

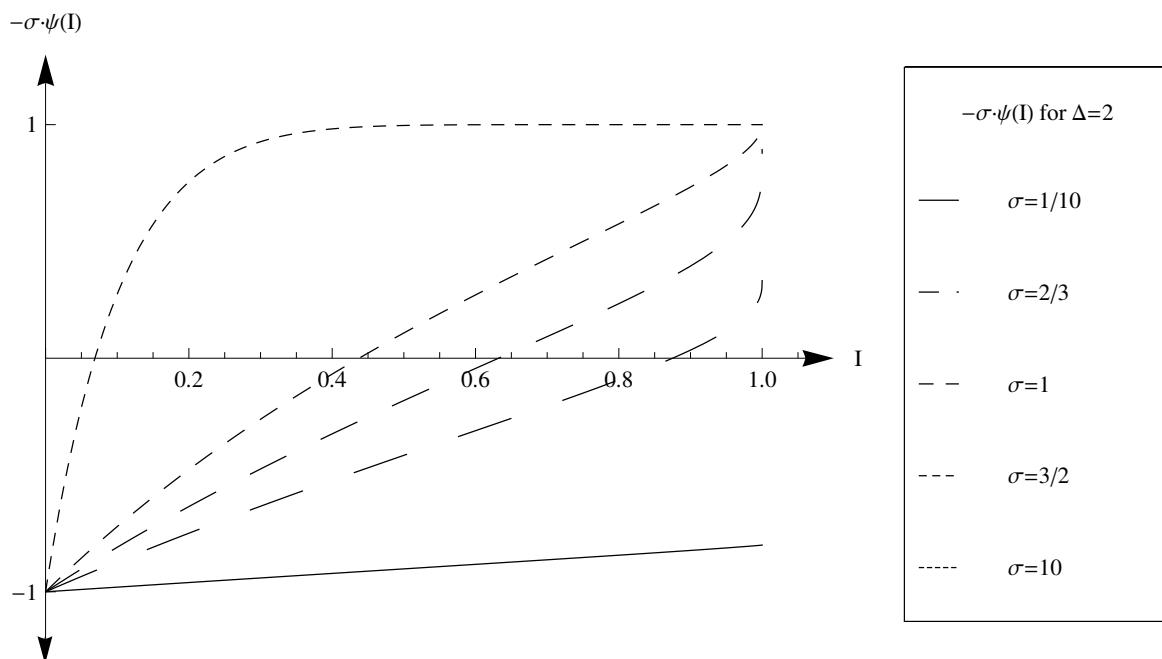


Figure 3: *Offshoring with “deep” cost advantage*

that differ a lot in the degree to which they require face-to-face contact or other features that make offshore performance costly. Intuitively, this should be conducive to high cost-savings, $\Omega(I)$, from offshoring and thus also enhance the potential for net job creation. However, what matters for net job creation according to proposition I is the *change* in $\Omega(I)$, and not its level, and this is governed by *local* task diversity. From figure 3 we learn that a higher degree of convexity, and thus task diversity, makes the turning point from a net job loss to job creation appear at earlier stages in the continuum of tasks. Moreover, given the monotonicity also of the derivative of $t(i)$, there can only be a single such turning point, if any. Intuitively, for offshoring technologies represented by (39), the prevalence of infinitely costly tasks shields domestic labor from such a scenario. Hence, once job creation from offshoring sets in, it continues to dominate the adjustment for all subsequent extensions of the offshoring margin. However, while the presence of a “deep” advantage shields from losing viability altogether, it is no guarantee that

have been discovered in the empirical literature that looks at the relationship between employment and openness; see Felbermayr et al. (2011).

offshoring will ever cause net job creation.

Our discussion of proposition II has emphasized two types of conditions that characterize the technology of offshoring and are responsible for the labor market adjustment to offshoring. We have called these the *slope* and the *interval properties*, respectively, relating to the schedule $t(i)$. The functional form introduced in (39) has the disadvantage that there is a single parameter, σ , that captures both the slope and the curvature of the cost schedule. To see what this means it is useful to further dissect the elasticity $\xi(I)$ into

$$\xi(I) = -\zeta(I)\Sigma(I) \quad \text{with} \quad \Sigma(I) := \frac{\int_0^1 t(i) di}{(1-I)t(I) + \int_0^I t(i) di} \in [0, 1]. \quad (41)$$

This clearly reveals that the slope and the curvature of $t(i)$ are two distinct properties of the offshoring technology that determine the *productivity effect* and thus the labor market effect of offshoring. The elasticity $\zeta(I)$ is familiar from above, reflecting the steepness of $t(i)$ at $i = I$. We may also see it as a measure of *local* task diversity. In contrast, the term $\Sigma(I)$ captures the curvature of $t(i)$ over the entire interval $i \in [0, 1]$. In figure 2 the numerator of $\Sigma(I)$ measures the area $DCBE$, while the denominator is the sum of the areas $DCBE$ and $EBGF$. Notice that proposition I requires, loosely speaking, $-\xi(I)$ to be large at relatively early stages of offshoring, i.e., for low values of I . Notice, moreover, that $t(i)$ being strictly convex as in (39) implies that $\int_0^I t(i) di$ comes close to its maximum only at late stages of offshoring. But, if the schedule is concave, then $\int_0^I t(i) di$ may come close to its maximum (at $I = 1$) also for low values of I . In other words, for a convex (concave) cost schedule $t(i)$, $\Sigma(I)$ is almost one at late (early) stages of offshoring. We now turn to a somewhat richer parameterization of this schedule that allows for both convexity and concavity, and where *overall* task diversity is controlled for independently of the shape of $t(i)$.

4.2 “Shallow” Cost Advantage

To discriminate between slope and curvature we may choose the following functional form

$$t(i) = 1 + \phi i^\epsilon, \quad (42)$$

with $\phi, \epsilon > 0$. Although 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 a finite value $t(1) = 1 + \phi$. Since

$t(0) = 1$, the parameter ϕ thus measures the *overall* degree of task diversity. A high overall degree of diversity means that looking at the entire interval of tasks, they differ a lot in terms of the characteristics that make them more or less costly to offshore.

Any given degree of task diversity may be associated with varying degrees of “*task concavity*”. By this we mean that task diversity need not be spread equally across the continuum of tasks. With a low degree of task concavity we mean that task diversity is concentrated among tasks with a high level of offshoring cost, and conversely for a high degree of task concavity where it is concentrated among tasks at the lower part of the continuum. In the specification (42) task concavity is governed by the parameter ϵ , whereby $\epsilon < 1$ ($\epsilon > 1$) generates a concave (convex) schedule $t(i)$, while $\epsilon = 1$ marks the knife edge case of linearity. Thus, the degree of task concavity falls as ϵ rises.

Figures 4 and 5 give two separate illustrations of $\psi(I)$, in order to highlight the role of task diversity and task concavity for job creation and job destruction in the adjustment to globalization. The crucial term $\psi(I)$ now emerges as

$$\psi(I) = \left[\frac{1}{1-I} - \Delta \frac{\left(1 + \frac{\phi}{1+\epsilon} I^\epsilon\right) \phi \epsilon I^\epsilon}{(1 + \phi I^\epsilon)^2 - (1 + \phi I^\epsilon) \left(\frac{\phi \epsilon}{1+\epsilon} I^{\epsilon+1}\right)} \right] \left(\frac{I^{1-\epsilon}}{\epsilon \phi} + \frac{I}{\epsilon \phi^2} \right). \quad (43)$$

As before, we want to anchor our illustration at $-\psi(0) = -1$. It is straightforward to see that for any functional form of $t(i)$ the term $[t'(I)/t(I)]\psi(I)$ approaches a value of one as I approaches 0. Hence we scale our plots accordingly.²⁷ Figure 4 highlights variations in the overall task diversity, while figure 5 highlights different degrees of task convexity. Both figures use $\Delta = 2$, as in figure 3. Figure 4 assumes $\epsilon = 5$, which implies a convex schedule $t(i)$ and thus a low degree of task concavity. In turn, figure 5 assumes $\phi = 10$, which implies a large overall task diversity.

The principal message of figure 4 is relatively easy to see. First of all, in contrast to the “deep” cost advantage above, job destruction clearly dominates as $I \rightarrow 1$. However, for intermediate levels of offshoring adjustment to further globalization is characterized by net job creation, provided the overall degree of task diversity is large enough. For low task diversity, say with $\phi = 0.5$, where all tasks are about equally difficult to offshore, extending the margin of offshoring

²⁷This 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 (43). But this is inconsequential for our qualitative analysis.

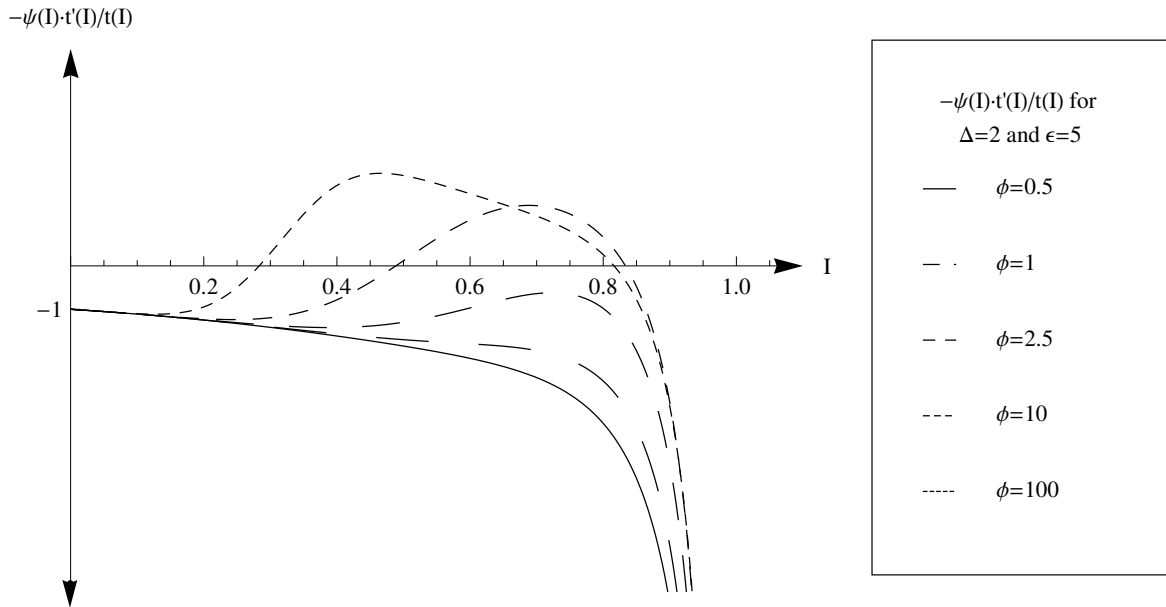


Figure 4: “Shallow” cost advantage and degree of “task diversity”

is always associated with a net job loss. Figure 5 is perhaps more interesting in that it explores the role of task concavity. We observe a notable pattern of variation. For a concave offshoring technology ($\epsilon < 1$), domestic employment falls monotonically with an increase in the offshoring margin. In terms of our discussion in the previous section, although for each conceivable level of offshoring the *interval property* is more favorable for a more concave technology, any increase in the term $\Sigma(I)$ that comes with a higher I is coupled with a worsening of the *local property*, i.e., a lowering of $\zeta(I)$.²⁸ The opposite is true for a convex technology, where the *local* and the *interval properties* reinforce each other. In this sense, task convexity is inherently conducive to net job creation over a certain sub-range of offshoring. However, net job creation requires a minimum amount of convexity. In figure 5, such sub-ranges emerge for $\epsilon = 3$, $\epsilon = 5$ and $\epsilon = 10$. These cases suggest a further noteworthy conclusion: While higher task convexity makes a *non-monotonic relationship* between domestic employment and the level of offshoring more likely, it also postpones the range of tasks where this relationship turns positive to ever later stages.

²⁸Notice the difference between the *local* measure $t'(I)$ and the *overall* degree of task diversity.

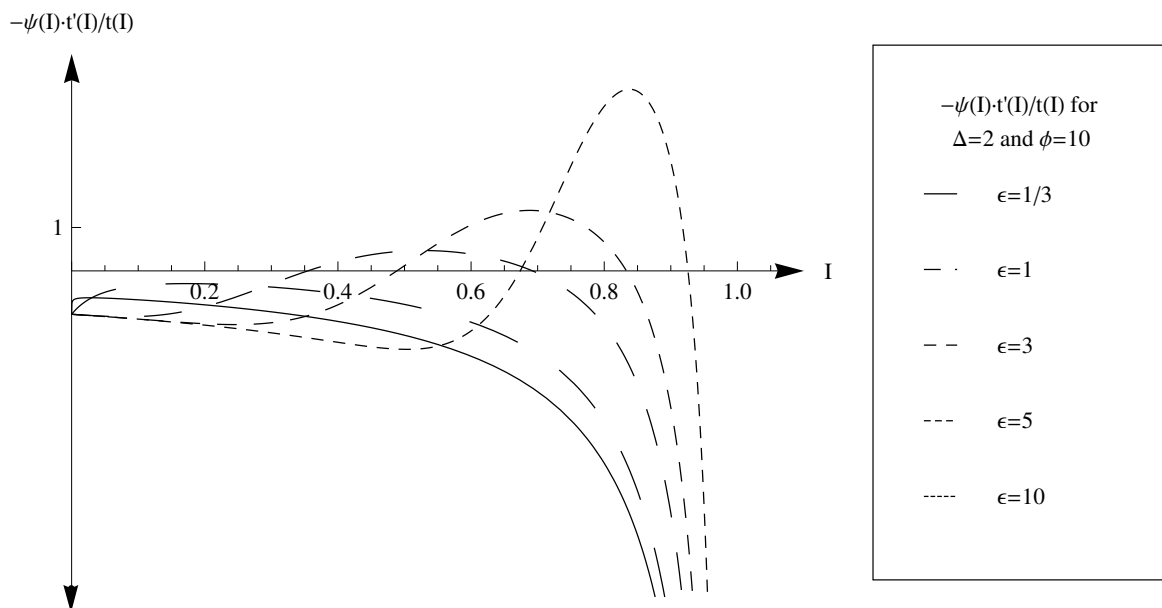


Figure 5: “Shallow” cost advantage and degree of “task concavity”

In a nutshell, the insights from our numerical exercise may be summarized as follows: Task diversity and task convexity both contribute to the likelihood that over a certain range of tasks an increase in the level of offshoring gives rise to higher domestic employment. But this range of tasks is likely to follow late in the secular process of offshoring.

5 Conclusion

Existing theory of offshoring mostly employs models that assume full employment. Instead of job destruction, these models stress cost savings from offshoring which make domestic firms more productive. Assuming domestic labor market clearance with flexible wages and smooth factor reallocation, offshoring thus appears as a force similar to technological change, with factor price effects depending on the sector- and factor-bias of this change, and with a clear potential of a Pareto improvement.

This is in strong contrast to the public debate where offshoring is mostly associated with domestic job destruction. We have therefore argued in this paper that there is an urgent need to

readdress offshoring with due emphasis on unemployment effects, even though the contribution of offshoring to aggregate job destruction up to this time is subject to debate. Towards this end, we have placed the model of *task trade* recently developed by Grossman & Rossi-Hansberg (2008) in a labor market environment that allows for *equilibrium unemployment*. We deliberately move away from the benign environment of smooth labor reallocation by assuming a single-sector economy. Moreover, we assume that the economy faces perfectly elastic supply in the foreign labor market. Our approach is general in that it allows for two different frictions that may be responsible for unemployment: Frictions of search and matching à la Pissarides (2000) and shirking frictions à la Shapiro & Stiglitz (1983). We represent either type of friction through a wage curve which is confronted with a so-called “task-trade-adjusted” labor demand curve.

Drawing on established literature, our approach assumes that offshoring is based on the notion of a continuum of tasks and affects labor demand at two margins. At the *extensive margin*, an improvement in the technology of offshoring causes job destruction in that certain tasks that have hitherto been performed by domestic workers are now performed offshore by foreign workers. At the same time, the cost savings that derive from such offshoring generates job creation at the *intensive margin*, meaning additional demand for labor to perform tasks where domestic labor still commands a cost advantage. Intuitively, with two offsetting effects, the effect on aggregate employment is ambiguous.

We have identified conditions under which the job creation at the intensive margin dominates the destruction that occurs at the extensive margin. Two types of conditions are relevant, both relating to the technology of offshoring which is represented through a simple cost schedule. This represents the general idea of task heterogeneity, meaning that some tasks are easier candidates to offshore provision than others. The *local condition* has to do with the steepness of this schedule at the margin. Other things equal a steep schedule favors net job creation. The other condition has to do with the shape of the schedule over the entire continuum of tasks, and we call it the *interval condition*. Other things equal, concentration of task heterogeneity among high-cost tasks, i.e., at the upper end of the interval, favors net job creation.

We have shown that the conditions necessary for net job creation vary in a systematic way over the interval of tasks, which in turn implies a potential for non-monotonicity. At early

stages of offshoring, job destruction at the extensive margin by necessity dominates adjustment to a technological improvement in the technology of offshoring. At later stages, however, the intensive margin of the adjustment may dominate so that offshoring additional tasks in effect causes net job creation. Given that offshoring is widely seen as a vehicle of job destruction, these are important conclusions.

We have also demonstrated that offshoring may have counter-intuitive effects also with respect to distribution, meaning that domestic wage income rises relative to non-wage income. Importantly, our result is different from standard Stolper-Samuelson results in that it does not rely on smooth factor reallocation. Although the principal mechanisms driving this result are the same as for the employment effects, the sufficient conditions are more restrictive.

The potential for a non-monotonic adjustment has so far been ignored by the empirical literature that estimates the employment effect of offshoring. We have shown that our theoretical result, which at first sight seems remote from observable data, may be translated into conditions that are amenable to empirical observation. This suggests specific improvements in empirical specifications that would allow for non-monotonic adjustment of employment to offshoring.

To shed further light on this potential of non-monotonicity, we have undertaken a numerical simulation relying on a parameterization of the aforementioned cost schedule. In doing so, we are able to sharpen our understanding of the characteristics of the offshoring technology that are responsible for whether or not offshoring more tasks will ever lead to net creation of jobs. These conditions have to do with the degree of task diversity, both at the margin and over the entire interval of tasks. But they also have to do with the concentration of such task diversity at the lower or upper end, respectively, of the task interval. We have described this using the notion of “task convexity”. Even though our model features a single sector, our numerical simulation suggests a distinction between two types of industries. In “deep advantage” industries, task diversity becomes infinite at the upper end of the interval where tasks are difficult to offshore. Industries with this type of offshoring technology will never lose viability in a certain country for reasons of cheaper offshoring alone. The same is not true, however, for “shallow advantage” industries, where task diversity is concentrated in early stages of offshoring and where the cost of offshoring further tasks converges to a finite level.

Appendix

A1 Derivation of Total Labor Cost

Firms maximize their discounted profits

$$\begin{aligned} \max_{l, V} \quad & \int_0^\infty e^{-r\tau} \left[F(l) - (1-I)wl - \kappa V - \beta \int_0^I t(i) di w^* l \right] d\tau \\ \text{s.t.} \quad & (1-I)\dot{l} = q(\theta)V - \lambda(1-I)l, \end{aligned} \quad (\text{A.1})$$

by choosing the optimal number of vacancies, V they want to post each period and, thus, determining the stock of workers, l , employed in each period. The corresponding Hamiltonian states

$$\begin{aligned} \mathcal{H}(l, V, \varphi) = e^{-r\tau} \left[F(l) - (1-I)wl - \kappa V - \beta \int_0^I t(i) di w^* l \right] \\ + \varphi \left[\frac{q(\theta)V}{1-I} - \lambda l \right], \end{aligned} \quad (\text{A.2})$$

where φ denotes the co-state variable. The transversality conditions are given by

$$\lim_{\tau \rightarrow \infty} l \geq 0, \quad \lim_{\tau \rightarrow \infty} \varphi \geq 0, \quad \lim_{\tau \rightarrow \infty} l\varphi \geq 0. \quad (\text{A.3})$$

Computing the first order conditions yields

$$\frac{\partial \mathcal{H}(l, V, \varphi)}{\partial V} = -(1-I)\kappa e^{-r\tau} + \varphi q(\theta) \stackrel{!}{=} 0, \quad (\text{A.4})$$

$$\frac{\partial \mathcal{H}(l, V, \varphi)}{\partial l} = e^{-r\tau} \left[F'_l(l) - (1-I)w - \beta \int_0^I t(i) di w^* \right] - \varphi \lambda \stackrel{!}{=} -\dot{\varphi}. \quad (\text{A.5})$$

Calculating $\dot{\varphi}$ from (A.4) with $\dot{\theta} = 0$ in the steady state before substituting into equation (A.5) yields

$$F'_l(l) = (1-I) \left[w + \frac{(r+\lambda)\kappa}{q(\theta)} \right] + \beta \int_0^I t(i) di w^*. \quad (\text{A.6})$$

Using equation (1) in order to replace w^* in the equation above we get

$$\frac{F'_l(l)}{\Omega(I)} = w + \frac{(r+\lambda)\kappa}{q(\theta)}, \quad (\text{A.7})$$

which, if compared to equation (5), reveals $W = w + \frac{(r+\lambda)\kappa}{q(\theta)}$.

A2 Offshoring and income distribution

In this appendix we derive conditions under which an expansion of the range of tasks that are performed offshore affects the domestic income distribution to the advantage of workers. We focus on an aggregate measure of income distribution defined as $D := \pi / [w(1 - I)l] = \pi / (wE)$ where π is defined as in (3) above. Replacing profits π , we find $D := [F(l) - F'(l)l] / (wE)$. For the sake of concreteness, we assume that $F(l) = f(l, k)$, where f is a standard linearly homogeneous production function and k is a second factor, say capital, which is fixed in supply. Furthermore, let us define $\delta := f_l(l, k)l / f(l, k)$. Thus, profits, $\pi = f_k(l, k)k$, accrue to capital owners and D is a measure of income distribution between capital and labor. We then have

$$\hat{D} = -(\hat{w} + \hat{E}) + \hat{f}_k. \quad (\text{A.8})$$

The changes in E and I appearing in this equation must be seen as driven by $\hat{\beta} < 0$, in line with the above comparative static results. Given that $\hat{\beta} < 0$ always leads to a higher overall labor input, $\hat{l} > 0$, it also leads to a higher capital rental π . It then follows that $\hat{D} < 0$ only, if adjustment involves $\hat{E} > 0$ and $\hat{w} > 0$. Unsurprisingly, the distribution of income changes in favor of workers only, if offshoring increases domestic employment and the domestic wage rate, i.e., if the condition of proposition I is satisfied.²⁹

Since capital, k , is fixed in supply we have $\hat{\pi} = \hat{f}_k = \delta \hat{l}$ such that equation (A.8) may be rewritten as

$$\hat{D} = -(\hat{w} + \hat{E}) + \delta \left[\hat{E} + \frac{I}{1 - I} \hat{I} \right], \quad (\text{A.9})$$

$$= \left(-\frac{\tilde{\omega}}{\omega} \alpha + \delta - 1 \right) \hat{E} + \delta \frac{I}{1 - I} \hat{I}. \quad (\text{A.10})$$

In the first line we employ $\hat{l} = \hat{E} + [I/(1 - I)] \hat{I}$, and the second line invokes the general equilibrium relationship $\hat{w} = (\tilde{\omega}\alpha/\omega) \hat{E}$.³⁰

We already know that $\hat{\beta} < 0$ leads to $\hat{D} < 0$ only, if the condition of proposition I is satisfied, $-\left(\frac{I}{1 - I} + \Delta\xi\right) > 0$, in which case $\hat{E} > 0$. From (A.8) we now recognize that a further necessary condition is $(1 + \alpha\tilde{\omega}/\omega) > \delta$. By assumption we have $0 < \delta < 1$, hence this assumption is always

²⁹Note that w and E always move in the same direction.

³⁰For the wage-employment relationship, see the discussion subsequent to equation (32) above.

fulfilled, since $\alpha\tilde{\omega}/\omega \equiv [\tilde{\mu} + (1 - \tilde{\mu})\eta]/[(1 - \eta)(1 - E)] \geq 0$. In order to identify a sufficient condition, for $\hat{D} < 0$ with $\hat{\beta} < 0$, we now need to substitute the above solutions for \hat{E} and \hat{I} in (A.10). We obtain

$$\hat{D} = \left(-\frac{\tilde{\omega}}{\omega}\alpha + \delta - 1 \right) \frac{\psi(I)}{1 + \vartheta(I)\alpha} \hat{\beta} - \delta \frac{I}{1 - I} \frac{\alpha}{\omega} \frac{1}{[\zeta(I)(1 + \vartheta(I))]} \hat{\beta}, \quad (\text{A.11})$$

$$= \left\{ \left(-\frac{\tilde{\omega}}{\omega}\alpha + \delta - 1 \right) \frac{I/(1 - I) + \Delta\xi(I)}{\zeta(I)[1 + \vartheta(I)\alpha]} \right\} \hat{\beta} - \left\{ \delta \frac{I}{1 - I} \frac{\alpha}{\omega} \frac{1}{[\zeta(I)(1 + \vartheta(I))]} \right\} \hat{\beta}. \quad (\text{A.12})$$

Given that $\zeta(I)$ as well as $\vartheta(I)$ and α are all positive, the sufficient condition for $\hat{D} < 0$ is

$$\left[-\tilde{\omega} + \frac{\omega}{\alpha}(\delta - 1) \right] \left[\frac{I}{1 - I} + \Delta\xi(I) \right] > \delta \frac{I}{1 - I} \frac{1 + \vartheta(I)\alpha}{1 + \vartheta(I)}. \quad (\text{A.13})$$

The right hand side is always positive. So is the first bracketed term on the left, since $0 < \delta < 1$. Again, we see that a necessary condition is that offshoring causes net job creation, whence the second bracketed term is negative as well. As expected, the sufficient condition is more likely to be fulfilled at later stages of offshoring where I is large. Moreover, we see that a large elasticity of labor demand, i.e., a high value of δ , is similarly conducive to $\hat{D} < 0$. Finally, the sufficient condition is more likely to be fulfilled for a high value of $\tilde{\omega}$, the elasticity of the wage rate w with respect to labor market tightness θ and a low value of ω , the elasticity of labor cost W with respect to labor market tightness. Notice that $\omega/\alpha = (1 - \eta)(1 - E)$, so the latter effect looms large for a low value of η and/or a low value of E . Using the ratio π/w to measure income distribution, the first bracketed term on the left then reads as $[-\tilde{\omega} + \frac{\omega}{\alpha}\delta]$. Again, a necessary condition is that this term be negative, in addition to the condition of proposition I. It is obvious that this set of conditions is more restrictive than if we use D to measure income distribution. This is intuitive since with this alternative measure we do not take into account the increase in the wage bill that is due to expansion of unemployment. In other words, instead of looking at aggregate factor incomes, we look at factor prices.

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