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Taking Public Opinion Seriously: A General Equilibrium Model of Low-Wage Competition, Offshoring, and Unemployment

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Abstract

This paper analyzes a North-South trade model with costly offshoring and equilibrium unemployment due to union wage setting. Reductions in the amount of resources required in the offshoring process usually decrease employment, though the opposite can happen at a low initial level of offshoring activity. If additional offshoring leads to a fall in the scale of Northern firms, the increase in Southern workers' utility comes at the expense of a reduction in each Northern agent's welfare. The model can be used to make a case for a "pragmatic union leader": unions have an incentive to take measures that reduce their bargaining power. With firm heterogeneity, there is scope for multiple equilibria.

JEL classification: F12, J64

Key words: offshoring, unemployment, North-South trade

1 Introduction

Emerging economies export commodities to high-wage countries because of lower production cost due to lower wages. Offshoring production to emerging markets costs jobs in high-wage countries if wages do not edge down. So offshoring does not benefit all agents in the high-wage country.

While most non-economists regard these statements as self-evident, many, if not most, economists disagree. There are two possible explanations for this "apparent disconnect between the public and academic views of the impact of trade on labor market outcomes" (Davidson and Matusz, 2009, p. 2; see also Mankiw and Swagel, 2006). One possible explanation is that the public is badly informed about what is actually going on in the global economy and/or gets the driving forces wrong. In fact, when the debate about offshoring, wages, and jobs resurfaced in the mid-1990s, economists (e.g., Freeman, 1995, and Krugman, 1995) pointed out that the public tends to overestimate the extent and, therefore, the significance of trade with low-wage countries and offshoring and that unemployment is largely determined by labor market institutions, not by international trade. The other possible explanation for the divergence in the public and academic views of the employment effects of offshoring is that the optimistic academic view is based on inadequate models of low-wage competition, offshoring, and unemployment. Some prominent economists, notably Blinder (2006) and Krugman (2008) (with a "guilty conscience", as he said famously when he presented his paper at the Brookings institution), conceded that we should not discard the second possibility prematurely.

The present paper presents a model in which an emerging economy exports commodities to a high-wage country because of lower production cost due to lower wages and offshoring production to the emerging market costs jobs in the high-wage country since wages do not edge down, so that offshoring does not benefit all agents in the high-wage country, and may even make them all worse-off. The model is Krugman's (1979) North-South trade model augmented to include costly offshoring and union wage setting.[1] Our main finding is that negative employment effects of offshoring are the rule, although the employment effects of further offshoring can be positive when there is little offshoring initially. Thus, our model is consistent with public opinion about the employment effects of offshoring in general as well as with the trend that concerns over employment have been growing as globalization proceeds.

[1]We adopt Helpman's (2006, p. 591) terminology: offshoring means the relocation of production processes from the home country to a foreign country; outsourcing means the purchase of an intermediate input formerly produced within the firm from an external supplier. So offshoring can take place within multinational enterprises (MNEs) or as offshore outsourcing. We argue below that, appropriately interpreted, our model encompasses both types of offshoring.

The model yields further interesting results. First, a welfare analysis shows that if additional offshoring raises employment, then it constitutes a Pareto improvement: workers in the North and in the South as well as firm owners gain. Otherwise, offshoring benefits workers in the South, but hurts their Northern counterparts. The impact on firm owners' real income depends on the effect on the scale of their firms, so if this effect is negative, all agents in the North lose (so there is no way to realize gains from trade in the North). An extension of the model with two factors of production gives rise to a similarly pessimistic assessment of the employment and welfare effects of offshoring. Second, the model provides an endogenous explanation for shrinking union power: Northern workers have an incentive to appoint a "pragmatic union leader", with preferences biased toward higher employment (or a weak union leader with low bargaining power). This is because they face a commitment problem: given that offshoring production is a longer-term decision than wage setting, workers have to look for a way to make the announcement credible that they will not fight for high wages once firms have decided to keep production at home. Third, we show that the extension of the model with heterogeneous firms (following Melitz, 2003), yields the possibility of multiple equilibria: if Northern unions anticipate a low real wage in the South, they set a high real wage, and offshoring activity is intensive; conversely, if they anticipate a high real wage in the South, they set a lower real wage, and there is little offshoring.[2]

The distinguishing feature of our model is that it allows for general equilibrium effects of costly offshoring to a low-wage country on relative production cost and unemployment in the North. The incentives to invest in offshore subsidiaries are endogenously determined by factor price differentials, and offshoring feeds back on production and employment decisions via shifts in factor prices. The model thus encompasses (in a static environment[3]) the experience of export-oriented emerging economies, which struggle with a dwindling cost advantage in the course of their development process. China is, of course, the prime current example:

> "'China has become a victim of its own success,' sighs Peter Tan, president and managing director of Flextronics in Asia. He finds it especially hard to hire and retain technical staff, ranging from finance directors to managers versed in international production techniques such as 'six sigma' and 'lean manufacturing'. There are not enough qualified workers to go around, causing rampant poaching and extremely fast wage

[2] An increase in the mass of goods producible in the South without a fixed cost has similar effects on employment and welfare as a decrease in the cost of offshoring (see footnotes 13 and 14). A setup without costly offshoring would not be suited to analyze the case for a pragmatic union leader or multiplicity of equilibria in the presence of productivity uncertainty.

[3] A dynamic model of the transition from a low-wage country to a high-wage country is in Arnold (2003).

inflation. 'China is definitely not the cheapest place to produce any more,' he says"

(The problem with Made in China, 2007). This is reminiscent of Japan in the 1980s and the maturing of other formerly emerging economies.

Our model is related to several strands of the international economics literature, so the following list of papers is necessarily incomplete. First, we mention some contributions on offshoring that use models without unemployment. Zhao (1998) analyzes foreign direct investment (FDI) in a two-country "North-North" model with union wage bargaining and factor price equalization (FPE). Firms' motive to invest in FDI is not to reduce cost, but to improve their position in the wage bargain. A non-unionized sector absorbs those workers who do not get employment in the unionized sector. Skaksen and Sørensen (2001) study a partial equilibrium industrial organization model of FDI and industry employment. As in our model, the offshoring decision precedes the wage bargaining process. More offshoring makes the demand curve for domestic labor less elastic, thereby raising the unions' wage claims. Antràs and Helpman (2004) analyze the emergence of different organizational forms of relocating production in a North-South model with incomplete contracts. In doing so, they rule out variations in relative wages by assuming that both the North and the South produce a homogeneous good under perfect competition, so that the wage rate coincides with the productivity of labor in the production of the homogeneous good. Helpman et al. (2004) study FDI in a general equilibrium North-North trade model with FPE based on Melitz' (2003) "new new trade theory" with heterogeneous firms. They address the decision to serve foreign markets via FDI or exporting. Thus, FDI is a means of saving trading costs, not of moving production to a low-wage country.[4] Grossman and Rossi-Hansberg (2008) analyze offshoring in a novel model of task trade that extends the Heckscher-Ohlin trade theory. The production of each final good requires a continuum of high- and low-skilled tasks and the offshoring costs differ between tasks. They emphasize a productivity effect of task trade that benefits the factor whose tasks are easier to offshore.[5] Lai (1998) extends the Helpman (1993) North-South endogenous growth model to allow for technology transfer to the South via FDI rather than imitation. He investigates how stronger protection of international property rights (IPR) in the South affects the extent of FDI in the steady state. In a related framework that builds on Grossman and Helpman (1991), Glass and Saggi (2001) analyze potential determinants for higher offshore outsourcing.

All the above mentioned models address offshoring but not unemployment. We proceed by briefly

[4]For more information on Antràs and Helpman (2004), Helpman et al. (2004) and related papers see the survey in Helpman (2006).

[5]A whole strand of literature builds on traditional trade models of comparative advantage in order to study the international fragmentation of production processes. See, for instance, the summary in Kohler (2007).

mentioning some papers that consider unemployment and trade in final goods and, afterwards, we present existing studies on offshoring and unemployment. Helpman and Itskhoki (2010) analyze trade and unemployment in a model with FPE and search frictions. In each country, one of the two sectors is characterized by heterogeneous firms. The labor market frictions are the only difference between the two countries and they may act as a source of comparative advantage. Felbermayr et al. (2011) incorporate the same type of labor market frictions in a one-sector model with two symmetric countries based on Melitz (2003). They examine the effects of trade liberalization on real wages and unemployment. In contrast, the three following contributions build on North-South endogenous growth models. Arnold (2002) analyzes the impact of imitation in the South on frictional unemployment in the North in a model based on Helpman (1993). Mondal and Gupta (2008) introduce efficiency wages for low-skilled Southern workers into the Helpman (1993) model. They investigate the impact of stronger IPR protection on unemployment in the South. Grieben and Şener (2009) use a different but related framework of North-South trade and endogenous growth. The Northern labor market is characterized by firm-level collective bargaining and a minimum wage. In this model with labor unions, the effects of unilateral trade liberalization on unemployment are studied.

In the following, we present contributions that address both aspects of interest, i.e. unemployment and offshoring. Egger and Kreickemeier (2008) apply the fair wage approach in order to study the impact of offshoring on the domestic skill premium and unemployment of the low-skilled workers. In their two-input, three-sector trade model, offshoring is possible only in the sector with middle skill-intensity. Kohler and Wrona (2010) analyze the employment effect of offshoring in a task trade model with search frictions and individual wage bargaining. A single-sector economy exports tasks due to the assumption of a given (low enough) foreign wage rate. They highlight that steady improvements in the offshoring technology may have a non-monotonic effect on employment. Mitra and Ranjan (2010) study the impact of offshoring on sectoral and economy-wide unemployment. They also use search frictions and individual bargaining as well as a fixed foreign wage rate. In their two-sector model, offshoring is possible only for one input used in one sector. They highlight the role of intersectoral labor mobility with respect to the effect of offshoring on unemployment. In a related job search model, Ranjan (2010) incorporates firm-level collective wage bargaining instead of individual bargaining. He uses a simple one-good model and assumes an upward-sloping supply curve of the offshored input (reduced form of Grossman and Rossi-Hansberg, 2008). Lower offshoring costs lead to increasing substitution of domestic labor and a lower domestic wage, since wage bargaining precedes the offshoring decision. Therefore, falling offshoring costs may have a non-monotonic impact on unemployment.[6] Eckel and Egger (2009) analyze the relationship between firm-level collective bargaining and the mode to serve the foreign market in a North-North trade model with heterogeneous firms and two-way FDI. There are two-sectors and the modeling of the differentiated-good sector is based on Helpman et al. (2004). The presence of labor unions makes FDI more attractive, since it strengthens the firm's bargaining position. Due to a wage-reducing effect of FDI, unemployment tends to be lower in open economies than in autarky. Skaksen (2004) studies the effects of both potential, but non-realized, and realized offshore outsourcing on domestic wages and employment. In a simple small open economy framework with one final good, the production of one intermediate input can be offshored to a low-wage country. The domestic labor market is unionized and wage bargaining precedes offshore outsourcing. The employment effects of falling offshoring costs differ considerably between potential, but non-realized, and realized offshore outsourcing. In contrast to Skaksen (2004), Koskela and Stenbacka (2009) analyze the case that offshore outsourcing takes place before wage bargaining. They also assume that the wage in the South is exogenous. Domestic and foreign labor are modeled as substitutes with a productivity differential. In this framework, offshore outsourcing increases the wage elasticity of domestic labor demand and this, in turn, leads to a wage-reducing effect. Additionally, offshoring mitigates the firm's profit reducing effect of higher domestic wages. Therefore, the effect of offshore outsouring on domestic unemployment depends on the bargaining power of the labor union. For a recent survey of the empirical literature on the labor market effects of offshoring, see Crinò (2009).

The paper is organized as follows. Section 2 introduces the model with one factor of production and without firm heterogeneity. Section 3 proves existence of a free trade equilibrium. Section 4 characterizes the employment and welfare effects of changes in the cost of offshoring. Section 5 makes the case for a pragmatic union leader. Section 6 and 7 introduce heterogeneous firms and a second factor of production, respectively. Section 8 concludes.

2 Model

This section describes the model. We will make some additional assumptions about the magnitudes of the model parameters below.

The world economy is made up of two countries, North and South. There are a continuum of measure $\bar{L}^N$ (> 0) of workers in the North and a continuum of measure $\bar{L}^S$ (> 0) of workers in the South. Each worker is endowed with one unit of labor. In addition, there are firm owners, who do not supply labor, in the North. In the baseline model, labor is the only factor of production. Later

[6] Up to now, this is only illustrated in a numerical example.

on, we introduce a second factor, skilled labor, in the North.

There is a continuum of measure one of industries i, indexed along the unit interval. Each industry produces varieties j of a differentiated good indexed along the interval $[0, n]$. The mass of varieties per industry n (> 0) is given, i.e., there is no product innovation. Each agent's preferences are described by the Dixit-Stiglitz (1977) utility function

$$\left[\int_0^1 \int_0^n x(i,j)^\alpha dj \; di\right]^{\frac{\beta}{\alpha}}, \tag{1}$$

where $x(i, j)$ is consumption of variety j of the commodity produced by industry i ($0 < \alpha < 1$ and $0 < \beta \leq 1$). Any two varieties are equally good substitutes for each other, irrespective of whether they are produced in the same industry or in different industries. Agents are either risk-averse ($\beta < 1$) or risk-neutral ($\beta = 1$). The virtue of having "a large number" of industries, rather than a single industry, is that this allows us to consider industry unions which are "large in the small but small in the large" (Neary, 2003): their wage setting does not affect aggregate income and the aggregate price level. Since the industries are all alike, we suppress the industry index i in what follows.[7]

For each variety j of each commodity i, there is a single producer in the North. This producer is able to produce "his" variety using a^N (> 0) units of labor per unit of output. For a subset of measure n^S of the n varieties producible in the North, there are also competitive producers in the South with the ability to produce the varieties with input coefficient a^S ($0 \leq n^S < n$ and $a^S > 0$). In order to express that the South is less productive than the North, one can assume $a^S > a^N$; but this is inessential to the analysis. In addition, the production of the remaining $n - n^S$ varieties can be moved to the South within MNEs. To do so, the Northern producer of a variety has to incur a fixed cost. We assume that the fixed cost consists of f^M (> 0) units of labor in the South only. In the model with skilled labor, we assume that offshoring also requires a fixed amount of skilled labor in the North.[8] We make two alternative assumptions about the input coefficients in Southern plants of MNEs. We start with the simple case of no uncertainty: the input coefficient a^S is the same for each firm that spends the fixed offshoring cost. Later on, following the "new new trade theory" with heterogeneous firms originating from Melitz (2003), we assume that the productivities are drawn from a Pareto distribution. This is meant to capture the effect that even established companies

[7] Up to Section 4 the model can alternatively be interpreted as one with a single industry and wage bargaining at the firm level.

[8] Introducing Northern labor as as input in the offshoring process in the one-factor model would raise subtle questions with regard to the wage setting process, so we postpone the introduction of "headquarter services" until Section 7.

face substantial uncertainty when they move production to emerging economies. Up to Section 4 we confine attention to symmetric equilibria, with the same level of offshoring activity and the same wage rate in each industry. Let n^M denote the measure of varieties offshored to the South for any i. Let w^N and w^S denote the wage rates in the North and in the South, respectively. Suppose the South has a cost advantage, in that $w^N a^N > w^S a^S$. Then in each industry $n - n^S - n^M$ varieties are supplied by a monopolist producing in the North, n^S varieties are produced under perfect competition in the South, and n^M varieties are supplied monopolistically by an MNE producing in the South. We argue below (at the end of Section 3) that the model can also be interpreted as one of offshore outsourcing.

In each industry i, there is a single union, which represents $\bar{L}^N$ workers. The industry union bargains over the wage rate with the firms in this sector producing in the North. Firms have the "right to manage" (RTM), so they determine employment after the wage rate is set. In the version of the model without uncertainty about the input coefficient in Southern plants, wage bargaining takes place *after* the offshoring decision. This ordering of events is meant to capture the fact offshoring production is a longer-term decision than wage setting. If employment L^N falls short of $\bar{L}^N$ in sector i, each worker faces the same probability $L^N/\bar{L}^N$ of employment.[9] Unemployed workers have zero income and reservation utility b (> 0). So expected utility is the sum of $L^N/\bar{L}^N$ times the the maximized value of (1) and $(1 - L^N/\bar{L}^N)b$.[10] Wages and employment maximize the Nash product subject to the constraint that employment is determined by the labor demand of the local firms. The firms' weight in the Nash bargain is denoted γ ($0 \leq \gamma < 1$). $\gamma = 0$ is the monopoly union special case. In the version of the model with uncertainty about the input coefficient in Southern plants, firms can choose to produce in the North, although they have paid the fixed cost of offshoring. To keep things simple, we focus on the monopoly union special case in this case.

[9] In labor economics, it is common to assume that workers who do not get a job in one unionized sector face a positive probability of getting a job in another unionized sector. Our assumption that "[E]ach worker is typically tied to one industry" (Parlour and Walden, 2011, p. 394) is also employed in the literature on hedging uncertain labor income. We believe that it is appropriate in our context, with the threat of job losses due to offshoring.

[10] In the presence of unemployment benefits tied to wages, the reservation utility depends on the wage level. Similarly, the value of being unemployed depends on economy-wide unemployment (i.e., the probability of finding employment) and on the wage earned once back in work in a dynamic matching setup. If there is a competitive sector that absorbs the workers who do not get jobs in the unionized sector, the competitive wage in this sector determines the reservation utility. These effects are absent in our model. For details, see Layard et al. (2005, Section 2.2).

3 Equilibrium with homogeneous firms

In this section, we show that, under suitable assumptions about the parameters, the model without uncertainty about the input coefficient for production in the South possesses a unique symmetric equilibrium with a cost advantage for the South and unemployment.

Such an equilibrium prevails if the following conditions are satisfied: operating cost is higher in the North than in the South ($w^N a^N > w^S a^S$); Northern producers without Southern competitors (i.e., firms producing in the North and MNEs) maximize monopoly profit; Southern producers supply varieties at price equal to unit cost; the measure of MNEs n^M is the same in each industry; it does not pay to move the production of further varieties abroad, i.e., either $n^M > 0$ and the fixed cost of setting up an MNE is equal to the difference between an MNE's operating profit and a Northern producer's operating profit, or $n^M = 0$ and the fixed cost is no less than the operating profit differential; for each employed worker and firm owner, consumption of the varieties of the differentiated goods maximizes utility subject to the budget constraint; demand equals supply for each variety of each good; the wage rate and employment maximize the Nash product subject to the constraint that employment is determined via firms' labor demand; there is excess supply of labor in the North; and the labor market in the South clears.

Let $p(i,j)$ denote the price of variety j of good i and $P = [\int_0^1 \int_0^n p(i,j)^{1-\varepsilon} dj\, di]^{1/(1-\varepsilon)}$, where $\varepsilon = 1/(1-\alpha)$. From (1), the world-wide demand for variety j of good i is

$$x(i,j) = \left[\frac{p(i,j)}{P}\right]^{-\varepsilon} \frac{I}{P}, \tag{2}$$

where I is world income. Firms producing in the North set $p(i,j) = a^N w^N/\alpha$, MNEs set $p(i,j) = a^S w^S/\alpha$, and the price of goods produced by Southern producers is $a^S w^S$. From (2),

$$x^N = \left(\frac{w^N a^N}{w^S a^S}\right)^{-\varepsilon} x^M,\ \ x^S = \alpha^{-\varepsilon} x^M, \tag{3}$$

where x^N, x^M, and x^S are the outputs of monopolists producing in the North, MNEs, and Southern firms, respectively.

From the definition of the price index and the pricing rules,

$$\left(\frac{w^N a^N}{P}\right)^{\varepsilon-1} = \alpha^{\varepsilon-1}\left(n - n^S - n^M\right) + \left(n^S + \alpha^{\varepsilon-1} n^M\right)\left(\frac{w^N a^N}{w^S a^S}\right)^{\varepsilon-1}. \tag{4}$$

The operating profit differential is $(w^S a^S x^M - w^N a^N x^N)/(\varepsilon-1)$. The fixed cost of setting up a subsidiary is $w^S f^M$. Using (3), the condition that it does not pay to move further varieties abroad becomes

$$(\varepsilon-1) f^M \geq \left[1 - \left(\frac{w^N a^N}{w^S a^S}\right)^{1-\varepsilon}\right]\left(\frac{w^N a^N}{w^S a^S}\right)^{\varepsilon} a^S x^N,\ \ n^M \geq 0, \tag{5}$$

with at most one strict inequality.

Consider the wage bargain between the industry-i union and the producers of varieties in an industry with $n - n^S - n^M > 0$. From (2) and the markup pricing rule, the demand for labor per firm $L^d : \{\mathbb{R}_+ \backslash \{0\}\} \times \mathbb{R}_+ \to \mathbb{R}_+$ is given by $L^d(w^N/P, I/P) = a^N[(w^N a^N)/(\alpha P)]^{-\varepsilon} I/P$. This can be used to rewrite a firm's real profit (i.e., firm profit deflated by the price index P) as $(w^N/P)L^d(w^N/P, I/P)/(\varepsilon - 1)$. The Nash product is

$$\left\{ \frac{(n - n^S - n^M)L^d\left(\frac{w^N}{P}, \frac{I}{P}\right)}{\bar{L}^N} \left[\left(\frac{w^N}{P}\right)^{\beta} - b \right] \right\}^{1-\gamma} \left[\frac{\frac{w^N}{P} L^d\left(\frac{w^N}{P}, \frac{I}{P}\right)}{\varepsilon - 1} \right]^{\gamma}.$$

An employed Northern worker's indirect utility is $(w^N/P)^\beta$ (from (2)). So the term in braces is a worker's expected utility gain compared to his reservation utility b (i.e., his threat point). Firms which bargain in the North have not incurred the fixed cost of offshoring, so their threat point is zero. The wage rate w^N and employment L^N maximize the Nash product subject to $(n - n^S - n^M)L^d(w^N/P, I/P) \leq \bar{L}^N$. We focus on an equilibrium in which the constraint is not binding, i.e., unemployment prevails. We will spell out the parameter condition necessary for this case to arise below. Then,

$$\frac{w^N}{P} = \left\{ \left[1 - \frac{\beta(1-\gamma)}{\varepsilon - \gamma} \right]^{-1} b \right\}^{\frac{1}{\beta}} = \frac{\omega^N}{a^N}. \tag{6}$$

We call the real wage rate in (6) the RTM wage. Given constant wage elasticity, shift parameters of the labor demand function do not affect the RTM wage (cf. Cahuc and Zylberberg, 2004, p. 395). In particular, this means that the wage rate does not go down when the amount of offshoring (i.e., n^M) rises. Firms which have sunk the offshoring cost have no incentive to adopt the RTM wage and produce in the North, since production is cheaper in the South. This lends support to the assumption that they are not party to the wage bargain in the first place. ω^N measures the Northern real wage w^N/P relative to its labor productivity $1/a^N$. Labor market clearing in the South requires $\bar{L}^S = a^S(n^S x^S + n^M x^M) + n^M f^M$ or, using (3),

$$\bar{L}^S = \left(\alpha^{-\varepsilon} n^S + n^M\right) \left(\frac{w^N a^N}{w^S a^S}\right)^{\varepsilon} a^S x^N + n^M f^M. \tag{7}$$

The price setting equation (4), the arbitrage condition (5), the wage setting rule for the North (6), and the labor market clearing condition for the South (7) jointly determine the real wage rate in the North w^N/P, the measure of varieties produced in MNEs n^M, the relative production cost

$(w^N a^N)/(w^S a^S)$, and the output of firms producing in the North x^N.[11] From (4) and (6),

$$\frac{w^N a^N}{w^S a^S} = \left[\frac{(\omega^N)^{\varepsilon-1} - \alpha^{\varepsilon-1}(n - n^S - n^M)}{n^S + \alpha^{\varepsilon-1} n^M}\right]^{\frac{1}{\varepsilon-1}} = f(n^M), \tag{8}$$

where $f : [0, n - n^S] \to \mathbb{R}_+$ if $n^S > 0$ and $f : (0, n - n^S] \to \mathbb{R}_+$ if $n^S = 0$. We assume that

$$(\omega^N)^{\varepsilon-1} - \alpha^{\varepsilon-1}(n - n^S) - n^S > 0, \tag{9}$$

so that $f(0) > 1$. Equation (8) combines price and wage setting. From (6) the Northern real wage is constant. From (4), for given $(w^N a^N)/(w^S a^S) > 1$, an increase in n^M raises the real wage in the North w^N/P, as the production of varieties moves to the relatively cheaper location. So the relative production cost $(w^N a^N)/(w^S a^S)$ has to fall in order to restore the original real wage rate. Hence, $f(n^M)$ is monotonically decreasing.

Suppose $f^M < (\alpha^\varepsilon \bar{L}^S)/[(\varepsilon - 1)n^S]$. Then, from (5) and (7),

$$\frac{w^N a^N}{w^S a^S} \leq \left[1 - (\varepsilon - 1)\frac{\alpha^{-\varepsilon} n^S + n^M}{\frac{\bar{L}^S}{f^M} - n^M}\right]^{\frac{1}{1-\varepsilon}} = g(n^M, f^M),\ n^M \geq 0, \tag{10}$$

with at most one strict inequality. g maps $\{(n^M, f^M) \in \mathbb{R}^2_+ |\ n^M < [\bar{L}^S/f^M - (\varepsilon - 1)\alpha^{-\varepsilon} n^S]/\varepsilon\}$ (i.e., those (n^M, f^M) for which the term in square brackets in (10) is positive) on $\mathbb{R}_+$. Equation (10) combines the condition that further offshoring is not profitable and labor market clearing in the South. Suppose $n^M > 0$. From (7), an increase the measure of MNEs n^M requires a decrease in the scale of each MNE x^M $(= [(w^N a^N)/(w^S a^S)]^\varepsilon x^N)$. From (5), the relative production cost $(w^N a^N)/(w^S a^S)$ has to rise in order to compensate for the ensuing decrease in the operating profit differential. Therefore, $g(n^M, f^M)$ is monotonically increasing in n^M. For $f^M \geq (\alpha^\varepsilon \bar{L}^S)/[(\varepsilon - 1)n^S]$, from (5) and (7), the fixed cost of entry exceeds the operating profit differential for all $n^M \geq 0$, so $n^M = 0$.

Figure 1 illustrates the determination of the equilibrium values of n^M and $(w^N a^N)/(w^S a^S)$ for given f^M. $f(n^M)$ falls from $f(0) > 1$ to unity as n^M grows large. $g(n^M, f^M)$ rises from $g(0, f^M) = [1 - (\varepsilon - 1)\alpha^{-\varepsilon} n^S/(\bar{L}^S/f^M)]^{1/(1-\varepsilon)} > 1$ to infinity as n^M rises towards $[\bar{L}^S/f^M - (\varepsilon - 1)\alpha^{-\varepsilon} n^S]/\varepsilon$. If $f(0) \geq g(0, f^M)$, there is a unique $n^{M*} \geq 0$ such that $f(n^{M*}) = g(n^{M*}, f^M)$. From (8) and (10), $f(0) \geq g(0, f^M)$ if, any only if,

$$f^M \leq \frac{\alpha^\varepsilon \bar{L}^S}{(\varepsilon - 1)n^S}\left[1 - \frac{n^S}{(\omega^N)^{\varepsilon-1} - \alpha^{\varepsilon-1}(n - n^S)}\right] = \bar{f}^M, \tag{11}$$

[11] The North does not possess an autarky equilibrium. For $n^S = n^M = 0$, (4) becomes $w^N a^N/P = \alpha n^{1/(\varepsilon-1)}$. There is in general no joint solution to this equation and (6); the unions' wage setting behavior and the firms' price setting behavior are incompatible with each other.

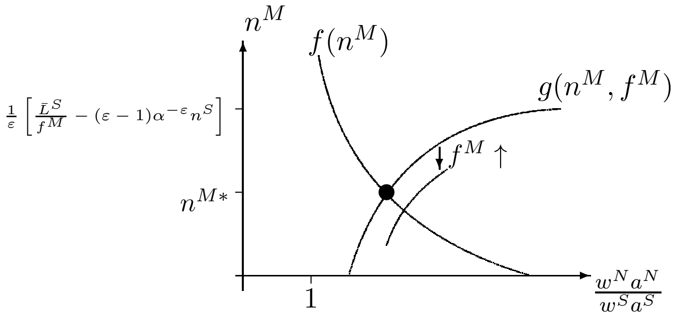

Figure 1: Equilibrium

($\bar{f}^M > 0$ due to (9)), and n^{M*} is then determined by

$$\frac{f^M}{\bar{L}^S - n^{M*} f^M} = \frac{1}{\varepsilon - 1} \frac{1}{\alpha^{-\varepsilon} n^S + n^{M*}} \frac{(\omega^N)^{\varepsilon-1} - \alpha^{\varepsilon-1}(n - n^S) - n^S}{(\omega^N)^{\varepsilon-1} - \alpha^{\varepsilon-1}(n - n^S - n^{M*})}. \tag{12}$$

For $f^M > \bar{f}^M$, the equilibrium is characterized by $n^M = 0$ ($= n^{M*}$) and $(w^N a^N)/(w^S a^S) = f(0) < g(0)$.

We have to make sure that there is unemployment and that n^{M*} does not exceed either $\bar{L}^S/f^M$ or $n - n^S$. Using $L^N = (n - n^S - n^M) a^N x^N$, (3), (7), and (8), employment in the North can be rewritten as

$$\begin{aligned} L^N &= (n - n^S - n^M) a^N \frac{\bar{L}^S - n^M f^M}{a^S(\alpha^{-\varepsilon} n^S + n^M)} \left[\frac{n^S + \alpha^{\varepsilon-1} n^M}{(\omega^N)^{\varepsilon-1} - \alpha^{\varepsilon-1}(n - n^S - n^M)}\right]^{\frac{1}{\alpha}} \\ &= \Psi(n^M, f^M). \end{aligned} \tag{13}$$

Ψ maps $\{(n^M, f^M) \in \mathbb{R}^2_+ |\ n_M \leq \min\{n - n^S,\ \bar{L}^S/f^M\},\ n^M > 0 \text{ if } n^S = 0\}$ on $\mathbb{R}_+$. Unemployment prevails if $\bar{L}^N$ is sufficiently large so that $\Psi(n^{M*}, f^M) < \bar{L}^N$. From the definition of g,

$$n^{M*} < \frac{1}{\varepsilon}\left[\frac{\bar{L}^S}{f^M} - (\varepsilon - 1)\alpha^{-\varepsilon} n^S\right] < \frac{\bar{L}^S}{f^M}.$$

(cf. Figure 1), so the condition $n^{M*} < \bar{L}^S/f^M$ is automatically satisfied. To check the condition $n^{M*} \leq n - n^S$, set $n^{M*} = n - n^S$ in (12). The right-hand side is positive, finite, and independent of f^M, and the left-hand side increases continuously from zero to infinity as f^M rises from zero to $\bar{L}^S/(n - n^S)$ then. Hence, there is $\underline{f}^M$ such that $n^{M*} = n - n^S$ for $f^M = \underline{f}^M$. Differentiating (12) totally gives

$$\begin{aligned} \frac{dn^{M*}}{df^M} \;\; = \;\; & -\frac{\bar{L}^S}{f^M\left(\bar{L}^S - n^{M*} f^M\right)} \left[\frac{f^M}{\bar{L}^S - n^{M*} f^M} \right. \\ & \left. + \frac{1}{\alpha^{-\varepsilon} n^S + n^{M*}} + \frac{\alpha^{\varepsilon-1}}{(\omega^N)^{\varepsilon-1} - \alpha^{\varepsilon-1}(n - n^S - n^{M*})}\right]^{-1} < 0 \end{aligned}$$

(cf. Figure 1). So $n^{M*} < n - n^S$ for $f^M > \underline{f}^M$.

Proposition 1: *Suppose (9) holds, $\Psi(n^{M*}, f^M) < \bar{L}^N$, and $f^M \geq \underline{f}^M$. Then a unique symmetric equilibrium with a cost advantage for the South and unemployment exists.*

The model has an alternative interpretation as one of offshore outsourcing. Consider an equilibrium with $n^{M*} > 0$, in which the operating profit differential $(w^S a^S x^M - w^N a^N x^N)/(\varepsilon - 1)$ is equal to the fixed cost of setting up a subsidiary $w^S f^M$. Suppose offshore outsourcing requires the same fixed amount of Southern labor f^M as offshoring within an MNE. Suppose further the monopolist for a given variety and a Southern producer can write a contract that ensures the delivery of x^M units of the variety at price $w^S a^S$ and prohibits the sale of output to any other party (alternatively, one can think of an intermediate input that is transformed one-to-one into final output by the Northern monopolist). Prices and quantities are the same as with offshoring within an MNE.[12]

4 Employment and welfare effects of offshoring

This section investigates the employment and welfare effects of changes in the labor requirement for offshoring f^M. A decrease in f^M tends to reduce employment. An exception to this rule prevails if there is little international economic activity initially: if the mass of goods producible in the South without a fixed cost n^S is small, then employment rises as f^M falls below the level $\bar{f}^M$ at which offshoring becomes profitable. In this case, the reduction in f^M yields a Pareto improvement: Northern workers' expected utility, Southern workers' utility, and firm owners' real profits rise. However, when employment falls, a decrease in the offshoring cost benefits Southern workers at the expense of their Northern counterparts. Firm owners' utility and Utilitarian worldwide social welfare possibly fall.

Consider an increase in f^M. From Figure 1, the mass of goods produced in MNEs in the South n^{M*} falls, which is conducive to employment. However, at the same time relative production cost $(w^N a^N)/(w^S a^S)$ rises, and this reduces the scale x^N of each active firm (see (5)). So the effect of an increase in n^M on employment is ambiguous. From the analysis in the preceding section, the relationship between the equilibrium measure of MNEs n^{M*} and the cost of offshoring in terms of Southern labor f^M is described by a continuous function $\Phi : [\underline{f}^M, \infty) \to \mathbb{R}_+$, which

[12] This reinterpretation of the model ignores the differences between different organizational forms of production, which is at the heart of Antràs and Helpman's (2004) incomplete contracts model. They assume that an MNE entails a higher fixed cost than an outsourcing agreement but is advantageous in that it gives the Northern firm a stronger bargaining position, since it avoids being threatened with not being delivered outsourced essential specialized inputs (see also Helpman, 2006).

satisfies $n^{M*} < \bar{L}^S/f^M$ and is monotonically decreasing for $f^M < \bar{f}^M$. Consider the composite function $\Gamma(f^M) = \Psi(\Phi(f^M), f^M) : [\underline{f}^M, \infty) \to \mathbb{R}_+$. Γ relates equilibrium employment to the labor requirement for offshoring (see Figure 2). We assume that $\bar{L}^N$ is large enough so that there is unemployment (i.e., $\Gamma(f^M) < \bar{L}^N$) for all admissible f^M. From $\Psi(n - n^S, f^M) = 0$ and $\Phi(\underline{f}^M) = n - n^S$, it follows that $\Gamma(\underline{f}^M) = 0$. $\Gamma(f^M) > 0$ for $f^M > \underline{f}^M$. The interesting question is whether $\Gamma(f^M)$ increases monotonically with f^M or possibly has a downward-sloping segment. The answer is provided by the following result:

Proposition 2: *Suppose* $\Gamma(f^M) < \bar{L}^N$ *for* $f^M \in [\underline{f}^M, \infty)$. *Then* $\Gamma'(f^M) < 0$ *for* f^M *sufficiently close to* $\bar{f}^M$ *if, and only if,*

$$n^S < \frac{n}{1 + \varepsilon\alpha^{2-\varepsilon}}$$

and

$$\alpha^2 \varepsilon n^S \left[1 + \frac{(1+\alpha^2\varepsilon)\alpha^{-\varepsilon} n^S}{n - n^S - \varepsilon\alpha^{2-\varepsilon} n^S}\right] < (\omega^N)^{\varepsilon-1} - \alpha^{\varepsilon-1}(n - n^S) - n^S. \tag{14}$$

Proof: Log-differentiating Γ, using (13), gives

$$\begin{aligned}
\frac{d\ln\Gamma(f^M)}{df^M} \quad = \quad & -\frac{n^{M*}}{\bar{L}^S - n^{M*}f^M} + \Phi'(f^M)\Bigg[-\frac{1}{n - n^S - n^{M*}} - \frac{f^M}{\bar{L}^S - n^{M*}f^M} \\
& -\frac{1}{\alpha^{-\varepsilon}n^S + n^{M*}} + \frac{\alpha^{\varepsilon-2}}{n^S + \alpha^{\varepsilon-1}n^{M*}} - \frac{\alpha^{\varepsilon-2}}{(\omega^N)^{\varepsilon-1} - \alpha^{\varepsilon-1}(n - n^S - n^{M*})}\Bigg],
\end{aligned} \tag{15}$$

where $n^{M*} = \Phi(f^M)$. Evaluating this derivative at $\bar{f}^M$ (interpreting $\Phi'(\bar{f}^M)$ as the left-hand derivative), using $\Phi(\bar{f}^M) = 0$ and (11), we have

$$\begin{aligned}
\frac{d\ln\Gamma(\bar{f}^M)}{df^M} \quad = \quad & \Phi'(\bar{f}^M)\Bigg\{-\frac{1}{n - n^S} - \frac{\alpha^\varepsilon}{(\varepsilon-1)n^S} + \frac{\alpha^\varepsilon}{(\varepsilon-1)\left[(\omega^N)^{\varepsilon-1} - \alpha^{\varepsilon-1}(n - n^S)\right]} \\
& -\frac{\alpha^\varepsilon}{n^S} + \frac{\alpha^{\varepsilon-2}}{n^S} - \frac{\alpha^{\varepsilon-2}}{(\omega^N)^{\varepsilon-1} - \alpha^{\varepsilon-1}(n - n^S)}\Bigg\}.
\end{aligned}$$

The term in braces is positive if, and only if, the conditions of the proposition hold. Given $\Phi'(\bar{f}^M) < 0$, this proves the proposition. ||

The start of offshoring activity thus possibly comes along with rising employment. However, as the labor requirement for offshoring falls and further production goes abroad, the employment effect certainly turns negative and, given that there is no positive lower bound on employment, significantly so. Numerical experimentation shows that if the conditions of the proposition are satisfied, the range of f^M-values for which $\Gamma'(f^M) < 0$ tends to be small. So positive employment effects of reductions in the fixed cost of offshoring appear to be the exception rather than the rule

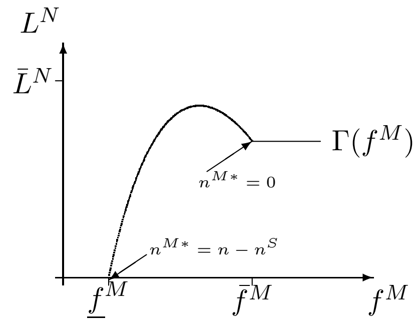

Figure 2: Employment effects of offshoring

in our model.[13] Notice also that the relative production cost $(w^N a^N)/(w^S a^S)$ falls when f^M falls (cf. Figure 1). That is, the observation that offshoring and unemployment soar precisely when the South's absolute advantage shrinks does not imply that these changes have different causes: these are the general equilibrium effects of cheaper offshoring in our model.

Next, consider the impact of offshoring on agents' welfare. The indirect utility Northern workers obtain from spending the RTM wage (6) is independent of f^M and exceeds the reservation utility. So their equilibrium expected utility is a function of employment alone, and the derivative has the same sign as $\Gamma'(f^M)$. The real wage in the South $w^S/P = (w^S/w^N)(w^N/P)$ is a decreasing function of the relative production cost $(w^N a^N)/(w^S a^S)$ alone. Since the equilibrium value of $(w^N a^N)/(w^S a^S)$ is an increasing function of f^M (see Figure 1), a decrease in f^M unambiguously raises Southern workers' utility for $f^M < \bar{f}^M$. From markup pricing and $L^N = (n - n^S - n^M)a^N x^N$, real profit of a firm producing in the North is $[1/(\varepsilon - 1)](w^N/P)L^N/(n - n^S - n^M)$. Since the real wage is fixed, equilibrium real profit is determined by scale alone. Let $h(f^M) = \Gamma(f^M)/[n - n^S - \Phi(f^M)] : [\underline{f}^M, \infty) \to \mathbb{R}^+$. h gives the equilibrium level of $L^N/(n - n^S - n^M)$. The derivative of equilibrium real profit with respect to f^M has the same sign as $h'(f^M)$ and

$$\frac{d \ln h(f^M)}{df^M} = \frac{d \ln \Gamma(f^M)}{df^M} + \frac{\Phi'(f^M)}{n - n^S - \Phi(f^M)}. \tag{16}$$

The same holds true for an MNE's profit, for the non-profitability of further offshoring implies that they make the same profit as Northern producers, if plants in the South are set up in the first place.

Proposition 3: *A marginal change in f^M causes a Pareto improvement if, and only if,* $df^M < 0$

[13]The employment effects of an increase in n^S (i.e., the mass of goods producible in the South without a fixed cost) are similar to the effects of a decrease in f^M (i.e., the fixed cost of producing further goods in the South). Ignoring costly offshoring, employment in the North is $\Psi(0, 0)$. Employment is small for n^S close to zero (recall that an equilibrium does not exist for $n^S = 0$) and for $n^S = n$ and positive in between. So the impact of an increase in n^S on employment is positive if there is little international trade initially, but turns negative at a higher level of n^S.

and $\Gamma'(f^M) < 0$.

Proof: Since Southern workers' utility is an decreasing function of f^M, only a decrease $df^M < 0$ in the offshoring cost can bring about a Pareto improvement. A decrease in f^M raises Northern workers' expected utility exactly if $\Gamma'(f^M) < 0$. From (16) and $\Phi'(f^M) < 0$, $\Gamma'(f^M) < 0$ implies $h'(f^M) < 0$, so the decrease in f^M also raises firms' real profit. ||

Northern workers gain because their probability of getting a job rises, Southern workers benefit because the technology transfer within MNEs raises the purchasing power of the wages they earn, and firm profits soar because both the increase in employment in the North and the increase in the measure of MNEs raise the scale of each firm that stays in the North. From Proposition 2, this situation arises when f^M falls below the level at which Northern firms start to operate plants in the South and n^S is sufficiently small.

Whenever $\Gamma'(f^M) > 0$, a decrease in f^M benefits Southern workers but harms their Northern counterparts. The firm owners' interests can coincide with either side. To see this, we first consider a case in which their interests are aligned with those of Southern workers. Substituting from (12) into (15) and then into (16) yields

$$\begin{aligned} h'(f^M) &= -\frac{n^{M*}}{\bar{L}^S - n^{M*}f^M} + \Phi'(f^M)\Bigg[-\frac{1}{\varepsilon-1}\frac{1}{\alpha^{-\varepsilon}n^S + n^{M*}}\frac{(\omega^N)^{\varepsilon-1} - \alpha^{\varepsilon-1}(n-n^S) - n^S}{(\omega^N)^{\varepsilon-1} - \alpha^{\varepsilon-1}(n-n^S-n^{M*})} \\ &\quad -\frac{1}{\alpha^{-\varepsilon}n^S + n^{M*}} + \frac{\alpha^{\varepsilon-2}}{n^S + \alpha^{\varepsilon-1}n^{M*}} - \frac{\alpha^{\varepsilon-2}}{(\omega^N)^{\varepsilon-1} - \alpha^{\varepsilon-1}(n-n^S-n^{M*})}\Bigg]. \end{aligned} \tag{17}$$

The term in square brackets is positive if, and only if,

$$(\omega^N)^{\varepsilon-1} - \alpha^{\varepsilon-1}(n-n^S) - n^S > \alpha^2\varepsilon n^S\left(1 + \frac{\alpha^{\varepsilon-1}n^{M*}}{n^S}\right)^2. \tag{18}$$

Proposition 4: *Suppose* $\Gamma'(f^M) > 0$ *and (18) holds for* $n^{M*} = n - n^S$*. Then a marginal decrease in* f^M *raises real profit.*

Proof: If (18) holds for $n^{M*} = n - n^S$, then it holds for all $n^{M*} \le n - n^S$. From (17), $h'(f^M) < 0$ for all $f^M < \bar{f}^M$. ||

The condition of the proposition ensures that the net effect of lower employment and more offshoring on the scale of producers staying in the North is positive. As a consequence, Southern workers and Northern firms gain from easier access to Southern production plants, at the expense of Northern workers.

Finally, we consider a case in which easier offshoring is detrimental to both workers and firm owners in the North:

Proposition 5: *Suppose (18) is violated for* $n^{M*} = 0$*. Then for* f^M *sufficiently close to* $\bar{f}^M$*, a marginal decrease in* f^M *reduces workers' expected utility and firm owners' real profit in the North.*

Proof: The fact that (18) is violated for $n^{M*} = 0$ implies that (14) is also violated, so $\Gamma'(\bar{f}^M) > 0$. For f^M close to $\bar{f}^M$, n^{M*} and, hence, the first term in the sum on the right-hand side of (17) are close to zero. If (18) is violated, the term in square brackets on the right-hand side of (17) is negative, so $h'(f^M) > 0$. ||

Unemployment soars, and this reduces the scale and profit of Northern firms. From the viewpoint of the North as a whole, there are losers but no winners from additional offshoring.[14]

Turning to aggregate social welfare (SW), suppose agents are risk-neutral (i.e., let $\beta = 1$), and define SW as the sum of all agents' individual (indirect expected) utilities. $\beta = 1$ implies that each agent's indirect utility is equal to his real income (i.e., income deflated by the price index P). Hence, SW is I/P. Using (2), markup pricing, (6), and $L^N = (n - n^S - n^M)a^N x^N$, this can be written as

$$\frac{I}{P} = \left(\frac{\omega^N}{\alpha}\right)^{\varepsilon} \frac{L^N}{n - n^S - n^M},$$

and the derivative of SW with respect to f^M has the same sign as $h'(f^M)$. From the analysis above we immediately obtain:

Proposition 6: *Let* $\beta = 1$*. Consider* $df^M < 0$*. SW rises if* $\Gamma'(f^M) < 0$*. SW rises if* $\Gamma'(f^M) > 0$ *and (18) holds for* $n^{M*} = n - n^S$*. For* f^M *sufficiently close to* $\bar{f}^M$*, SW falls if (18) is violated for* $n^{M*} = 0$*.*

The final part of the proposition strengthens the message of Proposition 5 further: not only does everyone in the North lose from additional offshoring, but the losses are so large that the aggregate worldwide SW goes down despite rising worker utility in the South (ignoring distributional considerations).

[14] Again, the effects of an increase in the mass of goods producible in the South without a fixed cost n^S are similar, when costly offshoring is ignored (cf. footnote 13). The derivative of Northern workers' expected utility with respect to n^S has the same sign as the derivative of $L^N = \Psi(0, 0)$ with respect to n^S. The same holds true for firms' aggregate real profit $(w^N/P)L^N/(\varepsilon - 1)$. Finally, an increase in n^S raises $(w^S a^S)/(w^N a^N)$, so that Southern workers' real wage $(w^S/w^N)(w^N/P)$ rises. Hence, an increase in n^S constitutes a Pareto improvement if L^N rises, while both Northern workers and firm owners lose if employment falls.

5 The case for a pragmatic union leader

The Northern labor unions face a serious commitment problem in a symmetric equilibrium with a cost advantage for the South and unemployment and a positive amount of offshoring (i.e., $n^{M*} > 0$). Suppose a union could commit to agree to a wage rate $w^N/P + dw^N/P$ ($dw^N/P < 0$) marginally below the RTM wage w^N/P in (6). This would cause a negligible loss in the indirect utility of an employed worker. At the same time, it would render the operating profit differential between North and South strictly smaller than the fixed cost of offshoring, so that all firms in the industry would leave production at home, and the demand for labor would surge from $(n - n^S - n^{M*})L^d(w^N/P,\, I/P)$ to $(n - n^S)L^d((w^N + dw^N)/P,\, I/P)$. If there were a way to make such a commitment, unions would strive to use it. In parallel to Rogoff's (1985) case for a "conservative central banker", this section proposes the appointment of a "pragmatic union leader" (PUL) as a way to commit to wage restraint. We show that an equilibrium might exist in which some unions set the RTM wage and others employ a PUL in order to commit to a lower wage rate. This provides an endogenous explanation of shrinking union power.

Suppose each industry union can appoint a non-combative union leader, who commits credibly to accept a wage rate in his industry $\tilde{w}^N/P$ equal to a given fraction δ of the RTM wage in (6):

$$\frac{\tilde{w}^N}{P} = \delta \frac{w^N}{P}, \tag{19}$$

where $[1 - \beta(1-\gamma)/(\varepsilon - \gamma)]^{1/\beta} \leq \delta \leq 1$ (the former inequality ensures that the wage is no less than the reservation wage $b^{1/\beta}$). One possible interpretation (analogous to a central banker with stronger inflation aversion than the public) is that the PUL maximizes union members' expected utility, but uses a lower reservation utility for the unemployed $\tilde{b}$ in doing so (where $[1 - \beta(1-\gamma)/(\varepsilon - \gamma)]b \leq \tilde{b} \leq b$). Letting $\delta = (\tilde{b}/b)^{1/\beta}$, (19) then follows from (6). A different interpretation is that the union appoints a weak union leader, with bargaining power $1 - \tilde{\gamma} \in [0,\, 1-\gamma]$. For each δ, there is $\tilde{\gamma}$ such that $\tilde{w}^N/P = \{b/[1 - \beta(1-\tilde{\gamma})/(\varepsilon - \tilde{\gamma})]\}^{1/\beta}$ satisfies (19). As in Rogoff (1985), the commitment entails no physical cost. However, the lower δ, the greater the degree of wage restraint implied by the commitment solution.

Let $\tilde{x}^N$ denote the output of a firm in an industry with commitment. From (2) and (19), $\tilde{x}^N/x^N = \delta^{-\varepsilon}$. Employment in the industry is $\tilde{L}^N = (n - n^S)a^N\tilde{x}^N$. We assume that $\tilde{L}^N < \bar{L}^N$ (see Figure 3). The necessary parameter condition is derived later on. Using $L^N = (n - n^S - n^M)a^N x^N$, it follows that

$$\frac{\tilde{L}^N}{L^N} = \frac{n - n^S}{n - n^S - n^M}\delta^{-\varepsilon}. \tag{20}$$

Let μ denote the proportion of industries with a PUL. The definition of an equilibrium with

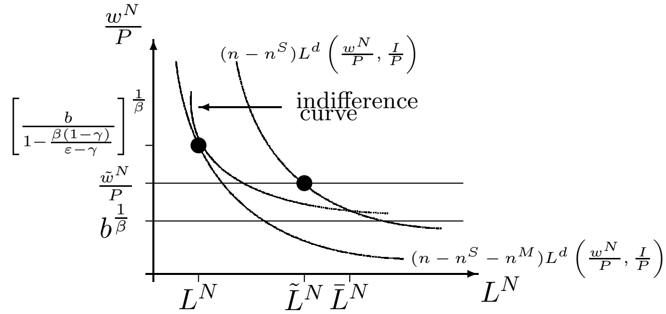

Figure 3: Employment with or without commitment

PULs is similar as in Section 3. We have to add the condition that expected utility with commitment $(\tilde{L}^N/\bar{L}^N)(\tilde{w}^N/P)^\beta + (1 - \tilde{L}^N/\bar{L}^N)b$ is greater than expected utility without commitment $(L^N/\bar{L}^N)(w^N/P)^\beta + (1 - L^N/\bar{L}^N)b$ and $\mu = 1$, or else the expected utilities are the same and $\mu \in (0, 1)$. Using (20), this additional condition can be written as

$$\frac{n^M}{n - n^S} \geq 1 - \delta^{-\varepsilon}\left[1 - \frac{\varepsilon - \gamma}{\beta(1-\gamma)}\left(1 - \delta^\beta\right)\right], \quad \mu \leq 1, \tag{21}$$

with at most one strict inequality. There is $\tilde{\delta}$ in the interval $([1 - \beta(1-\gamma)/(\varepsilon - \gamma)]^{1/\beta}, 1)$ such that the right-hand side of the first inequality in (21) is positive for $[1 - \beta(1-\gamma)/(\varepsilon-\gamma)]^{1/\beta} \leq \delta < \tilde{\delta}$ and non-positive for $\tilde{\delta} \leq \delta \leq 1$.

For $\tilde{\delta} \leq \delta \leq 1$, the first inequality in (21) holds for all $n^M \geq 0$. That is, the cost of commitment is low enough so that it pays to appoint a PUL irrespective of the amount of offshoring. Each industry union makes use of the commitment device. The analysis in Section 3 goes through, except that the real wage in (6) is lower by factor δ. However, if $n^M > 0$ in equilibrium, the commitment problem is still present: the appointment of a slightly *more* PUL would mean that the measure of firms which go abroad jumps to zero at the cost of a small loss in wages.

Let $\delta < \tilde{\delta}$, so that the right-hand side of the first inequality in (21) is positive. As in Section 3, let n^{M*} be defined as the equilibrium measure of MNEs in the absence of the possibility of commitment. If $n^M = n^{M*}$ violates the first inequality in (21) or satisfies it with equality, then the job losses due to offshoring are small enough so that it does not pay to commit to wage moderation, and the analysis in (3) goes through without modification. The interesting case is that the first inequality in (21) is strict for $n^M = n^{M*}$. In this case, there possibly exists an equilibrium with RTM wages in some sectors and PULs in others, and the commitment device is efficient, in that it reduces the amount of offshoring to zero, so that there is no incentive to appoint a more PUL.

Proposition 7: *Suppose the conditions of Proposition 1 are satisfied, and the first inequality in*

(21) is strict for $n^M = n^{M*}$. Suppose further $\delta < \tilde{\delta}$ and

$$f^M > \frac{\alpha^\varepsilon \bar{L}^S}{(\varepsilon-1)n^S}\left[1 - \frac{n^S}{(\omega^N)^{\varepsilon-1} - \left(\frac{\alpha}{\delta}\right)^{\varepsilon-1}(n-n^S)}\right]. \tag{22}$$

Then for $\bar{L}^N$ large enough, there is an equilibrium with $\mu \in (0,1)$.

Proof: The condition for non-profitability of further offshoring in industries with the RTM wage (5) is unchanged. The fact that the wage is lower implies that there is no offshoring in industries with a PUL. The price setting equation and the condition for labor market clearing in the South become

$$\begin{aligned}\left(\frac{w^N a^N}{P}\right)^{\varepsilon-1} &= (1-\mu)\left[\alpha^{\varepsilon-1}\left(n-n^S-n^M\right)+\left(n^S+\alpha^{\varepsilon-1}n^M\right)\left(\frac{w^N a^N}{w^S a^S}\right)^{\varepsilon-1}\right] \\ &\quad +\mu\left[\left(\frac{\alpha}{\delta}\right)^{\varepsilon-1}\left(n-n^S\right)+n^S\left(\frac{w^N a^N}{w^S a^S}\right)^{\varepsilon-1}\right]\end{aligned} \tag{23}$$

and

$$\bar{L}^S = \left[\alpha^{-\varepsilon}n^S + (1-\mu)n^M\right]\left(\frac{w^N a^N}{w^S a^S}\right)^{\varepsilon} a^S x^N + (1-\mu)n^M f^M, \tag{24}$$

respectively. Equations (5), (6), (21), (23), and (24) determine w^N/P, n^M, $(w^N a^N)/(w^S a^S)$, x^N, and μ. Equation (19) then pins down $\tilde{w}^N/P$. From (6) and (23) ,

$$\frac{w^N a^N}{w^S a^S} = \left[\frac{(\omega^N)^{\varepsilon-1} - \alpha^{\varepsilon-1}\left(1-\mu+\frac{\mu}{\delta^{\varepsilon-1}}\right)(n-n^S) + (1-\mu)\alpha^{\varepsilon-1}n^M}{n^S + (1-\mu)\alpha^{\varepsilon-1}n^M}\right]^{\frac{1}{\varepsilon-1}} = \tilde{f}(n^M,\mu), \tag{25}$$

where $\tilde{f} : [0,\, n-n^S] \times [0,1] \to \mathbb{R}$. From (5) and (24),

$$\frac{w^N a^N}{w^S a^S} \leq \left[1 - (\varepsilon-1)\frac{\alpha^{-\varepsilon}n^S + (1-\mu)n^M}{\frac{\bar{L}^S}{f^M} - (1-\mu)n^M}\right]^{\frac{1}{1-\varepsilon}} = \tilde{g}(n^M, f^M, \mu), \quad n^M \geq 0, \tag{26}$$

where $\tilde{g}$ maps $\{(n^M, f^M, \mu) \in \mathbb{R}^2_+ \times [0,1] \,|\, (1-\mu)n^M < [\bar{L}^S/f^M - (\varepsilon-1)\alpha^{-\varepsilon}n^S]/\varepsilon\}$ on $\mathbb{R}_+$. Let the measure of firms which offshore in industries with the RTM wage $\tilde{n}^{M*}$ be determined by (21) holding with equality. The assumption that n^{M*} satisfies the first inequality in (21) implies $n^{M*} > 0$ and $\tilde{n}^{M*} < n^{M*}$. The question is: does there exist $\tilde{\mu} \in (0,1)$ such that $\tilde{f}(\tilde{n}^{M*}, \tilde{\mu}) = \tilde{g}(\tilde{n}^{M*}, f^M, \tilde{\mu})$? The fact that $n^{M*} > 0$ implies $\tilde{f}(0,0) = f(0) > g(0, f^M) = \tilde{g}(0, f^M, 0)$. From (22), (25), and (26), we have $\tilde{f}(0,1) < \tilde{g}(0, f^M, 1)$. So $\tilde{f}(0,\mu') = \tilde{g}(0, f^M, \mu')$ for some $\mu' \in (0,1)$. For given f^M, let $\varphi : [0,\mu'] \to \mathbb{R}_+$ be defined by $\tilde{f}(\varphi(\mu),\mu) = \tilde{g}(\varphi(\mu), f^M, \mu)$. φ is a continuous real-valued function. By construction, $\varphi(0) = n^{M*}$ and $\varphi(\mu') = 0$. Hence, there is $\tilde{\mu} \in (0,\mu')$ such that $\varphi(\tilde{\mu}) = \tilde{n}^{M*}$, i.e., $\tilde{f}(\tilde{n}^{M*}, \tilde{\mu}) = \tilde{g}(\tilde{n}^{M*}, f^M, \tilde{\mu})$ (cf. Figure 4).

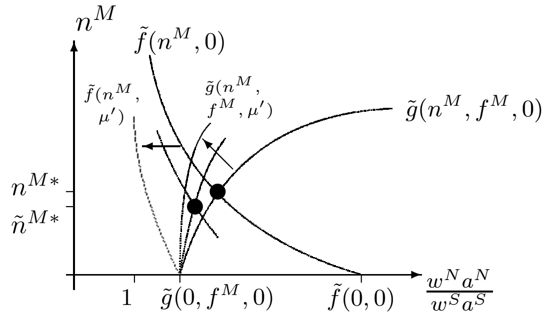

Figure 4: Equilibrium with $\tilde{\mu} \in (0, 1)$

The fact that $n^{M*} > 0$ implies $f^M < \bar{f}^M$. This does not contradict (22), since the right-hand side of (22) is less than $\bar{f}^M$. $\tilde{n}^{M*} < n^{M*}$ implies the validity of $(1-\mu)\tilde{n}^{M*} < \bar{L}^S / f^M$ and $\tilde{n}^{M*} < n - n^S$. The condition for unemployment in industries with a PUL is:

$$(n - n^S)\delta^{-\varepsilon} a^N \frac{\bar{L}^S - (1-\mu')\tilde{n}^{M*} f^M}{a^S \left[\alpha^{-\varepsilon} n^S + (1-\mu')\tilde{n}^{M*}\right]} \left[\frac{n^S + \alpha^{\varepsilon-1}\tilde{n}^{M*}}{(\omega^N)^{\varepsilon-1} - \left(1 - \mu' + \frac{\mu'}{\delta^{\varepsilon-1}}\right)(n - n^S)} \right] < \bar{L}^N.$$

Since $\tilde{n}^{M*}$ and μ' are independent of $\bar{L}^N$, the condition is satisfied for $\bar{L}^N$ large enough. Employment is lower in industries with RTM wages as well, so unemployment prevails there too. ||

The commitment problem is a direct and fairly general outcome of offshoring and union wage setting. In the standard RTM model without offshoring (with small competitive firms that produce a homogeneous good), no such problem arises: the RTM wage is the solution to the union's second-best optimization problem, and there is no interaction between the unions' optimization problems. If, however, a firm, anticipating the outcome of subsequent union wage setting, is indifferent between offshoring and producing in the home country, then a small reduction in the wage rate brings about a discrete reduction in the probability of offshoring. Proposition 7 shows a way how unions can at least partially overcome this problem.

6 Heterogeneous firms

So far we have neglected the uncertainties surrounding the establishment of a plant in an emerging economy. Productivity uncertainty appears particularly relevant with regard to offshoring to low-wage emerging markets. The recent experience of German manufacturers provides a good example (see Kinkel and Maloca, 2009). German firms were especially active in offshoring since the mid-1990s: in each of the two-year periods between 1995 and 2005, about 15-25 percent of the German manufacturing firms relocated (further) production abroad. The main target region was Central and Eastern Europe, the dominant motive cost reduction, and the preferred mode offshoring within MNEs (rather than offshore outsourcing). In 2007-09, this proportion fell to 9 percent (though it was still 45 percent for firms with 1,000 or more employees and 24 percent for the medium-sized manufacturers with 250 to below 1,000 employees). At the same time, 3 percent of all manufacturing firms re-relocated production to Germany. That is, there was one firm moving production back to Germany per three offshorers. The main motive for moving production back home was disappointment with the quality of production processes and the scope for handling them.

Following the new new trade theory initiated by Melitz (2003), the present section introduces uncertainty about the input coefficient in the South to the model of Section 2. A novel feature of the model is that uncertainty concerns only production abroad, while productivity in the North is certain (whereas the new new trade theory assumes that productivities are identical at different locations). Given that the typical product cycle involves offshoring of mature products (Vernon, 1966), this seems to be an appropriate representation of the firms' offshoring decision. We show that the interaction of firms' offshoring decision and unions' wage setting behavior provides a nantural explanation for multiple equilibria. We discuss the employment effects of switching from one such equilibrium to another and of changes in uncertainty and in the labor requirement for offshoring. We argue that the commitment problem of Section 5 remains present.

We focus on the monopoly union special case of RTM wage setting in this section. Firms which pay the fixed cost of offshoring $w^S f^M$ acquire the ability to produce in the South. The productivity of Southern subsidiaries is uncertain before the fixed cost is paid. Following Helpman et al. (2004) and Baldwin and Forslid (2010), each firm independently draws a productivity level in the South from the Pareto distribution, i.e., the probability of drawing an input coefficient $a' \leq a$ is $H(a) = a^{\lambda}$ for $0 \leq a \leq 1$, where $\lambda > \varepsilon - 1$. After productivity in the South is known, each monopoly union sets a uniform wage rate for its industry. After wages are determined, firms which have incurred the fixed cost decide whether to offshore or not. In the spirit of the new new trade theory, only those firms with sufficiently high productivity in the South actually move production abroad. The assumption that, as in the baseline model, the establishment of a Southern subsidiary precedes wage setting is meant to express that offshoring is a longer-term decision than wage setting. The assumption that not all MNEs actually produce in the South can be motivated by Bergin et al.'s (2009) observation that variation in the number of existing subsidiaries operating explains a sizeable portion of output volatility in MNEs.

Let n^M denote the mass of firms in industry i which incur the fixed cost of offshoring (which possibly exceeds the mass of firms which actually offshore production). Equilibrium is defined similarly as in the model with homogeneous firms, with the following modifications: either $n^M > 0$

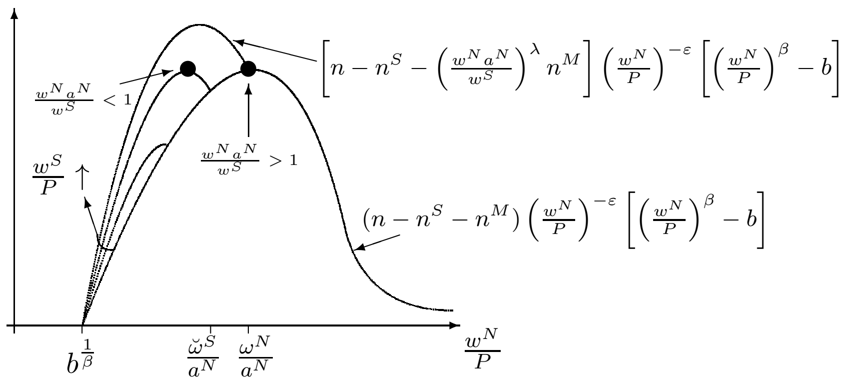

Figure 5: Wage setting with heterogeneous firms

and the fixed cost of setting up an MNE is equal to the *expected* difference between an MNE's profit and a Northern producer's operating profit, or $n^M = 0$ and the fixed cost is no less than the *expected* operating profit differential; firms which have incurred the fixed cost of offshoring relocate production to the South if, and only if, operating cost is lower there; if a firm has incurred the fixed cost but does not offshore, its profit in the North is no less than the fixed cost of offshoring.[15]

An MNE with input coefficient a in the South sets the markup price $w^N a^N/\alpha$ or $w^S a/\alpha$, depending on whether it produces in the North or in the South, respectively. From (2), its profit if it produces in the South is $w^S a[(w^S a)/(w^N a^N)]^{-\varepsilon} x^N/(\varepsilon - 1)$. An MNE offshores production if, and only if, this is no less than profit in the North $w^N a^N x^N/(\varepsilon - 1)$, i.e.,

$$a \leq \frac{w^N a^N}{w^S}. \tag{27}$$

The main that arises due to firm heterogeneity is that the union's objective function becomes non-concave, which implies that the optimum wage w^N/P is a discontinuous function of the prevailing wage rate in the South w^S/P. The monopoly union maximizes workers' expected utility gain compared to the reservation utility b subject to the industry labor demand curve. Using (27), the mass of firms that produce in the North is $n - n^S - \max\{(w^N a^N)/w^S)^{\lambda}, 1\}n^M$. Labor demand per

[15] If we dropped the final condition, we would have to allow for bankruptcy or introduce an insurance mechanism that redistributes income from "lucky" firms that draw a low input coefficient to high-a firms (we must not assume that there are worker-firm owners with both wage income and ownership shares, since the wage setting process assumes that workers have no income if they do not work).

firm is given by $L^d(w^N/P,\, I/P)$. Omitting the factor $(a^N)^{1-\varepsilon}\alpha^\varepsilon(I/P)/\bar{L}^N$, which it takes as given, the union's objective function is

$$\left[n - n^S - \max\left\{\left(\frac{w^N a^N}{w^S}\right)^\lambda,\, 1\right\} n^M\right]\left[\left(\frac{w^N}{P}\right)^\beta - b\right]\left(\frac{w^N}{P}\right)^{-\varepsilon}. \tag{28}$$

An increase in w^N/P has a twofold negative effect on employment. For one thing, it reduces labor demand per firm in the North (the intensive margin). For another, for $w^N/P < (w^S/P)/a^N$ (i.e., $w^N a^N < w^S$), it decreases the mass of firms operating in the North (the extensive margin). Consistent with the Rodrik (1997) hypothesis, offshoring thus increases the wage elasticity of labor demand. The function in (28) is depicted in Figure 5 for given n^M. The max term equals one for $w^N/P \geq (w^S/P)/a^N$. For $w^S/P \leq a^N b^{1/\beta}$, this condition is satisfied for all $w^N/P \geq b^{1/\beta}$. From Section 3, we know that the monopoly union sets $w^N/P = \omega^N/a^N$, where ω^N is defined by (6) with $\gamma = 0$. For $w^S/P > a^N b^{1/\beta}$, we have $w^N a^N/w^S < 1$ for w^N/P in the interval $(b^{1/\beta},\, (w^S/P)/a^N)$. Clearly, for w^S/P close enough to $a^N b^{1/\beta}$, ω^N/a^N is still the optimum wage rate (see the upper right panel of Figure 6). On the other hand, for $w^S/P = \omega^N$ $(> a^N b^{1/\beta})$, the left-hand derivative of the function in (28) is negative at $w^N/P = \omega^N/a^N$, so it attains a local maximum at some $w^N/P < \omega^N/a^N$. It follows that there is a real wage rate in the South $w^S/P = \breve{\omega}^S(n^M)$ such that (28) has two maxima (with the same level of expected utility), one at a wage rate $w^N/P < \breve{\omega}^S(n^M)/a^N$ (so that $w^N a^N/w^S < 1$) and the other one at a wage rate $w^N/P > \breve{\omega}^S(n^M)/a^N$ (so that $w^N a^N/w^S > 1$). The monopoly wage is ω^N/a^N for w^S/P up to $\breve{\omega}^S(n^M)$ and is implicitly determined by

$$\frac{w^N}{P} = \left[1 - \frac{\beta}{\frac{\lambda n^M}{(n-n^S)\left(\frac{w^N a^N}{w^S}\right)^{-\lambda} - n^M} + \varepsilon}\right]^{-\frac{1}{\beta}} b^{\frac{1}{\beta}} = \frac{\breve{\omega}^N\left(\frac{w^N a^N}{w^S a^S}, n^M\right)}{a^N}. \tag{29}$$

for $w^S/P > \breve{\omega}^S(n^M)$. $\breve{\omega}^N((w^N a^N)/(w^S a^S), n^M)$ is decreasing in its first argument, so if a solution w^N/P exists, then it is unique. Moreover, since $\breve{\omega}^N((w^N a^N)/(w^S a^S),\, n^M)$ rises when w^S/P rises, the optimum wage w^N/P is an increasing function of w^S/P for $w^S/P > \breve{\omega}^S(n^M)$.

The upper left panel of Figure 6 illustrates the dependence of $(w^N a^N)/(w^S a^S)$ on w^S/P. For $w^S/P < \breve{\omega}^S(n^M)$, w^N/P is constant, so $(w^N a^N)/(w^S a^S)$ falls as w^S/P rises. At $w^S/P = \breve{\omega}^S(n^M)$, $(w^N a^N)/(w^S a^S)$ jumps downward, from above $1/a^S$ to below $1/a^S$. For $w^S/P > \breve{\omega}^S(n^M)$, from (29), $(w^N a^N)/(w^S a^S)$ and w^N/P are inversely related. Since w^N/P is an increasing function of w^S/P, $(w^N a^N)/(w^S a^S)$ is a decreasing function of w^S/P.

Consider the inverse of the mapping of w^S/P on $(w^N a^N)/(w^S a^S)$ depicted in the upper left panel of Figure 6. There are $\underline{\nu}(n^M)$ and $\bar{\nu}(n^M)$ such that for $(w^N a^N)/(w^S a^S) \leq \underline{\nu}(n^M)$, there

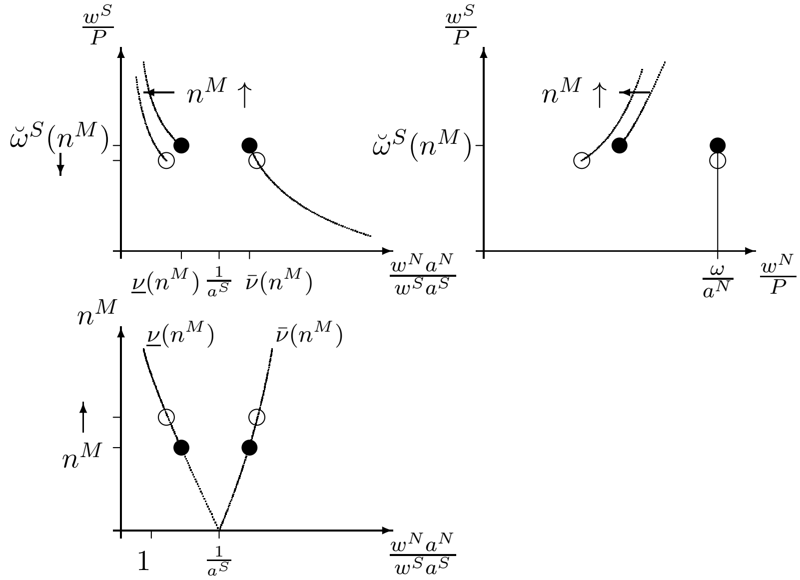

Figure 6: Admissible $((w^N a^N)/(w^S a^S),\, n^M)$ pairs

is w^S/P which induces the monopoly union to set $w^N/P = \breve{\omega}^N((w^N a^N)/(w^S a^S),\, n^M)/a^N$, and for $(w^N a^N)/(w^S a^S) \geq \bar{\nu}(n^M)$, there is w^S/P such that $w^N/P = \omega^N/a^N$. For $(w^N a^N)/(w^S a^S) \in (\underline{\nu}(n^M),\, \bar{\nu}(n^M))$ ($\ni 1/a^S$), there is no pair $(w^S/P,\, w^N/P)$ consistent with the monopoly union's maximizing decision. For $(w^N a^N)/(w^S a^S) < \underline{\nu}(n^M)$, when $(w^N a^N)/(w^S a^S)$ increases, w^S/P and, hence, w^N/P fall ($w^N/P = \breve{\omega}^N(0, n^M) = \omega^N$ for $(w^N a^N)/(w^S a^S) = 0$). So the wage rate w^N/P set by the monopoly union is a non-increasing function of $(w^N a^N)/(w^S a^S)$ in each of the intervals $(0,\, \underline{\nu}(n^M))$ and $(\bar{\nu}(n^M),\, \infty)$; but as $(w^N a^N)/(w^S a^S)$ jumps upward from $\underline{\nu}(n^M)$ to $\bar{\nu}(n^M)$, the monopoly real wage jumps upward from $\breve{\omega}^N(\underline{\nu}(n^M), n^M)$ to ω^N/a^N. This non-monotonicity will prove crucial for multiplicity of equilibria.

An increase in n^M reduces the value of the union's objective function (28) for all $w^N/P > b^{1/\beta}$. From the envelope theorem, the derivative of the maximum value of the union's objective function with respect to n^M is proportional to $\max\{(w^N a^N/w^S)^\lambda,\, 1\}$. Starting from a situation such that $w^S/P = \breve{\omega}^S(n^M)$ (so that (28) has two maxima), let n^M rise. Since the value of the maximum with $w^N/P > (w^S/P)/a^N$ (i.e., $\max\{(w^N a^N/w^S)^\lambda,\, 1\} = 1$) reacts stronger to the increase in n^M, the maximum with $w^N/P < (w^S/P)/a^N$ now has a higher value. Since the objective function decreases when w^S/P falls for $w^N/P < (w^S/P)/a^N$ and is independent of w^S/P for $w^N/P > (w^S/P)/a^N$, w^S/P has to fall in order to restore two maxima again, i.e., $\breve{\omega}^S(n^M)$ is a decreasing function. $\breve{\omega}^N((w^N a^N)/(w^S a^S), n^M)$ is decreasing in its second argument. So for any $w^S/P > \breve{\omega}^S(n^M)$, the optimum wage rate w^N/P and, consequently, $(w^N a^N)/(w^S a^S)$ fall as n^M rises (i.e., the relevant portions of the graphs in the upper panels of Figure 6 shift to the left). For the inverse of the mapping from w^S/P to $(w^N a^N)/(w^S a^S)$, this means that the bounds of the interval of non-admissible $(w^N a^N)/(w^S a^S)$-values $(\underline{\nu}(n^M),\ \bar{\nu}(n^M))$ change (the upper bound rises, the lower bound may rise or fall). For n^M and, hence, $\max\{(w^N a^N/a^S)^\lambda,\ 1\}n^M$ close to zero, the difference between the two optimum wages w^N/P for $w^S/P = \breve{\omega}^S$ is small, so $\underline{\nu}(n^M)$ and $\bar{\nu}(n^M)$ are close to $1/a^S$ (see the bottom panel of Figure 6). We summarize the outcome of the wage setting process in the North in the following result:

Proposition 8: *There are functions $\breve{\omega}^N((w^N a^N)/(w^S a^S),\ n^M)$ ($< \omega^N$ and decreasing in both arguments), $\underline{\nu}(n^M)$, and $\bar{\nu}(n^M)$ (with $\underline{\nu}(n^M) = \bar{\nu}(n^M) = 1/a^S$ for $n^M = 0$ and $\underline{\nu}(n^M) < \bar{\nu}(n^M)$ for $n^M > 0$) such that*

$$\frac{w^N}{P} = \begin{cases} \frac{\breve{\omega}^N\left(\frac{w^N a^N}{w^S a^S}, n^M\right)}{a^N}, & \frac{w^N a^N}{w^S a^S} \le \underline{\nu}(n^M) \\ \frac{\omega^N}{a^N}, & \frac{w^N a^N}{w^S a^S} \ge \bar{\nu}(n^M) \end{cases}. \tag{30}$$

The remainder of the equilibrium analysis is straightforward. From the definition of the price index and the markup pricing rules,

$$\left(\frac{w^N a^N}{P}\right)^{\varepsilon-1} = \begin{cases} \left[n - n^S - \left(\frac{w^N a^N}{w^S}\right)^\lambda n^M\right]\alpha^{\varepsilon-1} & \\ \quad +n^M \frac{\lambda\alpha^{\varepsilon-1}}{\lambda+1-\varepsilon}\left(\frac{w^N a^N}{w^S}\right)^\lambda + n^S\left(\frac{w^N a^N}{w^S a^S}\right)^{\varepsilon-1}, & \frac{w^N a^N}{w^S a^S} \le \frac{1}{a^S} \\ (n - n^S - n^M)\alpha^{\varepsilon-1} & \\ \quad +n^M \frac{\lambda\alpha^{\varepsilon-1}}{\lambda+1-\varepsilon}\left(\frac{w^N a^N}{w^S}\right)^{\varepsilon-1} + n^S\left(\frac{w^N a^N}{w^S a^S}\right)^{\varepsilon-1}, & \frac{w^N a^N}{w^S a^S} \ge \frac{1}{a^S} \end{cases}. \tag{31}$$

The condition that further offshoring is not profitable reads:

$$\begin{aligned} \frac{1}{\varepsilon-1}w^N a^N x^N \quad &\ge \quad H\left(\frac{w^N a^N}{w^S}\right) E\left[\frac{1}{\varepsilon-1}w^S a\left(\frac{w^S a}{w^N a^N}\right)^{-\varepsilon} x^N \,\middle|\, a \le \frac{w^N a^N}{w^S}\right] \\ &\quad + \left[1 - H\left(\frac{w^N a^N}{w^S}\right)\right]\frac{1}{\varepsilon-1}w^N a^N x^N - w^S f^M, \quad n^M \ge 0, \end{aligned}$$

with at most one strict inequality. Simplifying terms yields

$$f^M \ge \begin{cases} \frac{x^N}{\lambda+1-\varepsilon}\left(\frac{w^N a^N}{w^S}\right)^{\lambda+1}, & \frac{w^N a^N}{w^S a^S} \le \frac{1}{a^S} \\ \frac{x^N}{\lambda+1-\varepsilon}\frac{\lambda\left(\frac{w^N a^N}{w^S}\right)^\varepsilon - (\lambda+1-\varepsilon)\frac{w^N a^N}{w^S}}{\varepsilon-1}, & \frac{w^N a^N}{w^S a^S} \ge \frac{1}{a^S} \end{cases}, \quad n^M \ge 0, \tag{32}$$

with at most one strict inequality. The condition that firm profit in the North $w^N a^N x^N/(\varepsilon - 1)$ is sufficient to cover the fixed cost $w^S f^M$ for firms that do not offshore is

$$\left(\frac{w^N a^N}{w^S}\right)^\lambda \le \frac{\lambda}{\varepsilon-1} - 1$$

for $n^M > 0$. The labor market clearing condition for the South becomes

$$\bar{L}^S = \begin{cases} n^M \frac{\lambda x^N}{\lambda+1-\varepsilon} \left(\frac{w^N a^N}{w^S}\right)^{\lambda+1} + n^S a^S \alpha^{-\varepsilon} \left(\frac{w^N a^N}{w^S a^S}\right)^{\varepsilon} x^N + n^M f^M, & \frac{w^N a^N}{w^S a^S} \leq \frac{1}{a^S} \\ n^M \frac{\lambda x^N}{\lambda+1-\varepsilon} \left(\frac{w^N a^N}{w^S}\right)^{\varepsilon} + n^S a^S \alpha^{-\varepsilon} \left(\frac{w^N a^N}{w^S a^S}\right)^{\varepsilon} x^N + n^M f^M, & \frac{w^N a^N}{w^S a^S} \geq \frac{1}{a^S} \end{cases}. \tag{33}$$

Equations (30)-(33) jointly determine w^N/P, n^M, $(w^N a^N)/(w^S a^S)$, and x^N. From (30) and (31),

$$\frac{w^N a^N}{w^S a^S} = \begin{cases} \left\{ \frac{\breve{\omega}^N \left(\frac{w^N a^N}{w^S a^S}, n^M\right)^{\varepsilon-1} - \alpha^{\varepsilon-1}\left[n - n^S + \frac{\varepsilon-1}{\lambda+1-\varepsilon}\left(\frac{w^N a^N}{w^S}\right)^{\lambda} n^M\right]}{n^S} \right\}^{\frac{1}{\varepsilon-1}}, & \frac{w^N a^N}{w^S a^S} \leq \underline{\nu}(n^M) \\ \left[\frac{(\omega^N)^{\varepsilon-1} - \alpha^{\varepsilon-1}(n - n^S - n^M)}{n^S + \frac{\lambda}{\lambda+1-\varepsilon}(a^S)^{\varepsilon-1}\alpha^{\varepsilon-1} n^M}\right]^{\frac{1}{\varepsilon-1}}, & \frac{w^N a^N}{w^S a^S} \geq \bar{\nu}(n^M) \end{cases}. \tag{34}$$

Let $\breve{f}(n^M)$ denote the mapping that assigns solutions $(w^N a^N)/(w^S a^S)$ to this equality to n^M. For $(w^N a^N)/(w^S a^S) \geq \bar{\nu}(n^M)$, this is simply the right-hand side of the equation. From (32) and (33),

$$\begin{aligned} \frac{w^N a^N}{w^S a^S} &\leq \begin{cases} \left[\frac{(\lambda+1-\varepsilon)(a^S)^{-\lambda}\alpha^{-\varepsilon} n^S}{\frac{\bar{L}^S}{f^M} - (1+\lambda) n^M}\right]^{\frac{1}{\lambda+1-\varepsilon}}, & \frac{w^N a^N}{w^S a^S} \leq \frac{1}{a^S} \\ \left[\frac{\lambda}{\lambda+1-\varepsilon}(a^S)^{\varepsilon-1} - (\varepsilon-1)\frac{\frac{\lambda}{\lambda+1-\varepsilon}(a^S)^{\varepsilon-1} n^M + \alpha^{-\varepsilon} n^S}{\frac{\bar{L}^S}{f^M} - n^M}\right]^{\frac{1}{1-\varepsilon}}, & \frac{w^N a^N}{w^S a^S} \geq \frac{1}{a^S} \end{cases} \\ &= \breve{g}(n^M, f^M), \quad n^M \geq 0, \end{aligned} \tag{35}$$

with at most one strict inequality. The function $\breve{g}$ is increasing in n^M, increasing in f^M, and continuous. For $\lambda \to \infty$, the expectation of the input coefficient $E(a) = \lambda/(\lambda+1)$ goes to unity, and the variance $\sigma_a^2 = \lambda/[(\lambda+1)^2(\lambda+2)]$ goes to zero. Accordingly, as $\lambda \to \infty$ and $a^S = 1$ the functions $\breve{f}$ and $\breve{g}$ coincide with their counterparts in the model with homogeneous goods for $(w^N a^N)/(w^S a^S) \geq 1$ (see (8) and (10) with $a^S = 1$, respectively).

The main result in this section is that multiple equilibria can occur, and that this is not a theoretical curiosity that depends on the curvature of the functions which determine equilibrium, but a natural consequence of the non-monotonicity detected above.

Proposition 9: *There are parameters such that two symmetric equilibria with a cost advantage for the South and unemployment exist.*

Proof: Let $\bar{L}^N = 30$, $\bar{L}^S = 40$, $\alpha = 0.5$, $a^N = 0.3$, $a^S = 0.7143$, $n = 5$, $n^S = 0.1$, $f^M = 8$, $b = 2.5$, $\beta = 0.5$, and $\lambda = 2.5$. $\breve{f}$ and $\breve{g}$ intersect twice, at $(n^M, (w^N a^N)/(w^S a^S)) = (1.1539, 1.2797)$ (so that $1 < (w^N a^N)/(w^S a^S) < \underline{\nu}(n^M) = 1.3279$) and at $(n^M, (w^N a^N)/(w^S a^S)) = (1.4394, 1.6754)$ (so that $(w^N a^N)/(w^S a^S) > \bar{\nu}(n^M) = 1.5679$). In the former equilibrium, the real wage in the South is $w^S/P = 3.1565$. The two local maxima of the union's objective function occur at $w^N/P = 9.6174$ and $w^N/P = \omega^N/a^N = 11.1111$ with values 0.0259 and 0.0253, respectively. That is, the global

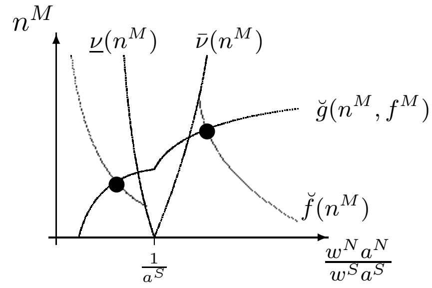

Figure 7: Multiple equilibria

maximum is at $w^N/P = 9.6174$. The condition that the owners of firms that incur the fixed cost of offshoring but do not go abroad have non-negative income is satisfied: $(w^N a^N/w^S)^\lambda = 0.7988 \leq 1.5 = \lambda/(\varepsilon - 1) - 1$. In the latter equilibrium, the real wage in the South is $w^S/P = 2.7854$. The two local maxima of the union's objective function occur at $w^N/P = 9.0570$ and $w^N/P = \omega^N = 11.1111$ with values 0.0220 and 0.0234. The global maximum is at $w^N/P = 11.1111$. $||$

The example in the proof is constructed such that there is a range of n^M-values in which $\breve{f}$ assigns two values of $(w^N a^N)/(w^S a^S)$ to each n^M and $\breve{g}$ intersects $\breve{f}$ twice (see Figure 7). The reason why $\breve{f}$ is possibly multi-valued is that the relation between $(w^N a^N)/(w^S a^S)$ and the wage rate w^N/P is non-monotonic (cf. Proposition 8). The function $\breve{f}$ is derived from the wage setting equation (30) and the price setting equation (31). According to the price setting equation (31), for given n^M, an increase in the relative production cost in the North $(w^N a^N)/(w^S a^S)$ causes an increase in the Northern real wage. If the wage setting process gave rise to a non-increasing relation between $(w^N a^N)/(w^S a^S)$ and w^N/P (as in the model with homogeneous goods), there could not be multiple values of $(w^N a^N)/(w^S a^S)$ consistent with firms' price setting and unions' wage setting behavior for given n^M. From (30), w^N/P is in fact a non-increasing function of $(w^N a^N)/(w^S a^S)$ in each of the intervals $(0, \underline{\nu}(n^M))$ and $(\bar{\nu}(n^M), \infty)$; but as $(w^N a^N)/(w^S a^S)$ jumps upward from $\underline{\nu}(n^M)$ to $\bar{\nu}(n^M)$, w^N/P jumps upward (see Figure 8). That is why both a low and a high level of relative production cost $(w^N a^N)/(w^S a^S)$ are compatible with agents' price and wage setting behavior. For the low value of $(w^N a^N)/(w^S a^S)$ $(< \underline{\nu}(n^M))$, the real wage in the South $(w^S/P > \breve{\omega}^S(n^M))$ is high, so unions in the North have an incentive to set wages low enough so that not all firms that have paid the fixed cost of offshoring go abroad. They take the negative impact of a marginal increase in w^N/P on n^M into account and set $w^N/P < \omega^N/a^N$. For $(w^N a^N)/(w^S a^S)$ $(> \bar{\nu}(n^M))$ high, the real wage rate in the South w^S/P $(< \breve{\omega}^S(n^M))$ is so low that keeping firms that have paid the fixed cost of offshoring at home requires a degree of wage moderation which is unattractive from the unions' point of view, so they set $w^N/P = \omega^N/a^N$.

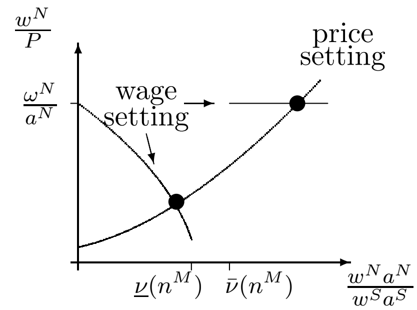

Figure 8: Wage setting and price setting

Employment in the North is $L^N = (n - n^S - n^M)a^N x^N$. From (32), (given f^M) the scale of Northern firms x^N is a monotonically decreasing function of relative production cost $(w^N a^N)/(w^S a^S)$ alone. This allows us to disentangle the effects of parameter changes on equilibrium employment in the same way as in the model with homogeneous firms: increases in n^M reduce employment via the mass of active firms in the North; increases in relative production cost $(w^N a^N)/(w^S a^S)$ reduce employment via the scale of each firm in the North. We use this fact to discuss the employment effects caused by switching from one of two equilibria to the other.

If two equilibria with $n^M > 0$ exist, both satisfy (35) with equality. Since (35) gives a monotonically increasing relation between n^M and $(w^N a^N)/(w^S a^S) = \breve{g}(n^M, f^M)$, employment is higher in the equilibrium with little offshoring (n^M low) and a low wage differential ($(w^N a^N)/(w^S a^S)$ low).

The commitment problem discussed in Section 5 remains present with firm heterogeneity. In a symmetric equilibrium with offshoring, the expected operating profit differential between South and North is equal to the fixed cost of offshoring. If a union could commit to set the wage rate w^N/P slightly below the equilibrium level (i.e., $\breve{\omega}^N((w^N a^N)/(w^S a^S), n^M)$ if $(w^N a^N)/(w^S a^S) < \underline{\nu}(n^M)$ and ω^N if $(w^N a^N)/(w^S a^S) > \bar{\nu}(n^M)$), then no firm in the industry would pay the fixed cost of offshoring, so employment and expected utility would surge. So each single union has an incentive to appoint a PUL who attaches a lower reservation utility to the unemployed or has lower bargaining power.

7 Headquarter services

The only thing that connects the home country with an offshore subsidiary in the model considered so far is property rights: the owners of an MNE get the profit made by selling the goods produced in the plant abroad. This contrasts with the fact that it is often issues that relate to the cooperation between parent and subsidiary (e.g., bridging cultural gaps, ensuring stability of production chains, quality controls) that are decisive for success or failure of offshoring. The present section introduces skilled labor as a second factor of production in the North, which is essential in providing headquarter services in MNEs. The focus in on the question of whether this commands a change in the rather pessimistic assessment of the employment and welfare effects of offshoring. The answer is in the negative.

We return to the model with homogeneous firms. In addition to the $\bar{L}^N$ (unskilled) workers, there are $\bar{H}^N$ (> 0) skilled workers in the North, each supplying one unit of skilled labor. Setting up a subsidiary in the South requires the input of f^N (≥ 0) units of skilled labor in the North and f^M units of labor in the South ($f^N > 0$ if $f^M = 0$). We assume that

$$n - n^S < \frac{\bar{L}^S}{f^M} < \frac{\bar{H}^N}{f^N}. \tag{36}$$

That is, there are enough labor in the South and enough skilled labor in the North to offshore the production of all varieties. The production function for varieties of the DS goods in the North is $x(i,j) = Ah(i,j)^\zeta l(i,j)^{1-\zeta}$ ($0 < \zeta < 1$, $A = \{[\zeta/(1-\zeta)]^{1-\zeta} + [(1-\zeta)/\zeta]^\zeta\}$), where $h(i,j)$ and $l(i,j)$ are the inputs of skilled and unskilled labor, respectively. The definition of an equilibrium is analogous as in Section 3 except that we add the market clearing condition for skilled labor in the North.

Let v^N denote the wage rate for skilled labor. The price of each variety $(v^N)^\zeta(w^N)^{1-\zeta}/\alpha$ is the usual markup on unit cost. The price setting equation becomes

$$\left(\frac{w^N}{P}\right)^{\varepsilon-1} = \alpha^{\varepsilon-1}\left(n - n^S - n^M\right)\left(\frac{w^N}{v^N}\right)^{\zeta(\varepsilon-1)} + \left(n^S + \alpha^{\varepsilon-1}n^M\right)\left(\frac{w^N}{w^S a^S}\right)^{\varepsilon-1} \tag{37}$$

(cf. (4)). The condition that it does not pay to move further varieties abroad becomes

$$(\varepsilon - 1)\left(f^M + \frac{w^N}{w^S a^S}a^S f^N\right) \geq \left[1 - \left(\frac{w^N}{w^S a^S}\right)^{1-\varepsilon}\left(\frac{v^N}{w^N}\right)^{\zeta(1-\varepsilon)}\right]\left(\frac{w^N a^N}{w^S a^S}\right)^{\varepsilon} a^S x^N, \quad n^M \geq 0, \tag{38}$$

with at most one strict inequality (cf. (5)). The Nash product for the wage bargain in industry i is

$$\left\{\frac{L^N}{\bar{L}^N}\left[\left(\frac{w^N}{P}\right)^\beta - b\right]\right\}^{1-\gamma}\left\{\frac{\alpha^\varepsilon}{\varepsilon-1}\left[\frac{(v^N)^\zeta(w^N)^{1-\zeta}}{P}\right]^{1-\varepsilon}\frac{I}{P}\right\}^\gamma.$$

The demand for labor in each industry is

$$(n - n^S - n^M)\frac{1}{A}\left(\frac{1-\zeta}{\zeta}\frac{v^N}{w^N}\right)^\zeta\left[\frac{(v^N)^\zeta(w^N)^{1-\zeta}}{\alpha P}\right]^{-\varepsilon}\frac{I}{P}.$$

The wage elasticity of labor demand $\varepsilon - \zeta(\varepsilon - 1)$ is constant. The wage rate is

$$\frac{w^N}{P} = \left[\frac{b}{1 - \frac{\beta(1-\gamma)}{\varepsilon-\gamma-\zeta(\varepsilon-1)}}\right]^{\frac{1}{\beta}} = \hat{\omega}^N \tag{39}$$

if there is unemployment (cf. (6)). Market clearing for skilled labor implies

$$\bar{H}^N = (n - n^S - n^M)B(a^N)^\varepsilon \left(\frac{v^N}{w^N}\right)^{-1-\zeta(\varepsilon-1)} x^N + n^M f^N, \tag{40}$$

where $B = (1/A)[\zeta/(1-\zeta)]^{1-\zeta}$. The labor market clearing condition for the South (7), the price setting equation (37), the arbitrage condition (38), the wage setting rule for the North (39), and the labor market clearing condition (40) jointly determine the equilibrium values of w^N/P, v^N/w^N, n^M, $(w^N)/(w^S a^S)$, and x^N.

We focus on a symmetric equilibrium with a cost advantage for the South and unemployment. From (37) and (39),

$$\frac{v^N}{w^N} = \left[\frac{(\hat{\omega}^N)^{\varepsilon-1} - (n^S + \alpha^{\varepsilon-1}n^M)\left(\frac{w^N}{w^S a^S}\right)^{\varepsilon-1}}{\alpha^{\varepsilon-1}(n - n^S - n^M)}\right]^{\frac{1}{\zeta(1-\varepsilon)}}. \tag{41}$$

From (7), (40), and (41),

$$\begin{aligned}\frac{\bar{H}^N - n^M f^N}{\bar{L}^S - n^M f^M} \quad &= \quad \frac{B}{a^S}\frac{(n - n^S - n^M)^{-\frac{1}{\zeta(\varepsilon-1)}}}{\alpha^{-\varepsilon}n^S + n^M}\left(\frac{w^N}{w^S a^S}\right)^{-\varepsilon} \\ &\quad \left[\frac{(\hat{\omega}^N)^{\varepsilon-1} - (n^S + \alpha^{\varepsilon-1}n^M)\left(\frac{w^N}{w^S a^S}\right)^{\varepsilon-1}}{\alpha^{\varepsilon-1}}\right]^{\frac{1+\zeta(\varepsilon-1)}{\zeta(1-\varepsilon)}}\end{aligned} \tag{42}$$

From (7), (38), and (41),

$$\begin{aligned}\alpha^{\varepsilon-1}(n - n^S) + n^S - (\hat{\omega}^N)^{\varepsilon-1}\left(\frac{w^N}{w^S a^S}\right)^{1-\varepsilon} \quad &\leq \quad (\varepsilon - 1)\frac{f^M + \frac{w^N}{w^S a^S}a^S f^N}{\bar{L}^S - n^M f^M} \\ &\quad \alpha^{\varepsilon-1}(n - n^S - n^M)(\alpha^{-\varepsilon}n^S + n^M), \quad n^M \geq 0,\end{aligned} \tag{43}$$

with at most one strict inequality. From (41), the South has a cost advantage (i.e., $w^S a^S < (v^N)^\zeta(w^N)^{1-\zeta}$) exactly if

$$\frac{w^N}{w^S a^S} > \frac{\hat{\omega}^N}{[n^S + \alpha^{\varepsilon-1}(n - n^S)]^{\frac{1}{\varepsilon-1}}} = \hat{\nu}^N. \tag{44}$$

To ensure a cost advantage for the South, we assume that

$$\frac{B}{a^S}\frac{(n - n^S)^{-\frac{1}{\zeta(\varepsilon-1)}}}{\alpha^{-\varepsilon}n^S}(\hat{\nu}^N)^{-\varepsilon}\left[\frac{(\hat{\omega}^N)^{\varepsilon-1} - n^S(\hat{\nu}^N)^{\varepsilon-1}}{\alpha^{\varepsilon-1}}\right]^{\frac{1+\zeta(\varepsilon-1)}{\zeta(\varepsilon-1)}} > \frac{\bar{H}^N}{\bar{L}^S}. \tag{45}$$

For $\zeta = 0$, (45) boils down to the corresponding condition (9) in Section 3. An equilibrium exists if, given f^M and f^N, there exists $(n^M, (w^N/(w^S a^S))$ with $0 \leq n^M < n - n^S$ and $w^N/(w^S a^S) > \hat{\nu}^N$ that satisfies (42) and (43).

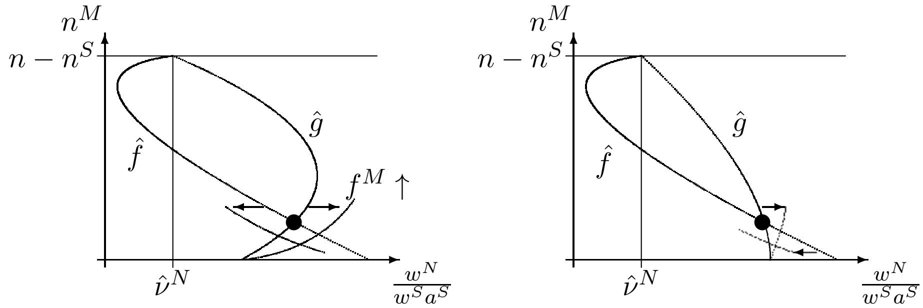

Figure 9: Equilibrium with headquarter services

Proposition 10: *Suppose (36) and (45) hold and $\bar{L}^N$ is sufficiently large. Then a symmetric equilibrium with a cost advantage for the South and unemployment exists.*

Proof: See the Appendix. ||

Equation (42) has a unique solution $w^N/(w^S a^S) = \hat{f}(n^M, f^M, f^N)$. $\hat{f}(n^M, f^M, f^N)$ starts at $\hat{f}(0, f^M, f^N) > \hat{\nu}^N$ and goes to $\hat{\nu}^N$ with infinite slope as $n^M \to n - n^S$. A solution to equation (43) holding with equality may or may not exist. If so, solutions come in pairs, and the smaller solution $\hat{g}(n^M, f^M, f^N)$ satisfies $\hat{g}(n^M, f^M, f^N) > \hat{\nu}^N$ for all n^M. In the main text, we assume that $\hat{g}(n^M, f^M, f^N)$ exists for all n^M and that $\hat{f}$ and $\hat{g}$ intersect at some positive n^M and $\partial\hat{f}/\partial n^M < \partial\hat{g}/\partial n^M$ (see Figure 9). For $\bar{L}^N$ sufficiently large, the intersection represents a symmetric equilibrium with a cost advantage for the South, unemployment, and offshoring.

Having established existence of equilibrium, we now address the comparative statics effects of changes in the labor requirement for offshoring on the amount of offshoring, the wage gap between North and South, employment, wages of skilled and unskilled workers in the North, and welfare. Broadly speaking, the analysis reinforces the conclusions drawn from the one-factor model: a decrease in the cost of offshoring raises Southern workers' utility, but it does not generally yield a Pareto improvement and possibly harms all agents in the North. While general analytical results are hard to come by, the model is tractable enough so that we can substantiate these claims analytically for the case of low offshoring cost. Since changes in f^M are easier to deal with than changes in f^N, we focus on the former. Throughout, it is understood that variables refer to equilibrium values.

Proposition 11: *Suppose $n^M > 0$ and $\partial\hat{f}/\partial n^M < \partial\hat{g}/\partial n^M$. Then $dn^M/df^M < 0$ and $d(w^N/(w^S a^S))/df^M > 0$.*

Proof: See the Appendix. ||

An increase in f^M shifts $\hat{f}$ to the left and $\hat{g}$ to the right. For $\hat{g}$ downward-sloping at the equilibrium point, the comparative statics effects are obvious from the right panel of Figure 9. For the opposite case, the proof requires some tedious algebra.

Numerical analysis shows that generally $dL^N/df^M > 0$. That is, employment falls when the labor requirement for offshoring f^M falls. This is easy to see for small offshoring costs:

Proposition 12: *$dL^N/df^M > 0$ for f^M and f^N small enough.*

Proof: See the Appendix. ||

Propositions 11 and 12 highlight the same conflict of interest between the workers in the two countries: a decrease in the cost of offshoring allows more productive use of labor in the South; but this comes at the expense of a decrease in unskilled Northern workers' probability of employment and, hence, their expected utility. The next proposition states that skilled workers may also lose:

Proposition 13: *For f^M and f^N small enough, a decrease in f^M raises Southern workers' utility but reduces both unskilled Northern workers' expected utility and skilled workers' utility.*

Proof: See the Appendix. ||

The fact that v^N/P falls while w^N/P is fixed means that the relative wage of skilled workers v^N/w^N falls.

Evidently, the commitment problem analyzed in Section 5 is present: each industry union would commit to agree to a wage rate $w^N/P + dw^N/P$ ($dw^N/P < 0$) marginally below the RTM wage w^N/P in (6) if it could, since this would completely eliminate the incentive to offshore at the cost of a negligible loss in the indirect utility of an employed worker.

8 Conclusion

The present paper analyzes the general equilibrium effects of costly offshoring to the South on relative production cost and unemployment in the North. The presented model is Krugman's (1979) North-South trade model augmented to include costly offshoring and union wage setting in the North. In this model, the incentives to invest in offshore subsidiaries are endogenously determined by factor price differentials, and offshoring feeds back on production and employment decisions via shifts in factor prices. Our analysis yields several interesting results: Falling fixed costs of offshoring usually decrease employment in the North, though the opposite can happen at a low initial level of offshoring activity. With respect to welfare, we find that additional offshoring constitutes a Pareto improvement, if it raises employment in the North. Otherwise, offshoring benefits workers in the South, but hurts their Northern counterparts. Firm owners in the North also lose, if additional offshoring leads to a fall in the scale of Northern firms. The extension of the model with two factors of production gives rise to a similarly pessimistic assessment of the employment and welfare effects of offshoring. Moreover, the model provides an endogenous explanation for shrinking union power. Unions have an incentive to appoint a "pragmatic union leader", in order to make the announcement credible that they will not fight for high wages once firms have decided to keep production at home. When extending the model for heterogeneous firms, multiple equilibria can occur. If Northern unions anticipate a low real wage in the South, they set a high real wage, and offshoring activity is intensive; conversely, if they anticipate a high real wage in the South, they set a lower real wage, and there is little offshoring.

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Appendix: Headquarter services

Proof of Proposition 10: Rewrite (42) as

$$0 = \frac{B}{a^S}\frac{(n-n^S-n^M)^{-\frac{1}{\zeta(\varepsilon-1)}}}{\alpha^{-\varepsilon}n^S+n^M}\left(\frac{w^N}{w^S a^S}\right)^{-\varepsilon}\left[\frac{(\hat{\omega}^N)^{\varepsilon-1}-(n^S+\alpha^{\varepsilon-1}n^M)\left(\frac{w^N}{w^S a^S}\right)^{\varepsilon-1}}{\alpha^{\varepsilon-1}}\right]^{\frac{1+\zeta(\varepsilon-1)}{\zeta(\varepsilon-1)}}$$

$$
\begin{aligned}
& -\frac{\bar{H}^N - n^M f^N}{\bar{L}^S - n^M f^M} \\
= \quad & \hat{F}\left(n^M, \frac{w^N}{w^S a^S}, f^N, f^M\right). \qquad \text{(A.1)}
\end{aligned}
$$

Rewrite (43) as

$$
\begin{aligned}
0 \quad \geq \quad & \alpha^{\varepsilon-1}(n - n^S) + n^S - (\hat{\omega}^N)^{\varepsilon-1}\left(\frac{w^N}{w^S a^S}\right)^{1-\varepsilon} \\
& -(\varepsilon-1)\frac{f^M + \frac{w^N}{w^S a^S} a^S f^N}{\bar{L}^S - n^M f^M}\alpha^{\varepsilon-1}(n - n^S - n^M)(\alpha^{-\varepsilon} n^S + n^M) \\
= \quad & \hat{G}\left(n^M, \frac{w^N}{w^S a^S}, f^N, f^M\right), \quad n^M \geq 0, \qquad \text{(A.2)}
\end{aligned}
$$

with at most one strict inequality.

Here and in what follows, we omit arguments of functions when convenient and use subscripts n and w to indicate partial derivatives with respect to n^M and $w^N/(w^S a^S)$, respectively. Denote the function in the first line of (A.1) as $\check{F}$. $\check{F}_w < 0$ for $w^N/(w^S a^S) < \hat{\omega}^N/(n^S + \alpha^{\varepsilon-1} n^M)^{1/(\varepsilon-1)}$. From (36), $\bar{H}^N - n^M f^N > 0$ and $\bar{L}^S - n^M f^M > 0$ for $n^M \in [0, n - n^S)$. So there is a unique $w^N/(w^S a^S) < \hat{\omega}^N/(n^S + \alpha^{\varepsilon-1} n^M)^{1/(\varepsilon-1)}$ that solves $\hat{F}(n^M, w^N/(w^S a^S), f^N, f^M) = 0$ for $n^M \in [0, n - n^S)$ (see the left panel of Figure 9). Define $\hat{f}(n^M, f^M, f^N)$ as this $w^N/(w^S a^S)$. From (45), $\check{F}(0, \hat{\nu}^N, f^N, f^M) > \bar{H}^N/\bar{L}^S$ and, therefore, $\hat{f}(0, f^M, f^N) > \hat{\nu}^N$. From (A.1), $\hat{f}(n - n^S, f^M, f^N) = \hat{\nu}^N$. Differentiating $\hat{F}$ partially yields

$$
\begin{aligned}
\hat{F}_n \quad = \quad & -\check{F}\Bigg[-\frac{1}{\zeta(\varepsilon-1)}\frac{1}{n - n^S - n^M} + \frac{1}{\alpha^{-\varepsilon} n^S + n^M} \\
& + \frac{1+\zeta(\varepsilon-1)}{\zeta(\varepsilon-1)}\frac{\alpha^{\varepsilon-1}}{(\hat{\omega}^N)^{\varepsilon-1}\left(\frac{w^N}{w^S a^S}\right)^{1-\varepsilon} - (n^S + \alpha^{\varepsilon-1} n^M)}\Bigg] \\
& -\frac{f^M \bar{H}^N - f^N \bar{L}^S}{(\bar{L}^S - n^M f^M)^2} \qquad \text{(A.3)}
\end{aligned}
$$

and

$$
\hat{F}_w = -\check{F}\left(\frac{w^N}{w^S a^S}\right)^{-1}\left[\varepsilon + \frac{1+\zeta(\varepsilon-1)}{\zeta}\frac{n^S + \alpha^{\varepsilon-1} n^M}{(\hat{\omega}^N)^{\varepsilon-1}\left(\frac{w^N}{w^S a^S}\right)^{1-\varepsilon} - (n^S + \alpha^{\varepsilon-1} n^M)}\right].
$$

So $\hat{f}_n(n - n^S, f^M, f^N) = -\hat{F}_n(n - n^S, \hat{\nu}^N, f^N, f^M)/\hat{F}_w(n - n^S, \hat{\nu}^N, f^N, f^M) = \infty$. In sum, $\hat{f}(n^M, f^M, f^N)$ starts at $\hat{f}(0, f^M, f^N) > \hat{\nu}^N$ and goes to $\hat{\nu}^N$ with infinite slope as $n^M \to n - n^S$ (see Figure A.1).

Define the function after the minus sign in the second line of (A.2) as $\check{G}$. As illustrated in the right panel of Figure 9, solutions $w^N/(w^S a^S)$ to (A.2) come in pairs. For (n^M, f^M, f^N) such that

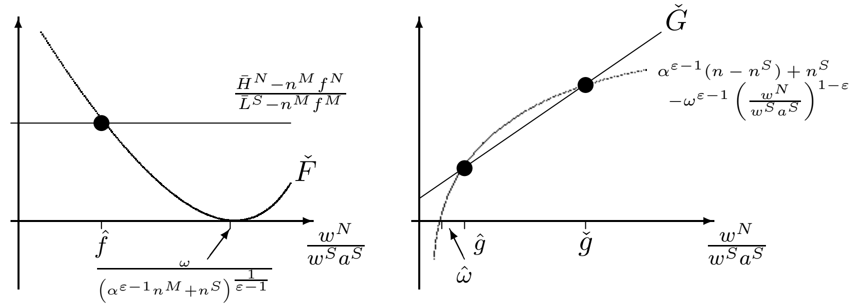


Figure A.1: Determination of $\hat{f}$, $\hat{g}$, and $\check{g}$

a solution exists, define $\hat{g}(n^M, f^M, f^N)$ as the smaller solution and $\check{g}(n^M, f^M, f^N)$ as the larger solution. As can be seen from Figure 9, $\hat{g}(n^M, f^M, f^N) > \hat{\nu}^N$ for all n^M. From (A.2), $\check{G}(n - n^S, w^N/(w^S a^S), f^M, f^N) = 0$, so $\hat{g}(n - n^S, f^M, f^N) = \hat{\nu}^N$. Differentiating $\hat{G}$ partially yields

$$\hat{G}_n = \check{G}\left(\frac{1}{n - n^S - n^M} - \frac{1}{\alpha^{-\varepsilon} n^S + n^M} - \frac{f^M}{\bar{L}^S - n^M f^M}\right) \tag{A.4}$$

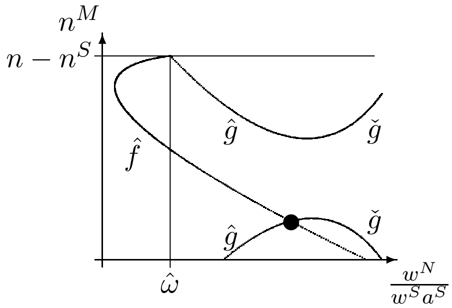
and

$$\hat{G}_w = (\varepsilon - 1)(\hat{\omega}^N)^{\varepsilon-1}\left(\frac{w^N}{w^S a^S}\right)^{-\varepsilon} - \check{G}\frac{a^S f^N}{f^M + \frac{w^N}{w^S a^S} a^S f^N}.$$

Since $\check{G} > 0$, $\hat{G}_n > 0$ for n^M close enough to $n - n^S$. Since $\check{G}(n - n^S, w^N/(w^S a^S), f^M, f^N) = 0$, $\hat{G}_w > 0$ for n^M close enough to $n - n^S$. Hence, $\hat{g}_n(n - n^S, f^M, f^N) = -\hat{G}_n(n - n^S, \hat{\nu}^N, f^N, f^M)/\hat{G}_w(n - n^S, \hat{\nu}^N, f^N, f^M) < 0$.

For given n^M, if $\hat{g}(n^M, f^M, f^N)$ exists, then (A.2) holds exactly if $w^N/(w^S a^S) \leq \hat{g}(n^M, f^M, f^N)$. If $\hat{g}$ does not exist, then (A.2) holds. If $\hat{f}(n^M, f^M, f^N) = \hat{g}(n^M, f^M, f^N)$ or $\hat{f}(n^M, f^M, f^N) = \check{g}(n^M, f^M, f^N)$ for some $n^M > 0$, then n^M and $w^N/(w^S a^S) = \hat{f}(n^M, f^M, f^N)$ constitute an equilibrium with offshoring. The fact that $\check{g}(n^M, f^M, f^N) \geq \hat{g}(n^M, f^M, f^N) > \hat{\nu}^N$ implies that condition (44) is satisfied. If $\hat{g}(0, f^M, f^N)$ exists and $\hat{f}(0, f^M, f^N) < \hat{g}(0, f^M, f^N)$ or if $\hat{g}(0, f^M, f^N)$ does not exist, then $n^M = 0$ and $w^N/(w^S a^S) = \hat{f}(0, f^M, f^N)$ constitute an equilibrium without offshoring. $\hat{f}(0, f^M, f^N) > \hat{\nu}^N$ implies that (44) is satisfied.

Suppose $\hat{g}(0, f^M, f^N)$ exists and $\hat{f}(0, f^M, f^N) > \hat{g}(0, f^M, f^N)$. If $\hat{g}$ exists for all n^M, then $\hat{f}$ and $\hat{g}$ intersect for some $n^M > 0$ and an equilibrium with offshoring exists (see Figure 9 in the running text). If $\hat{g}$ does not exist for all n^M, then $\hat{g}$ and $\check{g}$ converge for some $n^M > 0$ (corresponding to a tangency point in the right panel of Figure A.1), so $\hat{f}$ intersects either $\hat{g}$ or $\check{g}$ and an equilibrium with $n^M > 0$ exists (see the left panel of Figure A.2). If $\hat{g}(0, f^M, f^N)$ exists and $\hat{f}(0, f^M, f^N) \leq \hat{g}(0, f^M, f^N)$ or $\hat{g}(0, f^M, f^N)$ does not exist, then an equilibrium with $n^M = 0$ exists (see the right panel of Figure A.2).



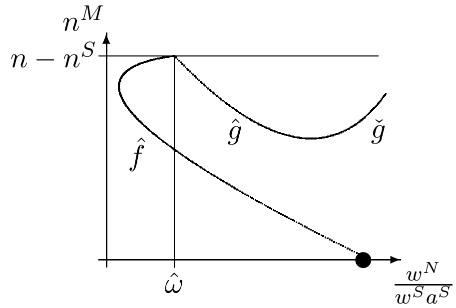


Figure A.2: Existence of equilibrium with two factors of production

From cost minimization, employment in the North is $L^N = [(1-\zeta)/\zeta](v^N/w^N)(\bar{H}^N - n^M f^N)$. Using (41), this can be rewritten as

$$L^N = \frac{1-\zeta}{\zeta}\left[\frac{(\hat{\omega}^N)^{\varepsilon-1} - (n^S + \alpha^{\varepsilon-1}n^M)\left(\frac{w^N}{w^S a^S}\right)^{\varepsilon-1}}{\alpha^{\varepsilon-1}(n - n^S - n^M)}\right]^{\frac{1}{\zeta(1-\varepsilon)}}(\bar{H}^N - n^M f^N). \tag{A.5}$$

Since the equilibrium values of n^M and $w^N/(w^S a^S)$ are independent of $\bar{L}^N$, there is unemployment if $\bar{L}^N$ is sufficiently large. ||

Proof of Proposition 11: From (A.1) and (A.2),

$$\hat{F}_f = -\frac{n^M(\bar{H}^N - n^M f^N)}{(\bar{L}^S - n^M f^M)^2} \tag{A.6}$$

and

$$\hat{G}_f = -\check{G}\left(\frac{1}{f^M + \frac{w^N}{w^S a^S}a^S f^N} + \frac{n^M}{\bar{L}^S - n^M f^M}\right), \tag{A.7}$$

where subscript f denotes partial differentiation with respect to f^M. So

$$\hat{F}_w < 0,\ \hat{F}_n < 0,\ \hat{F}_f < 0,\ \hat{G}_w > 0,\ \hat{G}_f < 0,\ \frac{\hat{F}_n}{\hat{F}_w} > \frac{\hat{G}_n}{\hat{G}_w} \tag{A.8}$$

in equilibrium. The final inequality states that $\hat{f}_n < \hat{g}_n$. From (A.1) and (A.2),

$$\frac{dn^M}{df^M} = \frac{\hat{F}_w\hat{G}_f - \hat{F}_f\hat{G}_w}{\hat{F}_n\hat{G}_w - \hat{F}_w\hat{G}_n},\quad \frac{d\left(\frac{w^N}{w^S a^S}\right)}{df^M} = \frac{\hat{F}_f\hat{G}_n - \hat{F}_n\hat{G}_f}{\hat{F}_n\hat{G}_w - \hat{F}_w\hat{G}_n}.$$

From (A.8), an increase in the labor requirement for offshoring in the South reduces the equilibrium amount of offshoring: $dn^M/df^M < 0$.

The wage gap between North and South increases (i.e., $d(w^N/(w^S a^S))/df^M > 0$) if, and only if,

$$\hat{F}_f\hat{G}_n < \hat{F}_n\hat{G}_f.$$

From (A.8), this condition is satisfied if $\hat{G}_n \geq 0$. In the opposite case, inserting (A.3), (A.4), (A.6), and (A.7), dividing by $\check{G}$ (> 0), using $\check{F} = (\bar{H}^N - n^M f^M)/(\bar{L}^S - n^M f^M)$, multiplying by $(\bar{L}^S - n^M f^M)^2/(\bar{H}^N - n^M f^M)$ (> 0), and simplifying terms yields

$$\begin{aligned}
-\frac{n^M[\bar{L}^S - (n - n^S) f^M]}{(n - n^S - n^M)(\bar{L}^S - n^M f^M)} \quad < \quad & \left(\frac{\bar{L}^S - n^M f^M}{f^M + \frac{w^N}{w^S a^S} a^S f^N} + n^M\right) \\
& \left\{\frac{1}{\zeta(\varepsilon - 1)}\left[-\frac{1}{n - n^S - n^M}\right.\right. \\
& \left.+\frac{\alpha^{\varepsilon-1}}{(\hat{\omega}^N)^{\varepsilon-1}\left(\frac{w^N}{w^S a^S}\right)^{1-\varepsilon} - (n^S + \alpha^{\varepsilon-1} n^M)}\right] \\
& +\frac{\alpha^{\varepsilon-1}}{(\hat{\omega}^N)^{\varepsilon-1}\left(\frac{w^N}{w^S a^S}\right)^{1-\varepsilon} - (n^S + \alpha^{\varepsilon-1} n^M)} \\
& \left.+f^M f^N \frac{\frac{\bar{H}^N}{f^N} - \frac{\bar{L}^S}{f^M}}{(\bar{H}^N - n^M f^N)(\bar{L}^S - n^M f^M)}\right\} \\
& +\frac{\bar{L}^S - n^M f^M}{f^M + \frac{w^N}{w^S a^S} a^S f^N} \frac{1}{\alpha^{-\varepsilon} n^S + n^M}.
\end{aligned}$$

The fact that $w^N/(w^S a^S) > \hat{\nu}^N$ implies that the term in square brackets in the second line is positive. So the validity of the inequality follows from condition (36). ||

Proof of Proposition 12: Log-differentiate (A.5) to obtain

$$\begin{aligned}
\frac{d \ln L^N}{d f^M} \quad = \quad & \left[-\frac{f^N}{\bar{H}^N - n^M f^N} - \frac{1}{\zeta(\varepsilon - 1)} \frac{1}{n - n^S - n^M}\right. \\
& \left.+\frac{1}{\zeta(\varepsilon - 1)} \frac{\alpha^{\varepsilon-1}}{(\hat{\omega}^N)^{\varepsilon-1}\left(\frac{w^N}{w^S a^S}\right)^{1-\varepsilon} - (n^S + \alpha^{\varepsilon-1} n^M)}\right] \frac{dn^M}{df^M} \\
& +\frac{1}{\zeta} \frac{(n^S + \alpha^{\varepsilon-1} n^M)\left(\frac{w^N}{w^S a^S}\right)^{-1}}{(\hat{\omega}^N)^{\varepsilon-1}\left(\frac{w^N}{w^S a^S}\right)^{1-\varepsilon} - (n^S + \alpha^{\varepsilon-1} n^M)} \frac{d\left(\frac{w^N}{w^S a^S}\right)}{df^M}.
\end{aligned} \tag{A.9}$$

From (A.9), $dL^N/df^M > 0$ exactly if

$$\begin{aligned}
0 \quad < \quad & \left\{-\left[\frac{\zeta(\varepsilon - 1) f^N}{\bar{H}^N - n^M f^N} + \frac{1}{n - n^S - n^M}\right]\right. \\
& \left.\left[(\hat{\omega}^N)^{\varepsilon-1}\left(\frac{w^N}{w^S a^S}\right)^{1-\varepsilon} - (n^S + \alpha^{\varepsilon-1} n^M)\right] + \alpha^{\varepsilon-1}\right\} \frac{dn^M}{df^M} \\
& +(\varepsilon - 1)(n^S + \alpha^{\varepsilon-1} n^M)\left(\frac{w^N}{w^S a^S}\right)^{-1} \frac{d\left(\frac{w^N}{w^S a^S}\right)}{df^M}.
\end{aligned} \tag{A.10}$$

From (A.2),

$$\alpha^{\varepsilon-1} - \frac{(\hat{\omega}^N)^{\varepsilon-1}\left(\frac{w^N}{w^S a^S}\right)^{1-\varepsilon} - (n^S + \alpha^{\varepsilon-1} n^M)}{n - n^S - n^M} \leq (\varepsilon - 1)\frac{f^M + \frac{w^N}{w^S a^S} a^S f^N}{\bar{L}^S - n^M f^N}(\alpha^{-1} n^S + \alpha^{\varepsilon-1} n^M).$$

So for $f^M \to 0$ and $f^N \to 0$, the term in braces in (A.10) goes to zero. ||

Proof of Proposition 13: Southern workers' utility is $w^S/P = (w^S/w^N)(w^N/P)$. The real wage for unskilled labor in the North w^N/P is fixed via (39). From Proposition 11, $d(w^N/(w^S a^S))/df^M > 0$. So w^S/P rises as f^M falls.

As their real wage is fixed, unskilled workers' expected utility falls whenever employment falls. From Proposition 12, this happens for f^M and f^N small enough.

The real wage of skilled workers in the North $v^N/P = (v^N/w^N)(w^N/P)$ falls whenever v^N/w^N falls. From (41), v^N/w^N is given by the power term in (A.5), so

$$\frac{d\ln\left(\frac{v^N}{w^N}\right)}{df^M} = \frac{d\ln L^N}{df^M} + \frac{f^N}{\bar{H}^N - n^M f^N}.$$

The fact that L^N decreases as f^M falls for f^M and f^N small enough implies that v^N/w^N and, hence, v^N/P also fall for f^M and f^N small enough. ||