On Footloose Industries, Asymmetric Information, and Wage Bargaining

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This version: September 2003

Abstract: If capital becomes internationally mobile but labor does not, is the bargaining outcome for workers worsened? In this paper we show that the answer to this question depends critically on the information structure of the bargaining process. In particular, we demonstrate a hitherto under appreciated information role of capital mobility in determining the distribution of output between workers and employers. In doing so we bring together three strands of literature that are not often seen together — incentive compatible contracting, union-employer bargaining, and the consequences of capital mobility.

JEL Classification: F2, J5, D8
Keywords: foreign direct investment, bargaining under asymmetric information, union wage and employment.

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1 Introduction

If capital becomes internationally mobile but labor does not, is the bargaining outcome for workers worsened? In this paper we show that the answer to this question depends critically on the information structure of the bargaining process. In particular, we demonstrate a hitherto under appreciated informational role of capital mobility in determining the distribution of output between workers and employers.

We begin with an intuitive account of the problem and of our approach. Consider the standard union-employer bargaining framework under perfect information where the union makes a "take it or leave it" wage-employment offer. If the employer accepts then the bargain is complete. If the employer does not, neither side gets the benefit of production. The union will thus make an offer just attractive enough to the employer to accept. In such a setting a key determinant of the outcome is the elasticity of the marginal value product of labor with respect to employment (in other words, the wage elasticity of labor demand). The larger is this elasticity, the less favorable will be the outcome for the union. The role of capital mobility can now be seen clearly. Allowing capital to be mobile increases the wage elasticity of labor demand, since production activities can now be relocated in response to higher wages, and this makes the union worse off. Such a line of argument is to be found, for example in Rodrik (1997).[1]

The framework set out above has been criticized in the union bargaining literature because if it is to be believed we would never observe any strikes and less than full employment of union labor. This is an obvious violation of empirical reality.[2] The literature proceeds to model bargaining in the presence of imperfect information, a setting which can indeed generate strikes and less than full employment of the union workforce. Suppose, for example,

[1]Using U.S. data, Slaughter (1997) investigates whether there is indeed a positive relationship between labor demand elasticity and openness, and finds mixed empirical support. Panagariya (1999) examines the theoretical robustness of the labor demand elasticity and openness relationship and argues based in part on the factor price equalization theorem, that the schedule of factor prices with respect to foreign direct investment is perfectly elastic in the diversification cone.

[2]Card (1990) provides theoretical implications and empirical support of a model of union bargaining under asymmetric information. McConnell (1989) provides empirical estimates of the slope of the concession schedule (in wage and strike duration space) as implied by the asymmetric information framework. Also see Abowd and Tracy (1989) and Cramton, Taylor and Tracy (1995) for empirical investigations of strike duration and wage outcomes, taking into account product market characteristics of the firm and labor market regulations.

that the employer is fully informed about the total factor productivity of the firm but the union is not. Then in a closed economy the union fashions an offer schedule for each level of possible productivity. Since information is revealed after the bargain is struck, it is at least theoretically possible for there to be less than full employment of the union workforce-in other words, strikes. Moreover, the union cannot now be as well off as before, since the firm earns an informational rent from the fact that the union cannot perfectly tailor its offer to a known marginal value product of labor (MVPL) curve. The greater the spread of MVPL, i.e. the greater the imperfection of information, the worse off will the union be.[3]

But suppose now that investing abroad is an option for the firm after it sees the union offer. Will the union be better off or worse off? There are now two forces in play. First, as before, this openness increases the elasticity of the MVPL curve at each level of productivity, and this tends to have all of the effects discussed in the perfect information setting. But second, it can have an effect on the spread of MVPL's. If it increases this spread, in other words, if it widens the gap in MVPL for any given gap in productivity, it worsens the union's position by increasing the informational rent extractable by the employer. If it decreases the spread then it effectively reduces the asymmetric information and thereby strengthens the union's hand.

The object of this paper is to elaborate upon this informational consequence of capital mobility. We develop a model in which the competing forces affecting the bargaining outcome can be brought into sharp relief, and their relative strengths can be analyzed in detail. In doing so we bring together three strands of literature that are not often seen together-incentive compatible contracting, union-employer bargaining, and the consequences of capital mobility. The plan of the paper is as follows. Section 2 introduces the basic notation and model. Section 3 derives the basic results. Section 4 concludes.

[3]This is also a burgeoning literature on foreign direct investment under asymmetric information. See Bond and Gresik (1996), Calzolari, Diaw and Pouyet (2002), Prusa (1990) for example, that examine investment policy formation with asymmetrically informed government / governments and perfectly informed multinationals. Also see Bagwell and Staiger (2003) for the informational role of the locational choice of multinationals.

2 The Basic Model

A firm and a labor union constitute the two parties of the bargaining process. The employer is endowed with $\bar{K}$ units of capital, and hires laborers from a pool of labor union members to produce an output. Let $R(\sigma, \ell, k) = \sigma k^{\beta} \ell^{\alpha}$ denote the revenue function, with $\alpha + \beta < 1$. σ denotes the productivity of the firm. The range of σ is given by $[\underline{\sigma}, \bar{\sigma}]$.

The labor union is made up of $\mathcal{L}$ members, each with one unit of labor time. A contract between the union and the firm stipulates a wage-employment pair, respectively, w and ℓ, where $w/\mathcal{L}$ denotes wage per union member, and $1 - \ell/\mathcal{L}$ is the amount of labor time spent on strike by each union member. Each union member earns a reservation wage income, to be denoted as $\bar{W}$, in the event of strike induced unemployment. The preferences of the labor union are represented by a utility function that embodies the interests of all $\mathcal{L}$ number of union members, $U(W, L) = w + \bar{W}(\mathcal{L} - \ell)$.

Let demand for capital in the rest of the world be perfectly elastic, offering unit returns $r^*_{\sigma} = r^* \sigma^{\delta}$, with $r^* > 0$, for capital originating from firms with productivity σ in the home country.[4] δ denotes the location specificity of the firm's capital.[5] More specifically, define

Definition 1 *The productivity of capital exhibits home-bias if and only if*

$$1 = \frac{\partial \log R(\sigma, k, \ell)}{\partial \log \sigma} > \frac{\partial \log r^*_{\sigma} K}{\partial \log \sigma} = \delta.$$

Thus, when the productivity of capital is subject to home-bias $(1 > \delta)$, raising the productivity of the firm σ leads to higher (proportionate) revenue gains at home than abroad.

The decision problem of the firm involves allocating capital between the home country (k) and the rest of the world $(\bar{K} - k)$, taking union employment ℓ, and wage proposal w as given. The restricted home profit (π) function is given by

[4]We model foreign demand for capital as perfectly elastic for two reasons. First, we are interested in investment behavior by the individual firm, and hence the lack of market power in world market for capital would seem to be a reasonable assumption. Second, while the absence of investment opportunities (a perfectly inelastic foreign demand for capital at zero capital flow) represents one extreme, the case of perfectly elastic demand represents the other, wherein union's ability to command high wages is likely to be affected the most.

[5]We shall also assume throughout that parameters $\bar{W}$, $\bar{K}$ and r^* take on values that permit outward foreign investment, with $R_K(\sigma, L, \bar{K}) \leq r^*_{\sigma}$, when employment level in the home country equates the marginal value product of labor with the opportunity cost of labor $\bar{W}$. This requires that $r^*_{\sigma} \bar{K} \geq \beta \left[\left(\frac{\alpha}{\bar{W}} \right) \left(\sigma \bar{K}^{\beta} \right)^{\alpha} \right]^{\frac{1}{1-\alpha}}$.

$$\pi(\sigma,\ell) \equiv \max_k \{R(\sigma,k,\ell) - r^*_\sigma k\},$$
$$= (1-\beta)\left(\sigma(\frac{\beta}{r^*_\sigma})^\beta \ell^\alpha\right)^{\frac{1}{1-\beta}} \quad (1)$$

By standard arguments, the restricted home profit function is increasing and quasi-convex in σ. Meanwhile, π is decreasing and quasi-concave in $r^*_\sigma = r^*\sigma^\delta$. With both of these effects depending critically on δ, we rearrange the restricted home profit function to yield:

$$\pi(\sigma,\ell) = (1-\beta)\left(\sigma^{1-\delta\beta}(\frac{\beta}{r^*})^\beta \ell^\alpha\right)^{\frac{1}{1-\beta}} \equiv \phi\ell^{\frac{\alpha}{1-\beta}} \quad (2)$$

where $\phi = \phi(\sigma) = (1-\beta)(\sigma^{1-\delta\beta}(\frac{\beta}{r^*})^\beta)^{\frac{1}{1-\beta}}$ will henceforth be referred to as the mobility-adjusted productivity of the firm in the home country. As may be expected, ϕ rises with σ if and only if productivity improvements lead to proportionate revenue gains abroad that are not too much higher than that attainable in the home country. This requires $\delta < 1/\beta$.

The mobility adjusted productivity of the firm determines the profit of the firm at home, and the value of marginal product of labor in the home country in much the same way as σ does in the absence of capital mobility. To see this, note that at given ℓ, restricted profit $\pi(\cdot)$ at home rises proportionately with $\phi > 0$. Likewise, the marginal value product of the labor $v(\cdot)$ in the home country with capital mobility is proportional to ϕ, with

$$v(\phi,\ell) = R_\ell(\sigma,k^*,\ell) + R_K(\sigma,k^*,\ell)\frac{\partial k^*}{\partial \ell}$$
$$= v_o(\sigma,k^*,\ell) + R_K(\sigma,k^*,\ell)\frac{\partial k^*}{\partial \ell}$$
$$= \frac{\alpha}{1-\beta}\phi\ell^{\frac{\alpha}{1-\beta}-1} \quad (3)$$

where

$$v_o(\sigma,k^*,\ell) = \alpha\sigma\ell^{\alpha-1}(k^*)^\beta \quad (4)$$

denotes the marginal value product of labor when capital is immobile at k^*, while k^* solves the maximization problem of the firm, with

$$k^*(\sigma,\ell) = argmax_k \{R(\sigma,k,\ell) - r^*_\sigma k\} = \left(\frac{\beta\sigma\ell^\alpha}{r^*_\sigma}\right)^{\frac{1}{1-\beta}}. \quad (5)$$

Put another way, the level of employment that allows the union to equate the reservation wage $\bar{W}$ with the marginal value product of labor is simply

$$L_o(\sigma, k) = \{\ell | \bar{W} = v_o(\sigma, k, \ell)\} = \left(\frac{\alpha\sigma k^\beta}{\bar{W}}\right)^{\frac{1}{1-\alpha}} \tag{6}$$

when capital is immobile, and

$$\ell_o(\phi) = \{\ell | \bar{W} = v(\phi, \ell)\} = \left(\frac{\alpha\phi}{(1-\beta)\bar{W}}\right)^{\frac{1-\beta}{1-\alpha-\beta}} \tag{7}$$

when capital is mobile. Clearly, L_o and ℓ_o are respectively increasing in σ and ϕ.[6]

Also denote the total profit function (y^*) of the firm as

$$y^*(\sigma, \ell, w) = R(\sigma, \ell, k^*) - w + r^*_\sigma(\bar{K} - k^*(\sigma, \ell)) \tag{8}$$

$$= \phi\ell^{\frac{\alpha}{1-\beta}} - w + r^*\sigma^\delta \bar{K}, \tag{9}$$

where ϕ plays once again a key role, and pins down in particular how the share of total profit to be attributed to production in the home country depends on the productivity of the firm σ.[7] These observations prompt us to define

Definition 2 *Foreign direct investment gives rise to productivity reversal in the home country if and only if ϕ is strictly decreasing with respect to σ, or equivalently, if and only if $\delta > 1/\beta$.*

In the sequel, we will focus solely on the case wherein foreign direct investment does not give rise to productivity reversals. The case where δ is greater than $1/\beta$ is analogous, and can be similarly worked out. Any key modifications that may be required will be noted in what follows.

3 Asymmetric Information

To see how Definitions 1 and 2 assist in sorting out the possible impacts of capital mobility on bargaining outcomes, we turn now to a description of the informational environment facing

[6]Note also that the implied price elasticities of demand for labor associated with equations (6) and (7) suggest, as in Rodrik (1997), that the elasticity of labor demand is higher when capital is mobile than when it is not. We shall return to this point in Section (3.1).

[7]As long as total profit ($y^*(\cdot)$) exceeds profits $\pi(\cdot)$ in the home country, which holds under our parameter assumptions, routine differentiation gives $\pi(\sigma, \ell, p)/]y^*(\sigma, \ell)$ increasing in σ if and only if ϕ is strictly increasing in σ.

workers and employers. In particular, while the firm is perfectly aware of its productivity type, the union's belief on σ is represented by a cumulative probability distribution function $F(\sigma)$ on $[\underline{\sigma}, \bar{\sigma}]$, with an associated density function $F'(\sigma) = f(\sigma) > 0$. Also let the hazard rate $f(\sigma)/(1 - F(\sigma))$, or equivalently, the elasticity of the incidence of high productivity firms with respect to σ ($\epsilon^f(\sigma) \equiv -(dlog(1 - F(\sigma)))/dlog\sigma$), be increasing in σ.[8]

Given δ, therefore, the induced cumulative distribution function and the density function of the mobility adjusted productivity of the firm ϕ, $G(\phi)$ and $g(\phi)$, are given respectively by[9]

$$G(\phi) = F\left((\frac{\phi}{(1-\beta)(\frac{\beta}{r^*})^{\beta}})^{\frac{1-\beta}{1-\delta\beta}} \right), \quad g(\phi) = \frac{\partial G(\phi)}{\partial \phi}, \tag{10}$$

The range of ϕ, $[\underline{\phi}, \bar{\phi}]$, is just $[(1-\beta)\left(\underline{\sigma}^{1-\delta\beta}(\frac{\beta}{r^*})^{\beta}\right)^{\frac{1}{1-\beta}}, (1-\beta)\left(\bar{\sigma}^{1-\delta\beta}(\frac{\beta}{r^*})^{\beta}\right)^{\frac{1}{1-\beta}}]$. The associated elasticity $-d\log(1 - G(\phi))/d\log\phi$ will be denoted as $\epsilon^g(\phi)$. We have the following result:

Lemma 1 *1. The size of the range of mobility adjusted productivity levels $\bar{\phi} - \underline{\phi}$, decreases as δ increases.*
As δ tends to $1/\beta$, $G(\phi, \delta)$ puts unit mass on $\phi = (1-\beta)(\beta/r^*)^{\frac{\beta}{1-\beta}}$.

2. At given σ, the hazard rate associated with the mobility adjusted productivity of the firm is strictly less than (greater than) the hazard rate associated with σ, with

$$\frac{1}{\epsilon^g(\phi(\sigma, r^*_\sigma))} = \frac{1-\delta\beta}{1-\beta}\left(\frac{1-F(\sigma)}{\sigma f(\sigma)}\right) \leq (>) \frac{1}{\epsilon^f};$$

if and only if the productivity of capital does not exhibit (exhibits) home bias ($\delta \geq (<) 1$). As δ tends to $1/\beta$, $1/\epsilon^g(\phi, r^*_\sigma) = 0$.

Whenever δ is less than unity, the implied location specificity of the productivity of capital favors the investment of capital by relatively high (low) productivity firms in the home country (abroad). This effectively strengthens the informational advantage of high productivity firms, as the union may be induced to distort employment levels even more to deter high

[8] As is well-known, the assumption of an upward sloping hazard rate is satisfied by a wide range of probability distribution functions, including for example the normal and the uniform distributions.

[9] With productivity reversal, ϕ is monotonically decreasing with respect to σ. The induced cumulative distribution function of ϕ is thus $1 - F((\frac{\phi}{(1-\beta)(\frac{\beta}{r^*})^{\beta}})^{\frac{1-\beta}{1-\delta\beta}})$. In addition, the range of ϕ is given by $[(1-\beta)\left(\bar{\sigma}^{1-\delta\beta}(\frac{\beta}{r^*})^{\beta}\right)^{\frac{1}{1-\beta}}, (1-\beta)\left(\underline{\sigma}^{1-\delta\beta}(\frac{\beta}{r^*})^{\beta}\right)^{\frac{1}{1-\beta}}]$.

productivity firms from opting for a low wage, low employment contract. Analytically, this shows up in the form a restricted home profit function that is strictly convex in σ (Lemma 1), and a corresponding widening of the range of inward orientation $[\underline{\phi}, \bar{\phi}]$ subsequent to openness.

In contrast, however, if δ is greater than unity, high productivity firms is more likely to export higher amounts of capital abroad. Indeed, as δ tends to $1/\beta$, productivity differences of capital in the home country is exactly balanced by productivity differences abroad. The union thus effectively operates in an environment where information asymmetry is no longer an issue, and $G(\phi)$ puts unit mass on $(1-\beta)(\beta/r^*)^{\frac{\beta}{1-\beta}}$, even though the true value of σ remains unknown to the union.

3.1 The Bargaining Outcome with a Footloose Industry

The rest of the analysis essentially utilizes the insights developed so far. Let us define $w(\phi)$ and $\ell(\phi)$ as the wage and employment schedules to be proposed by the union, targeting a firm with mobility adjusted productivity type ϕ. Also let $y(\phi, \widehat{\phi})$ be the variable part of the profit function, when a firm with mobility adjusted productivity ϕ chooses a union contract that targets $\widehat{\phi}$:

$$y(\phi, \widehat{\phi}) = \phi \ell(\widehat{\phi})^{\frac{\alpha}{1-\beta}} - w(\widehat{\phi}), \quad y(\phi, \phi) = y(\phi).$$

The union's decision problem entails the design of a wage bill and an employment schedule, respectively $w(\phi)$ and $\ell(\phi)$, that jointly maximize expected union welfare while eliciting truth-telling on the part of the firm. By the revelation principle, such a contract satisfies (i) incentive compatibility, and (ii) individual rationality.

In particular, incentive compatibility requires that $y(\phi) \geq y(\phi, \widehat{\phi})$ and $y(\widehat{\phi}) \geq y(\widehat{\phi}, \phi)$, or

$$(\phi - \widehat{\phi})\ell(\phi)^{\frac{\alpha}{1-\beta}} \geq y(\phi) - y(\widehat{\phi}) \geq (\phi - \widehat{\phi})\ell(\widehat{\phi})^{\frac{\alpha}{1-\beta}}, \tag{11}$$

Thus, strike duration is shorter in firms with higher mobility adjusted productivity: $\phi > \widehat{\phi} \Rightarrow \ell(\phi) > \ell(\widehat{\phi})$. In addition, the variable profit function $y(\phi)$ is convex in ϕ, and differentiable almost everywhere, with

$$\dot{y}(\phi) = \ell(\phi)^{\frac{\alpha}{1-\beta}}. \tag{12}$$

Note that individual rationality for the firm with the lowest mobility adjusted productivity $\phi = \underline{\phi}$, along with incentive compatibility, is sufficient for individuality rationality for $\phi > \underline{\phi}$, since

$$\begin{aligned}\underline{\phi}\ell(\underline{\phi})^{\frac{\alpha}{1-\beta}} - w(\underline{\phi}) + r^*\underline{\sigma}^\delta \bar{K} &\geq r^*\underline{\sigma}^\delta \bar{K} \\ \Leftrightarrow 0 &\leq y(\underline{\phi}) \leq y(\phi, \underline{\phi}) \leq y(\phi),\end{aligned}$$

for any $\phi \geq \underline{\phi}$.

The optimization problem of the union is thus subject to four contraints: (I) $y(\underline{\phi}) \geq 0$; (II) $\dot{y}(\phi) = \ell(\phi)^{\frac{\alpha}{1-\beta}}$; (III) $\ell(\phi)$ is nondecreasing in ϕ, and finally, (IV) $\ell(\phi) \leq \mathcal{L}$. As will become apparent in the sequel, constraints (III) and (IV) are not binding. Thus, the Hamiltonian for the optimal control problem of the union is simply:

$$H = \left(\phi\ell^{\frac{\alpha}{1-\beta}} + \bar{W}(\mathcal{L} - \ell) - y\right) g(\phi) + \eta(\phi)\ell^{\frac{\alpha}{1-\beta}}, \tag{13}$$

where $\eta(\phi)$ is the costate variable. The necessary conditions for optimization as given by the following:

$$\begin{aligned}\frac{\alpha}{1-\beta}\ell(\phi)^{\frac{\alpha}{1-\beta}-1}(\phi + \eta(\phi)) - \bar{W} &= 0 \\ -\eta'(\phi) &= -g(\phi) \\ \eta(\bar{\phi}) &= 1.\end{aligned}$$

Routine manipulations yield the following expression that gives the employment schedule in the optimal contract:

$$\frac{\alpha}{1-\beta}\phi\ell(\phi)^{\frac{\alpha}{1-\beta}-1}\left(1 - \frac{1}{\epsilon^g(\phi)}\right) = \bar{W} \tag{14}$$

which drives a wedge between the marginal value product of labor and the reservation wage of the union. The size of this wedge depends on the elasticity $\epsilon^g(\phi)$.

Recall that employment in the absence of information asymmetry ($\ell_0(\phi)$) – one which allows the union to equate the opportunity cost of employment with the firm $\bar{W}$ and the derived (inverse) demand for labor $v(\phi, \ell)$ – is simply

$$\ell_0(\phi) = \left(\frac{\alpha}{1-\beta}\frac{\phi}{\bar{W}}\right)^{\frac{1-\beta}{1-\alpha-\beta}}.$$

It thus follows that for the firm with the highest mobility adjusted productivity, employment level is efficiently set by the union with

$$\ell(\bar{\phi}) = \left(\frac{\alpha}{1-\beta}\frac{\bar{\phi}}{\bar{W}}\right)^{\frac{1-\beta}{1-\alpha-\beta}} = \ell_0(\bar{\phi})$$

as $G(\bar{\phi}) = 1$.

Making use of the definition of $\ell_0(\phi)$, and that of ϕ, a more intuitive way of presenting $\ell(\bar{\phi})$ above can be had by a change of variables. In particular, denote $\ell^*(\sigma)$ as $\ell(\phi(\sigma))$, and $\ell_0^*(\sigma)$ as $\ell_0(\phi(\sigma))$. The definition of $G(\phi)$ can be used to yield a simplified expression for $\ell(\phi)$, with

$$\ell(\phi(\sigma)) = \ell^*(\sigma) = \ell_0^*(\sigma)\left(1 - \frac{1-\delta\beta}{1-\beta}(\frac{1}{\epsilon^f(\sigma)})\right)^{\frac{1-\beta}{1-\alpha-\beta}}, \tag{15}$$

which states that total union employment is almost always only a fraction of that which can be achieved when information asymmetry is not an issue. In addition, the size of the employment loss, relative to the perfect information benchmark, is decreasing in the size of δ.

3.2 Openness and Union Employment

To examine how union employment changes with the mobility of capital, we require an analogous expression for union employment in the absence of capital mobility under information asymmetry. In addition, we also need to have a gauge on how the wage distortions induced by information asymmetry – in the form of a wedge between the marginal value product of labor and the reservation wage $\bar{W}$ – ultimately feeds back to changes in employment levels with and without capital mobility.

But as may be expected, the problem of the union when capital is immobile is very similar, with but two exceptions.[10] First, the productivity level σ, rather than the mobility adjusted productivity ϕ serves as the relevant random variable. Second, the marginal value products of labor, with and without capital mobility, were expressed in equations (3) and (4) as

$$v(\phi) = \frac{\alpha}{1-\beta}\phi\ell^{\frac{\alpha}{1-\beta}-1}, \;\; v_0(\sigma,\ell,k) = \alpha\sigma\ell^{\alpha-1}k^{\beta}.$$

Thus, as in Rodrik (1997), the price elasticity of the derived labor demand rises from $1/(1-\alpha)$ to $(1-\beta)/(1-\alpha-\beta)$, implying therefore a larger employment distortion due to the same wage distortion, when capital market opens up. Specifically, let $L(\sigma)$ be the level of union employment that solves the optimal control problem of the union when capital is immobile, we

[10]See the Appendix of an abbreviated proof of these results.

have

$$L(\sigma) = L_0(\sigma)\left(1 - \frac{1}{\epsilon^f(\sigma)}\right)^{\frac{1}{1-\alpha}} \leq L_0(\sigma). \tag{16}$$

To recall, $L_0(\sigma)$ is simply union employment when both information asymmetry and capital mobility are absent (Equation (6)). We have the following result:

Proposition 1 *The change in union employment subsequent to openness when information is asymmetric is given by:*

$$\begin{aligned}\log \ell^*(\sigma) - \log L(\sigma) &= \log \ell_0^*(\sigma) - \log L_0(\sigma) \\ &+ \left(\frac{1-\beta}{1-\alpha-\beta} - \frac{1}{1-\alpha}\right)\log(1 - \frac{1}{\epsilon^f(\sigma)}) \\ &+ \frac{1-\beta}{1-\beta-\alpha}\left(\log(1 - \frac{1-\delta\beta}{1-\beta}\frac{1}{\epsilon^f(\sigma)}) - \log(1 - \frac{1}{\epsilon^f(\sigma)})\right). \end{aligned} \tag{17}$$

Thus, the change in union employment once the option of capital mobility opens depends on the interaction of three effects. First, $\log \ell_0^*(\sigma) - \log L_0(\sigma)$ represents the change in union employment when information asymmetry is not an issue. The size of this difference depends on whether there is excess supply of capital $\bar{K}$ in the home country, given r^* and $\bar{W}$. Second, since information asymmetry in effect drives a wedge between the reservation union wage and the marginal product of labor, the more elastic is the demand for labor, the larger will be the corresponding impact on employment. Now, as the elasticity of demand for labor from $1/(1-\alpha)$ to $(1-\beta)/(1-\alpha-\beta)$ when capital market opens up, this second effect has an unambiguous negative effect on the right hand side of equation (17), since $1 - \frac{1-\delta\beta}{1-\beta}\frac{1}{\epsilon^f(\sigma)} < 1$. Finally, openness can nevertheless imply a net positive impact on union employment, if the third term on the right hand side of equation (17), which represents the *informational* role of capital mobility, is sufficiently large.

In particular, if $\delta < 1$, and hence $\epsilon^g(\phi(\sigma)) > \epsilon^f(\sigma)$ (Lemma 1), the productivity of capital exhibits home bias. In turn, capital mobility strengthens the informational advantage of the firm, and union employment is necessarily falls at given σ. If $\delta \geq 1$, however, the third term of the right hand side of equation (17) is strictly positive. Clearly, the larger δ is, the more likely it is that employment can in fact increase with openness. The question, however, is whether there is a clearly identifiable range of δ's that can accomplish this in equilibrium. To this end,

Proposition 2 *There exists* $\delta^* \in (1, 1/\beta)$ *such that*

$$\frac{\ell^*(\sigma) - L(\sigma)}{L(\sigma)} > \frac{\ell_0^*(\sigma) - L_0(\sigma)}{L_0(\sigma)}.$$

for all $\delta > \delta^*$, *and* $\sigma < \bar{\sigma}$. *In addition,*

$$\frac{\ell^*(\bar{\sigma}) - L(\bar{\sigma})}{L(\bar{\sigma})} = \frac{\ell_0^*(\bar{\sigma}) - L_0(\bar{\sigma})}{L_0(\bar{\sigma})}.$$

Proof: Making use of equations (7) and (15), it can be readily confirmed that $(\ell^*(\sigma) - L(\sigma))/L(\sigma)$ is strictly increasing in δ. Note, in addition, evaluated at $\delta = 1/\beta$,

$$\frac{\ell^*(\sigma) - L(\sigma)}{L(\sigma)} - \frac{\ell_0^*(\sigma) - L_0(\sigma)}{L_0(\sigma)} = \frac{\ell_0^*(\sigma)}{L_0(\sigma)} \left[\frac{1}{\left(1 - \frac{1}{\epsilon^f(\sigma)}\right)^{\frac{1}{1-\alpha}}} - 1 \right] > 0.$$

Evaluated at $\delta = 1$,

$$\frac{\ell^*(\sigma) - L(\sigma)}{L(\sigma)} - \frac{\ell_0^*(\sigma) - L_0(\sigma)}{L_0(\sigma)} = \frac{\ell_0^*(\sigma)}{L_0(\sigma)} \left[\frac{\left(1 - \frac{1}{\epsilon^f(\sigma)}\right)^{\frac{1-\beta}{1-\alpha-\beta}}}{\left(1 - \frac{1}{\epsilon^f(\sigma)}\right)^{\frac{1}{1-\alpha}}} - 1 \right] < 0.$$

The first part of the proposition thus follows from the intermediate value theorem. The second part of the proposition follows directly from equation (15).

Intuitively, Proposition 1 states that as long as δ is sufficiently close to $1/\beta$, the fraction of employment losses once the option of capital mobility opens up is strictly less than the perfect information benchmark. The following observations are immediate.

Corollary 1 *If the productivity of capital exhibit home-bias, openness can never increase union employment in the presence of information asymmetry.*

Corollary 2 *If* $\ell_0^*(\sigma) = L_0(\sigma)$ *when information imperfection is not an issue, then openness gives rise to*

1. *strictly higher union employment when information is asymmetric*

$$\ell^*(\sigma) - L(\sigma) > 0$$

for all $\sigma < \bar{\sigma}$ *and* $\delta > \delta^*$, *despite the fact that*

2. equilibrium capital outflow is strictly positive, $k(\sigma, \ell^*(\sigma)) < \bar{K}$ for $\sigma < \bar{\sigma}$.

We have thus the following employment ranking in the two capital mobility and the two information regimes

$$L(\sigma) < \ell^*(\sigma) < \ell_0^*(\sigma) = L_0(\sigma).$$

Since information asymmetry leads to a reduction in employment given any one of the two capital mobility regimes, $L(\sigma) < L_0(\sigma)$ and $\ell^*(\sigma) < \ell_0^*(\sigma)$. However, since $\delta > \delta^*$, capital mobility reduces the degree of information asymmetry confronting the union. Indeed, the conditions of Corollary 2 guarantee that $L(\sigma) < \ell^*(\sigma)$.

The second observation in the proposition follows upon substituting the expression for $\ell^*(\sigma)$ into $k(\sigma, \ell)$. Since under-employment ($\ell^*(\sigma) < \ell_0^*(\sigma)$) decreases the returns to capital in the home country, there is thus strictly positive capital outflow even when none exists in the absence of asymmetric information.

3.3 Openness, Profits and Wages

Turning now to the welfare and the wage earning of the union, constraint (II), equation (15), and the definition of $y(\phi)$ jointly imply that

$$y(\phi(\sigma)) \equiv y^*(\sigma) = \int_{\underline{\sigma}}^{\sigma} \frac{1-\delta\beta}{1-\beta} \ell^*(t)^{\frac{\alpha}{1-\beta}} \frac{\phi(t)}{t} dt \tag{18}$$

$$w^*(\sigma) = \phi(\sigma)\ell^*(\sigma)^{\frac{\alpha}{1-\beta}} - y^*(\sigma). \tag{19}$$

As should be apparent, the informational rent of the firm is directly related to the location specificity of capital. In particular, as δ tends to $1/\beta$, informational asymmetry effectively vanishes, and $y(\phi(\sigma))$ accordingly tends to zero, for any firm type σ.

Thus, the wage bill that the union can maximally extract from the firm is likewise intimately linked to the location specificity of capital. Indeed, union welfare may rise or fall when capital markets open up, depending on the interplay between savings on informational rent, and the loss of employment opportunities as outward capital flow takes place. For the same reasons, the profits of the firm may similarly rise or fall when the option to export capital abroad opens up. In particular,

Proposition 3 *In the absence of productivity reversal, the change in union wage income subsequent to openness is given by:*

$$
\begin{aligned}
\log w^*(\sigma) - \log W(\sigma) \quad = \quad & \log w_0^*(\sigma) - \log W_0(\sigma) \\
& + \left(\frac{\alpha}{1-\alpha-\beta} - \frac{1}{1-\alpha} \right) \log(1 - \frac{1}{\epsilon^f(\sigma)}) \\
& + \frac{\alpha}{1-\beta-\alpha} \left(\log(1 - \frac{1-\delta\beta}{1-\beta}\frac{1}{\epsilon^f(\sigma)}) - \log(1 - \frac{1}{\epsilon^f(\sigma)}) \right) \\
& + \log \left(1 - \frac{1-\delta\beta}{1-\beta} \int_{\underline{\sigma}}^{\sigma} \left(\frac{t}{\sigma} \right)^{\frac{1-\delta\beta}{1-\alpha-\beta}} \frac{1}{t} \Omega^g(t) dt \right) \\
& - \log \left(1 - \int_{\underline{\sigma}}^{\sigma} \left(\frac{t}{\sigma} \right)^{\frac{1}{1-\alpha}} \frac{1}{t} \Omega^f(t) dt \right) \qquad (20)
\end{aligned}
$$

$$
\Omega^g(t) = \left((1 - \frac{1-\delta\beta}{1-\beta}\frac{1}{\epsilon^f(t)})/(1 - \frac{1-\delta\beta}{1-\beta}\frac{1}{\epsilon^f(\sigma)} \right)^{\alpha/(1-\alpha-\beta)} < 1
$$

and

$$
\Omega^f(t)) = \left((1 - \frac{1}{\epsilon^f(t)})/(1 - \frac{1}{\epsilon^f(\sigma)} \right)^{\alpha/(1-\alpha)} < 1.
$$

Thus, the change in union wage earnings once the option of capital mobility opens depends on the interaction of four effects. The first three of these effects are analogous to the factors governing the corresponding change in union employment displayed in Proposition 2. In particular, $\log w_0^*(\sigma) - \log W_0(\sigma)$ represents the change in wage earnings in the absence of information asymmetry. As discussed, this is unambiguously negative as soon as the option of capital mobility opens up. The second effect is likewise strictly negative, as higher labor demand elasticity in the presence of capital mobility exacerbates the negative output impact of the proportionate wage gap $1 - 1/\epsilon^f(\sigma)$. The third effect concerns the size of the wage gap required to elicit truth-telling, and is strictly negative (positive) whenever the productivity of capital exhibits (does not exhibit) home bias.

A final effect concerns the informational rent of the firm, $y^*(\sigma)$ and $Y(\sigma)$. In particular, if $\delta = 1/\beta$, capital mobility deprives the firm completely of its informational advantage, and difference displayed in the last two terms of equation (20) is strictly positive. We have the following:

Proposition 4 *As δ tends to $1/\beta$,*

1. *total profits of the firm approaches* $r^*_\sigma \bar{K}$ *for all* $\sigma \in [\underline{\sigma}, \bar{\sigma}]$,

2. *the welfare of union members approaches the perfect information benchmark with capital mobility,* $w^*_0(\sigma) + \bar{W}(\mathcal{L} - \ell^*_0(\sigma))$,

Turning now to the welfare of the union, respectively denote $U(\sigma)$ and $u(\sigma)$ as the welfare of the union with and without capital mobility, we have

$$\begin{aligned} U(\sigma) - u(\sigma) &= \bar{W}\left[L(\sigma) - \ell^*(\sigma)\right]\left(\frac{1-\Omega^f(\sigma)}{\alpha(1-1/\epsilon^f(\sigma))} - 1\right) \\ &\quad + \bar{W}\left[\frac{1-\Omega^f(\sigma)}{\alpha(1-1/\epsilon^f(\sigma))} - \frac{(1-\beta)(1-\Omega^g(\sigma))}{\alpha(1-(1-\delta\beta)/((1-\beta)\epsilon^f(\sigma))}\right]\ell^*(\sigma). \end{aligned}$$

The first term in square brackets reflects the employment impact of foreign direct investment in the presence of information asymmetry. From Corollary 2, $L(\sigma) < \ell^*(\sigma)$ as δ is sufficiently close to $1/\beta$. The second term in square brackets reflects the combined impact of (i) the information rent ($\Omega^g(\sigma)$ and $\Omega^f(\sigma)$), and (ii) the size of the wage gap required to elicit truth telling ($1/\epsilon^f(\sigma)$ and $(1-\delta\beta)/((1-\beta)(\epsilon^f(\sigma)))$ on union welfare. In both cases, the closer δ is to $1/\beta$, the more likely it is that the welfare of the union $u(\sigma)$ exceeds $U(\sigma)$.

4 Conclusion

It has long been recognized that greater openness in foreign investment regimes is likely to disadvantage workers in their bargaining with employers because it increases the elasticity of the marginal value product of labor (MVPL) curve. This paper has highlighted a hitherto underappreciated informational role of openness in affecting the bargaining outcome in a world of asymmetric information. Openness can reduce or increase the variability of the marginal value product of labor curve, and hence the informational rent that the firm can extract from the union. Whether it does so or not depends crucially on how foreign returns vary with domestic productivity.

If foreign returns increase very fast as domestic productivity of capital increases, openness will lead more productive firms to invest abroad disproportionately, leaving disproportionately less capital at home. This reduces the domestic MVPL disproportionately, relative to the increase expected by the simple increase in domestic productivity. In this case, therefore, openness to foreign investment will reduce the spread of MVPL and hence improve the outcome for workers in a world of bargaining with asymmetric information. This effect will counteract the conventional negative effect on workers of an increase in the elasticity of the MVPL curve as a result of greater openness. However, if foreign returns to capital increase sufficiently slowly as domestic productivity of capital increases, then the spread of MVPL increases and workers are disadvantaged all round by greater openness.

Apart from bringing together capital mobility, incentive compatibility and bargaining together in a way that they are not usually brought together, our analysis thus highlights a key feature that needs to be explored – the precise empirical relationship between domestic returns and foreign returns in a cross section of firms. This is an interesting area for further research.

Appendix

In this Appendix, we briefly describe the solution to the optimal control problem of the union when capital is immobile. We seek a wage bill and an employment schedule, respectively $W(\sigma)$ and $L(\sigma)$, that jointly maximize expected union welfare while satisfying incentive compatibility, and individual rationality. Since the profit function is given by $Y(\sigma,\widehat{\sigma})\sigma\bar{K}^{\beta}L(\widehat{\sigma})^{\alpha}-W(\widehat{\sigma})$, with $Y(\sigma,\sigma)=Y(\sigma)$. It can be readily verified that incentive compatibility requires that $(\sigma-\widehat{\sigma})\bar{K}^{\beta}L(\sigma)^{\alpha}\geq Y(\sigma)-Y(\widehat{\sigma})\geq(\sigma-\widehat{\sigma})\bar{K}^{\beta}L(\widehat{\sigma})^{\alpha}$. In addition, $Y(\sigma)$ is convex, and differentiable almost everywhere, with

$$\dot{Y}(\sigma)\equiv\frac{dY(\sigma)}{d\sigma}=p\bar{K}^{\beta}L(\sigma)^{\alpha}.$$

If the contract yields non-negative profits for a firm with $\sigma=\underline{\sigma}$,

$$0\leq Y(\underline{\sigma})\leq Y(\sigma,\underline{\sigma})\leq Y(\sigma,\sigma),\quad \sigma>\underline{\sigma}$$

where the inequalities follow respectively since $Y(\sigma,\widehat{\sigma})$ is monotonically increasing in σ and since incentive compatibility is satisfied.

Thus, the decision problem of the union is subject to four constraints: (i) $Y(\underline{\sigma})$ is non-negative; (ii) $\dot{Y}(\sigma)=p\bar{K}^{\beta}L(\sigma)^{\alpha}$; (iii) $L(\sigma)$ is non-decreasing with respect to σ and finally, (iv) $L(\sigma)\leq\mathcal{L}$. Setting up the Hamiltonian as in equation (13), the union welfare maximizing contract requires that

$$V(\sigma, L(\sigma), p)\left(1 - \frac{1}{\epsilon^f(\sigma)}\right) = \bar{W}. \tag{21}$$

Rearranging terms, we obtain,

$$L(\sigma) = L_0(\sigma)\left(1 - \frac{1}{\epsilon^f(\sigma)}\right)^{\frac{1}{1-\alpha}} < L_0(\sigma). \tag{22}$$

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