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A Political Economy Model of the Permissible Number of Immigrants*

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Abstract: The paper examines a model in which the number of immigrants allowed into a country is the outcome of a costly political lobbying process between a firm and a union. The union and the firm bargain over the wage of the native-born after the number of immigrants that will be permitted is known. Comparative statistics results are derived to show how the reservation wage of immigrants, the size of the union, the sensitivity of the legislature to lobbying, the reservation wage of the native-born, and economic growth affect the permissible number of immigrants and the post-immigration wage of the native-born. We also discuss some limitations of our results.

Keywords: all-pay auction, bargaining, immigration, lobbying, reservation wage.

JEL Classification: D72, D73, J5, J61.

1. Introduction

There are several factors that affect the number of immigrants allowed into a country. Some of these include excess demand for labour, competing opportunities in other countries (DeVoretz and Maki 1983), humanitarian reasons, and family re-unification as is the case in Canada's immigration policy (see also Akbar and DeVoretz 1993, and Borjas 1994).

It is widely recognized that a political lobbying process also determines the number of immigrants into a country (see, for example, Benhabib 1996; Borjas 1994; DeVoretz 1996; Goldin 1994; Green and Green 1996). For example Goldin (1994, p. 223) writes: "Because the story of immigration restriction is a legislative one, its main players will be representatives, senators, and presidents. But behind the legislative tale are the shifting interests of various groups. The first is organized labour . . . and unorganized labour. Owners of capital are the second…and immigrants both new and old are the third." The interests of these groups will differ because immigration has different effects on them. For example, immigration may depress the wages of unskilled workers resulting in an increase in the share of income accruing to skilled workers and capital owners. Borjas (1995) calls this gain the "immigration surplus." Indeed, some empirical papers have shown that immigration could depress the wages of the native born (see, for example, Borjas 1994) and the references cited therein). In theory, however, this depends on one's assumptions about the human capital content of immigrants and whether they are substitutes or complements to native labour.

To the best of my knowledge, there is not any work which formally shows how lobbying determines the number of immigrants. Recently, Sollner (1999) demonstrated in a one-sector model how immigration lowers the wages of unskilled labour and increases the return on capital. He then argues that this would lead unskilled workers to lobby against immigration. However, he does not model the lobbying contest. Also Benhabib (1996) uses a median-voter model to determine the quality of immigrants but *not* the number of immigrants allowed into a country. He suggests that examining the latter issue would be an interesting research endeavour. Indeed, on a more general note, Borjas (1994, p. 1693) observes that "...further research on the political economy of immigration might greatly improve our understanding of the properties of the equilibrium in the immigration market."

In this paper, we model the lobbying contest and examine how the reservation wage of immigrants, the size of the union, the sensitivity of the legislature to lobbying, and economic growth affect the post-immigration wage of the native-born and the permissible number of immigrants of homogeneous quality. By "permissible number" of immigrants, we simply mean the number of immigrants that would be allowed into a country. One may think of this as the annual target level of immigration in Canada, which was tabled by the minister under the 1976 Immigration Act (see DeVoretz 1996), or as the annual quota of H1B visas issued in the USA.

In our framework, we imagine workers as being represented by a union. In line with insider-outsider theory, the current workers may be labeled the "insiders" and the prospective workers, who are immigrants in our model "outsiders," although one does not necessarily require a union for the insider-outsider theory (see, Lindbeck and Snow 1988).

The paper is organized as follows: in the next section, we present a lobbying contest based on the model in Amegashie (1999a). We postulate a relationship between the post-immigration wage of the native-born and the number of immigrants. We then model the lobbying contest under two alternative assumptions: in one model the contestant who exerts the higher lobbying effort is not necessarily the winner. In the other model, the contestant with the higher effort is the winner. In Section 3, we pursue similar analysis but derive the relationship between the post-immigration wage of immigrants and the number of immigrants from a bargaining model. Section 4 concludes the paper.

2. The immigration lobbying contest

As discussed above, there are factors other than lobbying which determine the number of permissible immigrants; however, some of these factors may well be related to lobbying. For example, even if the number of immigrants is partly determined by excess demand in the labour market, as in DeVoretz and Maki (1983), this information could be supplied by firms as part of their lobbying efforts. Hence, it is not unreasonable to assume that the number of permissible immigrants is the outcome of a political lobbying process. Let the current wage be $\overline{w}$. All the unionized native workers will receive $\overline{w}$ in the absence of immigrants. Let $\underline{\underline{w}} < \overline{w}$ be the post-immigration wage of the native-born. Let the number of native workers be fixed at $\overline{L}_N$. Suppose that the firm has the production function, $f(L) = L^{\sigma}$, where $L = \overline{L}_N + L_I$ is the total number of workers and $0 < \sigma \leq 1$. We also assume that *all* immigrants are paid $\underline{w}$ ($\leq \underline{\underline{w}}$), their reservation wage.

2.1 Imperfectly discriminating contest (the lottery model)

Let y and x be the firm's and union's lobbying expenditures respectively. Following Tullock (1980), let the probability that the firm wins the lobbying contest be $\theta(x, y) = \dfrac{y^{\tau}}{x^{\tau} + y^{\tau}}$, where $\tau > 0$ is a measure of the sensitivity of the politician or legislative body to lobbying expenditures.[1] Then the union wins the contest with probability $(1- \theta)$. Note that for any finite τ, the lobbyist with higher expenditure does not necessarily win the contest. This may be the case for two reasons: (i) if lobbying expenditures are not in terms of money, then the legislative body may not be able to perfectly discriminate between the expenditures of the lobbyists, and (ii) there may be other factors, apart from lobbying expenditures, which determine the outcome of the contest (see Clark and Riis 1996 for a formal proof). We relax this assumption in the next section when we consider the all-pay auction, where the lobbyist with the higher expenditure wins the contest with certainty. It is important to note that there is an aspect of the success probability in this contest that we do not model. If the legislative body determines the winner through majority voting, then it is not only the expenditure of a contestant that matters but also how this expenditure is allocated among the members of the legislature. Such a game is modeled in Amegashie (1999c) and Congleton (1984) in their

1 See Amegashie (1998, 1999a, 1999c), Konrad (1999), Ellingsen (1991), and Rama (1997) for extensions of Tullock's model. For an interesting survey, see Nitzan (1994).

analyses of the effect of committees on rent-seeking effort. To simplify the game, we ignore this problem.

Assume that the number of permissible immigrants is given by L_I = g(y), where $g'(y) > 0$. For simplicity, we assume that g(y) = by, with b > 0. Assume that the firm sells its final product at a constant price, $p > \overline{w}$.

Note that the model here is similar to Amegashie (1999a), except that the contestants are non-identical.[2] The firm's lobbying expenditure affects the size of the rent it gets from employing immigrants and indeed, L_I, is an increasing function of its lobbying effort. Note that we could also model the game as follows: In stage 1, the union announces it wage. In stage 2, the firm chooses its preferred number of immigrants (which also determines the number of the native-born that will be employed). Then in stage 3, they both simultaneously exert their lobbying efforts. In such a framework, if we solve the game backwards, the solution in the lobbying sub-game will give a positive relationship between the firm's lobbying effort and its preferred number of immigrants, for example, y = y(L_I). In this section, we only focus on the lobbying sub-game. Our assumption is that the firm knows that if it wants L_I immigrants, it has to spend y = (L_I/b) dollars in lobbying and it will be successful with probability, y/(x + y). In section 3, we model the bargaining and lobbying sub-games and look for a sub-game perfect equilibrium.

It is important to note that the two models are fundamentally different. In the sequential model above, y is increasing in L_I because the higher is L_I the more the union lobbies and hence the firm also has to increase its lobbying effort.[3] If the union does not lobby, then the legislative body or politician will approve the firm's proposal of L_I immigrants even if the firm does not lobby. Indeed, in the sequential model, the firm's lobbying effort determines the probability that it wins the contest but *not* the number of immigrants. In our model, the firm cannot get $L_I > 0$ without lobbying, even if the union does

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[2] See the exchange between Amegashie (1999b) and Clark (1999) on this model. Note, however, that Clark's critique is not relevant here because we are not interested in the relationship between aggregate lobbying expenditures and the number of lobbyists.

[3] This would be the case if the higher the number of immigrants, the lower the wage or employment of the native-born. An increasing and strictly concave production function would ensure this result.

not lobby. Without any lobbying, $L_I = 0$. Unlike the sequential model, therefore, the positive relationship between y and L_I is not due to the union's lobbying effort. Rather, it is based on the assumption that the firm's lobbying effort determines the number of permissible immigrants. The union lobbies for zero immigration. Thus the firm's lobbying effort determines two things: (i) the number of immigrants, and (ii) the probability that it will be successful.

Assuming that $\sigma = 1$, the firm's expected profit could be written as

$$\pi^f = \theta[p(L_I + \bar{L}_N) - \underline{w}\, L_I - \underline{\underline{w}}\, \bar{L}_N)] + (1 - \theta)[\, p\bar{L}_N - \bar{w}\, \bar{L}_N] - y,$$

which could be simplified, noting that $L_I = by$, to obtain

$$\pi^f = \theta[(p-\underline{w})by + (\bar{w} - \underline{\underline{w}})\bar{L}_N] + (p - \bar{w})\bar{L}_N - y. \qquad (1)$$

Assuming that the union seeks to maximize the total wage of its members, its payoff can be written as

$$\pi^u = (1 - \theta)\bar{w}\, \bar{L}_N + \theta \underline{\underline{w}}\, \bar{L}_N - x,$$

which can be rewritten as

$$\pi^u = (1- \theta)[(\bar{w} - \underline{\underline{w}})\bar{L}_N] + \underline{\underline{w}}\, \bar{L}_N - x. \qquad (2)$$

Note that $V^u \equiv (\bar{w} - \underline{\underline{w}})\bar{L}_N$ and $V^f \equiv (p-\underline{w})by + (\bar{w} - \underline{\underline{w}})\bar{L}_N$ are the union's and firm's valuations (respectively) of winning the contest. The firm has a higher valuation than the union, if $y > 0$. Indeed, this is the case in equilibrium.[4]

We now model how the number of immigrants affects the post-immigration wage of the native-born. We postulate that the higher the number of immigrants, the lower the post-immigration wage of the native-born. That is $\underline{\underline{w}} = \underline{\underline{w}}(L_I)$, where $\underline{\underline{w}}$ is decreasing in L_I. Specifically, we assume that $\underline{\underline{w}} = \bar{w} - \beta(L_I)^{\alpha} \geq \underline{w}$,[5] where $0 < \alpha < 1$ and $\beta > 0$. When $L_I = 0$, then $\underline{\underline{w}} = \bar{w}$. We have in mind a bargaining process where the union and the firm bargain

[4] This is because x = 0, y = 0, cannot be an equilibrium, since each contestan tthen has the incentive to spend a small but positive amount on lobbying and win the contest with certainty.
[5] In our numerical solution to the game, we choose our parameters carefully to satisfy this restriction.

over the wage but *not* over employment (i.e., the current employment level of the native-born remains unchanged). The possibility of being able to lobby for immigrants puts the firm in a stronger bargaining position than would be the case if this possibility did not exist. Technically, the higher the number of immigrants, the higher the firm's threat point or outside option (i.e., the firm's payoff when there is no agreement between the union and the firm). It is the outcome of this bargaining process that is captured in the relationship, $\underline{\underline{w}} = \overline{w} - \beta(L_I)^{\alpha}$. In Section 3, we explicitly derive a similar relationship assuming that the firm and union choose the post-immigration wage to maximize a Nash (bargaining) product.

Putting $\underline{\underline{w}} = \overline{w} - \beta(L_I)^{\alpha}$ into (1) and (2) and noting that L_I = by, we get

$$\pi^f = \theta[(p-\underline{w})by + \varphi \overline{L}_N y^{\alpha}] + (p - \overline{w})\overline{L}_N - y. \tag{1'}$$

and

$$\pi^u = (1-\theta)[\varphi \overline{L}_N y^{\alpha}] + (\overline{w} - \varphi y^{\alpha})\ \overline{L}_N - x, \tag{2'}$$

where $\varphi \equiv \beta b^{\alpha}$.

Assuming that $\tau = 1$, the optimal values of x and y must satisfy the pair of equations below in a Cournot-Nash equilibrium:

$$\frac{\partial \pi^f}{\partial y} = V^f\left[\frac{1}{x+y} - \frac{y}{(x+y)^2}\right] + \frac{y}{x+y}[\hat{b} + \alpha\varphi\overline{L}_N y^{\alpha-1}] - 1 = 0 \tag{3}$$

and

$$\frac{\partial \pi^u}{\partial x} = V^u\left[\frac{1}{x+y} - \frac{x}{(x+y)^2}\right] - 1 = 0 \tag{4}$$

where $\hat{b} \equiv (p-\underline{w})b$.

We can simplify (3) and (4) to obtain

$$x(V^u + \hat{b}y) + y(x+y)\,[\hat{b} + \alpha\varphi\overline{L}_N y^{\alpha-1}] = (x+y)^2 \tag{3'}$$

and

$$yV^u = (x+y)^2 \tag{4'}$$

where in (3') we have made use of the fact that $V^f = V^u + \hat{b}y$. We now need to solve (3') and (4') simultaneously for x and y. We proceed as follows: Let $T \equiv x + y$ be aggregate lobbying expenditures. Let {x*, y*} be the optimal solution. Then T* = x* + y*. Having found x* and y*, we can write y* = γT* and x* = (1-γ)T*, where 0 < γ < 1. Putting these expressions into (4') and simplifying gives $T^* = [\varphi \bar{L}_N \gamma^{(1+\alpha)}]^{1/(1-\alpha)}$.

Noting that y* = γT*, x* = (1-γ)T*, $T^* = x^* + y^* = [\varphi \bar{L}_N \gamma^{(1+\alpha)}]^{1/(1-\alpha)}$, we can simplify (3') to get

$$(1-\gamma)[\hat{b}(\gamma T^*) + \varphi \bar{L}_N (\gamma T^*)^{\alpha}] + \gamma T^*[\hat{b} + \alpha\varphi\bar{L}_N(\gamma T^*)^{\alpha-1}] - T^* = 0 \qquad (5)$$

Note that we can solve for γ from (5). Once its value is obtained, it follows that x* and y* have been obtained. We solve for γ numerically using the mathematics software, MAPLE V Release 5. We find that γ has three roots; two complex roots and one real root. We ignore the complex roots. We check that the second-order conditions for a maximum hold.

Since γ ≡ θ, the expected number of permissible immigrants is

$$L_I^e = \gamma b y^* = b\gamma^2 T^* = b(\varphi \bar{L}_N)^{1/(1-\alpha)}\gamma^{(3-\alpha)/(1-\alpha)} \qquad (6)$$

Now $\partial L_I^e/\partial \underline{w} = b(\varphi \bar{L}_N)^{1/(1-\alpha)}[(3-\alpha)/(1-\alpha)]\ \gamma^{(3-\alpha)/(1-\alpha)-1}(\partial\gamma/\partial \underline{w})$. Hence, *a priori*, this derivative cannot be signed, unless we can establish the sign of $(\partial\gamma/\partial \underline{w})$. We resort to numerical simulations, which show that $\partial\gamma/\partial \underline{w} < 0$ (see Table 1 below).[6] Hence $\partial L_I^e/\partial \underline{w} < 0$. This gives the following proposition:

Proposition 1: *The lower the reservation wage of immigrants, the higher the expected permissible number of immigrants.*

[6] One can totally differentiate equation (5) to find an expression for this derivative. However, it cannot be signed analytically.

The intuition behind proposition 1 is simple. A fall in $\underline{w}$ increases the valuation of the firm without changing the valuation of the union. This increases the firm's lobbying effort, its probability of success and hence the permissible number of immigrants.

Table 1: The relationship between $\underline{w}$ and γ, for p = 10, b = 0.01, $\overline{w} = 8$, $\alpha = 0.5$, $\beta = 0.1$, and $\overline{L}_N$ = 100.

$\underline{w}$	γ
1	0.7836
1.5	0.7816
2.0	0.7797
2.5	0.7777
3.0	0.7758
3.5	0.7737
4.0	0.7719
4.5	0.7701
5.0	0.7682
5.9	0.7648

Note from Table 1 that the probability that the firm wins the contest is greater than 0.5 (i.e., $\gamma > 0.5$). This means that the firm has a higher probability of winning the contest. This is due to the fact that the firm has a higher valuation than the union (i.e., $V^f > V^u$) in equilibrium, since y* > 0.

Suppose that there is an increase in demand as a result of economic growth. Suppose this increases the price of the product. Then we have

$$\frac{\partial L_I^e}{\partial p} = \left[k \frac{\partial \gamma}{\partial p} \right]$$

where $k \equiv [(3-\alpha)/(1-\alpha)]b(\varphi \overline{L}_N)^{1/(1-\alpha)}\gamma^{(3-\alpha)/(1-\alpha)-1}$. To sign this derivative, we need to establish the sign of $\partial\gamma/\partial p$. Note that when we change $\underline{w}$, we are actually changing $\hat{b} \equiv (p-\underline{w})b$ in equation (5). Since p and $\underline{w}$ affect $\hat{b}$ in opposite directions, $(\partial\gamma/\partial p)(\partial\gamma/\partial \underline{w}) < 0$. Then $\partial\gamma/\partial p > 0$, since $\partial\gamma/\partial \underline{w} < 0$. Our numerical simulations, which we do not report, confirm this result. Hence we get the following proposition:

Proposition 2: *If economic growth increases the prices of final goods, then there will be an increase in the expected permissible number of immigrants.*

Since our model is a partial equilibrium model, proposition 2 (and probably all our propositions) will only make sense if we consider the permissible number of immigrants to a particular industry (say, the computer industry). Proposition 2 accords very well with our intuition as it implies that the prospect of bigger profits will induce firms to lobby more for immigrants and increase the number of permissible immigrants.

Since $\underline{\underline{w}} = \overline{w} - \varphi(\gamma T^*)^{\alpha}$, we obtain $\partial \underline{\underline{w}} / \partial \underline{w} = -\varphi \{\partial[(\gamma T^*)^{\alpha}]/\partial\gamma\} (\partial\gamma/\partial \underline{w})$. Given that given T* is increasing in γ and $(\partial\gamma/\partial \underline{w}) < 0$, it follows that $\partial \underline{\underline{w}} / \partial \underline{w} > 0$. This gives the following proposition:

Proposition 3: *The lower the reservation wage of immigrants, the lower the expected post-immigration wage of the native-born.*

Now $\partial L_I^e / \partial \overline{L}_N = k\ (\partial\gamma/\partial \overline{L}_N) + \{b\varphi^{1/(1-\alpha)}(\overline{L}_N)^{1/(1-\alpha)-1}\gamma^{(3-\alpha)/(1-\alpha)}/(1-\alpha)\}$. Our numerical simulations show that $(\partial\gamma/\partial \overline{L}_N) = 0$, which implies that $\partial L_I^e / \partial \overline{L}_N > 0$. This gives the following proposition:

Proposition 4: *An increase in the size of the union leads to an increase in the expected permissible number of immigrants.*

An increase in the size of the union increases the valuation of both the union and the firm by the same proportion, resulting in no change in γ. But the increase in y* means that the number of permissible immigrants increases. Note that an increase in the size of the union increases the firm's valuation because the fall in the total wage bill for the native-born as a result of immigration is greater.

While we are unable to obtain analytical results for our model, the following analytical result in Nti (1999) confirms our results.

Proposition 4 (Nti 1999): *Effort of the favored player* (i.e., the player with the higher valuation) *increases with his own valuation and with the valuation of the underdog* (i.e., player with the lower valuation); *effort of the underdog increases with her own valuation but decreases with the valuation of the favored player.* Parentheses mine.

It follows from the proposition that any increase in the valuations of the lobbyists in our model has a positive *reinforcing* effect on the firm's lobbying effort but exerts *opposing* effects on the effort of the union. The proposition suggests that what drives our results is the fact that the firm has a higher valuation than does the union. Note, however, that the fact that the firm's lobbying effort affects the number of immigrants is not the reason why the firm has a higher valuation than the union. To see this, assume that the number of immigrants, if the firm wins the contest, is $\overline{L}_I$, regardless of y. If we replace "by" in equation (1) and compare it with equation (2), it is easy to see that the firm will still have a higher valuation than the union. We believe the firm will usually have a higher valuation than the union, if the union cares only about its total wage receipts, $w\overline{L}_N$. The reason is that any gain in total wage receipts by the union will be a loss to the firm and vice versa. Hence, total wage receipts will be part of both the firm's and union's valuations. However, there are other factors — such as the price of the firm's output — which are unlikely to enter into the union's valuation but will have a positive effect on the firm's valuation.

2.2 The all-pay auction

In the section, we model the contest under the alternative assumption that the lobbyist with the higher effort wins with certainty. This corresponds to the case where τ is infinitely large. That is

$$\hat{\theta}(x,y) = \begin{cases} 1 & \text{if } y > x \\ 1/2 & \text{if } y = x \\ 0 & \text{if } y < x \end{cases}$$

We shall draw on results in Hillman and Riley (1989) and Baye, Kovenock and de Vries (1993, 1996) to solve the game. The only difference is that unlike our case where the contestant's valuations depend on lobbying expenditures, the games in the all-pay auction literature have exogenous valuations.[7]

The results derived by Baye, Kovenock, and de Vries (1996), Ellingsen (1991), and Hillman and Riley (1989) for all-pay auctions with exogenous valuations are very useful for our model but should be applied to it with caution. As these authors and others have observed, there is no equilibrium in pure strategies in all-pay auctions. To see this, consider the standard case where V^f and V^u are fixed (i.e., do not depend on y). Suppose the union bids $0 < x^* \leq V^u$. Then the firm's optimal response is $y^* = x^* + \varepsilon < V^f$ (i.e., marginally higher than x*). But then $x^* > 0$ cannot be an optimal response to $y^* = x^* + \varepsilon$. Also it is obvious that $x^* = y^* = 0$ cannot be an equilibrium. Hence, there is no equilibrium in pure strategies.

However, in our model, there may be an equilibrium in pure strategies.[8] To see this, suppose that the firm can choose y such that it wins the contest with certainty. Then it will choose y to maximize $[p(\overline{L}_N + L_I)^\sigma - \underline{w}L_I - \underline{\underline{w}}\overline{L}_N] - y$. Let the optimal y be $\overline{y}$ and suppose that it is an interior solution. If it is a corner solution, then we assume that it is determined by a maximum number of immigrants beyond which the legislative body would not approve any additional immigrants. Let $V^u = \overline{V}^u$, given that $y = \overline{y}$ and assume that $\overline{y} \geq \overline{V}^u$. Then when the firm bids $\overline{y}$, the union's optimal reply is zero and the firm wins the contest with certainty. This is an equilibrium because the firm has no incentive to bid less than $\overline{y}$, given

[7] See Konrad (1999) for an all-pay auction with endogenous valuations.

that the union bids zero. Thus there may be an equilibrium in pure strategies. To rule out this equilibrium and focus on mixed strategies, we assume that $\bar{y} < \bar{V}^u$.[9] Then if $\bar{y} < \bar{V}^u$, bidding $\bar{y}$ cannot be an equilibrium for the firm since the union may be able to marginally bid higher than $\bar{y}$ and win the contest with certainty. Suppose the firm can choose $\hat{y} \neq \bar{y}$, such that $\hat{y} \geq \hat{V}^u$. Then if the firm bids $\hat{y}$, the union will bid zero. But then given that union bids zero, the firm should bid $\bar{y}$ instead of $\hat{y}$. Therefore, there is no equilibrium in pure strategies.

Consider then $\bar{y} < \bar{V}^u$. We look for an equilibrium in mixed strategies. Let $\tilde{y}$ be the solution to y = V^u. That is, $\tilde{y} = \tilde{V}^u$. From the preceding analysis if the firm bids $\tilde{y}$ or any y, such that y > V^u, it will win the contest with certainty. Assume that $\tilde{y}$ gives a higher value of $\{[p(\bar{L}_N + L_I)^\sigma - \underline{w}L_I - \underline{\underline{w}}\bar{L}_N]$ - y} than any y which satisfies y > V^u. Then in the mixed strategy equilibrium, the firm will never bid more than $\tilde{y} = \tilde{V}^u$. In what follows, we claim, without proof, that the support of the firm's equilibrium mixed strategy is [0, $\tilde{V}^u$] and the union also has this equilibrium support. Note that $\tilde{V}^u = [\varphi \bar{L}_N (\tilde{y})^\alpha]$ and $\tilde{V}^f = \tilde{V}^u + (p-\underline{w})b\tilde{y}$. Then $\tilde{y} = [\varphi \bar{L}_N]^{1/(1-\alpha)} = \tilde{V}^u$.

We interpret a mixed strategy as a randomization of pure strategies. Then the highest payoff associated with these pure strategies should be the expected payoff in any mixed-strategy equilibrium. Hence following the analyses above, we conclude that in any mixed-strategy equilibrium, the firm's expected payoff is $\tilde{V}^f - \tilde{V}^u$. This is the highest payoff

[8] See Amegashie (2000).

associated with playing a pure strategy. This payoff will be obtained if the firm were to bid $\tilde{y}$ with certainty. It follows that the union's payoff in a mixed-strategy equilibrium is zero.[10]

Let $G_f(y)$ and $G_u(x)$ be the cumulative density functions (c.d.f) associated with the players' mixed strategies. Then in a mixed-strategy equilibrium, the following equations must hold:

$$G_u(y)\,\tilde{V}^f - y = \tilde{V}^f - \tilde{V}^u \tag{7}$$

and

$$G_f(x)\,\tilde{V}^u - x = 0, \tag{8}$$

Solving equations (7) and (8) gives the equilibrium c.d.f's, which we may write as

$$G_f(y) = \frac{y}{\tilde{V}^u} \quad \text{for } y \in [0,\ \tilde{V}^u]$$

and

$$G_u(x) = 1 - \frac{\tilde{V}^u}{\tilde{V}^f} + \frac{x}{\tilde{V}^f} \quad \text{for } x \in [0,\ \tilde{V}^u].$$

The equilibrium c.d.f's show that firm bids uniformly on $[0,\ \tilde{V}^u]$, while the union puts a probability mass equal to $(1 - \tilde{V}^u/\tilde{V}^f)$ on $x = 0$.

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[9] We do this for the following reason: we did some numerical simulations and were unable to obtain parameter values for which $\bar{y} \geq \bar{V}^u$ holds.

[10] From (1') and (2'), it is easy to see that the firm and union are guaranteed $[\bar{w} - \varphi(y)^{\alpha}]\,\bar{L}_N$ and $(p - \bar{w})\,\bar{L}_N$ (respectively) with or without lobbying. Hence these payoff must be added to their payoffs in any mixed-strategy equilibrium. However, since the union and the firm have no control over these payoffs, they ignore them when choosing their optimal mixed strategies. Indeed, these payoffs are not part of their valuations in the lobbying contest.

The expected bids are

$$Ey^{**} = \int_0^{\tilde{V}^u} y dG_f(y) = \frac{\tilde{V}^u}{2} \quad \text{and} \quad Ex^{**} = \int_0^{\tilde{V}^u} x dG_u(x) = \frac{(\tilde{V}^u)^2}{2\tilde{V}^f}.$$

The probability that the firm wins the contest is equal to the probability that it bids more than union's expected bid. This equals [1 – G_f(Ex**)] = [1 – Ex**/ $\tilde{V}^u$] = (1 - $\tilde{V}^u/2\tilde{V}^f$). Then the probability that the union wins is simply $\tilde{V}^u/2\tilde{V}^f$.

It is important to note that our solution to the game is not novel. We have followed the solution method in Baye, Kovenock, and de Vries (1996), Ellingsen (1991), and Hillman and Riley (1989). The only novelty is the determination of $\tilde{V}^u$ and the possibility of a pure-strategy equilibrium (see Amegashie 2000).

The expected number of permissible immigrants is

$$\hat{L}_I^e = b\hat{\theta}y^{**} \tag{9}$$

where for notational convenience the expectations sign is suppressed.

Given that $\tilde{V}^u = [\varphi \bar{L}_N]^{1/(1-\alpha)}$, it follows that y** = 0.5$[\varphi \bar{L}_N]^{1/(1-\alpha)}$. We can write $\hat{\theta}^*$ = (1 – 0.5 $\tilde{V}^u/\tilde{V}^f$) = [1 – 0.5 $\tilde{y}$ /($\tilde{y}$ + $\hat{b}$ $\tilde{y}$)] = [1 – 0.5/(1 + $\hat{b}$)]. The expected number of permissible immigrants is then

$$\hat{L}_I^e = b\hat{\theta}^* y^{**} = 0.5b[1 - \frac{0.5}{1+\hat{b}}][\varphi \bar{L}_N]^{1/(1-\alpha)} \tag{10}$$

It is then straight-forward to confirm all the propositions in section 2.1.

The difference between the permissible number of immigrants under the all-pay auction and the imperfectly discriminating contest is

$$\Delta \equiv \hat{L}_I^e - L_I^e = b[\varphi \bar{L}_N]^{1/(1-\alpha)}\left[0.5\left(\frac{0.5+\hat{b}}{1+\hat{b}}\right) - \gamma^{(3-\alpha)/(1-\alpha)}\right] \qquad (11)$$

Our simulations show that Δ could be positive or negative. In particular, we found, for example, that Δ is positive for $\alpha = 0.2$ and negative for $\alpha = 0.5$. This leads us to the following proposition:

Proposition 5: *The sensitivity of the legislature to lobbying has an ambiguous effect on the number of permissible immigrants.*

While we do not have an intuition for this proposition, it is consistent with proposition 2 in Nti (1999), part of which states that: "The fraction of player valuations expended in rent-seeking… is not monotonic in the returns to scale parameter (i.e., the sensitivity parameter)…" Parenthesis mine.

From inspection of equation 10, it is easy to see that the number of permissible immigrants is increasing in α. Noting that $\underline{\underline{w}} = \bar{w} - \beta(L_I)^{\alpha}$, we see that for a given number of immigrants, the fall in the post-immigration wage of natives is higher, the higher is α. This leads us to the following proposition.

Proposition 6: *The bigger is the negative effect of immigration on the wage of natives, the higher is the expected permissible number of immigrants*.

This result seems counter-intuitive. But as before, it arises because the bigger is the negative effect of immigration on the wage of natives, the higher is the valuation of the firm resulting in a sufficiently big increase in its lobbying effort. It is important to note that all our propositions *crucially* depend on the extent to which immigration is influenced by lobbying.

3. The immigration contest with bargaining

In section 2, we postulated that the post-immigration wage is inversely related to the number of immigrants. In this section we *derive* a similar relationship using the Nash bargaining solution. As before, we assume that the union and the firm bargain over the wage holding the employment level of native workers constant. Note that bargaining over the wage takes place *after* the outcome of the lobbying game is known. We solve the game backwards. We first solve the bargaining sub-game and then solve the lobbying sub-game.

Let $\tilde{w}$ be the wage of the native workers when there is no agreement between the firm and the union. Call this the reservation wage of natives. In the event of no agreement, the firm will only employ immigrants. Hence the Nash bargaining product may be written as

$$\Omega = (\underline{\underline{w}}\overline{L}_N - \tilde{w}\overline{L}_N)^{\phi}[p(\overline{L}_N + L_I)^{\sigma} - \underline{w}L_I - \underline{\underline{w}}\overline{L}_N - (pL_I^{\sigma} - \underline{w}L_I)]^{1-\phi}, \qquad (12)$$

where $0 < \sigma < 1$, $L_I \geq 0$, and ϕ and $(1-\phi)$ reflect the bargaining strengths of the union and the firm. We may write the maximand in (12) as

$$\Omega' = \phi\log(\underline{\underline{w}}\overline{L}_N - \tilde{w}\overline{L}_N) + (1-\phi)\log[p(\overline{L}_N + L_I)^{\sigma} - \underline{w}L_I - \underline{\underline{w}}\overline{L}_N - (pL_I^{\sigma} - \underline{w}L_I)] \qquad (12')$$

Maximizing (12') with respect to $\underline{\underline{w}}$ and setting $\phi = 0.5$ gives

$$\underline{\underline{w}}^* = \frac{p(\overline{L}_N + L_I)^{\sigma} - pL_I^{\sigma} + \tilde{w}\overline{L}_N}{2\overline{L}_N} \qquad (13)$$

Then from (13), $\overline{w}^*$, the wage of the natives when the union wins the lobbying game, is

$$\bar{w}^* = \frac{p(\bar{L}_N)^\sigma + \tilde{w}\bar{L}_N}{2\bar{L}_N} \tag{14}$$

It follows from (13) that $\partial \underline{\underline{w}}^*/\partial L_I < 0$, given that $0 < \sigma < 1$. Note that (13) shows that $\underline{\underline{w}}^*$ may not be a function of only L_I but may also be a function of p, $\bar{L}_N$, and $\tilde{w}$. This implies that it *may* not be correct to treat β and $\bar{w}$ (in $\underline{\underline{w}} = \bar{w} - \beta(L_I)^\alpha$) as constants in the comparative statics exercises involving p and $\bar{L}_N$ in section 2. It turns out, however, this new specification does not affect our results.

We solve the lobbying game assuming that the lobbyist with the higher effort wins with certainty (i.e., all-pay auction). The contestants' valuations are $V^f = [p(\bar{L}_N + L_I)^\sigma - \underline{w}L_I - \underline{\underline{w}}^*\bar{L}_N - (p\bar{L}_N^\sigma - \bar{w}^*\bar{L}_N)]$ and $V^u = (\bar{w}^*\bar{L}_N - \underline{\underline{w}}^*\bar{L}_N)$, where $V^f > V^u$ if $[p(\bar{L}_N + L_I)^\sigma - \underline{w}L_I - p\bar{L}_N^\sigma] > 0$. This condition may not hold for all y. However, in the mixed-strategy equilibrium, the firm will prefer $V^f > V^u$, since this gives a *positive* expected payoff. To see this, note that if the firm's expected effort is such that $V^f \leq V^u$, then its expected payoff is *zero*. So, at the risk of repetition, we note that since $V^f > V^u$ gives a positive expected payoff, the firm will satisfy this condition in the mixed-strategy equilibrium, *if possible*.[11] Note that this condition may not hold, if for example, $\underline{w}$, is sufficiently high. In what follows, we assume that $\underline{w}$ is sufficiently low such that in the

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[11] Konrad (1999) follows a similar but less straight-forward analysis. This is because in his model of strategic trade policy, the government can use an export tax or export subsidy to manipulate the valuation of its domestic firm engaged in a trade contest. Unlike our case, the government may not always prefer the case where its firm has the higher valuation. It may choose an export tax, which gives its firm a zero payoff in the lobbying contest but gives the government a positive payoff.

mixed-strategy equilibrium, $V^f > V^u$. In subsequent work, we shall consider the case where it is not possible to achieve this result.[12]

As in section 2.2, define $\hat{y}$ such that $\hat{y} = \hat{V}^u$. Then following the same analysis as before, the expected lobbying effort of the firm, $y^{***} = \hat{V}^u/2$. So in the sub-game perfect equilibrium, the expected number of permissible immigrants is

$$\tilde{L}_I^e = b(1 - \frac{0.5\hat{V}^u}{\hat{V}^f})y^{***} \tag{15}$$

Note that y*** will not be a function of $\underline{w}$, since $\hat{V}^u$ is not a function of $\underline{w}$. So $\partial\tilde{L}_I^e / \partial\underline{w} = 0.5\hat{V}^u b y^{***}(\partial\hat{V}^f / \partial\underline{w})/\left(\hat{V}^f\right)^2 < 0$. This confirms proposition 1.

Since the post-immigration wage of natives is decreasing in the number of immigrants, it follows that the lower is the reservation wage of natives, the lower is the expected post-immigration wage of natives (i.e., proposition 3). We have confirmed the other propositions numerically.

Note that if we substract equation (13) from equation (14), the reservation wage of natives drops out. Hence the union's valuation is independent of the reservation wage of natives. This is because the native workers are guaranteed this wage, whether or not there is immigration. Thus we get the following proposition:

Proposition 7: *The permissible number of immigrants is independent of the reservation wage of native workers.*

[12] We hasten to add that this is an easy and straight-forward extension.

4. Conclusion

The propositions in this paper offer some potentially testable hypotheses, which may be the basis for future empirical work on immigration. However, such an analysis is not without problems. As noted in Section 1, several factors apart from those in our model determine the number of immigrants. Therefore, it may not be easy to isolate these factors in empirical work.

We are inclined to believe that one of the most robust predictions of our model is the effect of a price increase on the permissible number of immigrants. It reflects the general idea that the profit motive, which is central to the market system, will induce firms to lobby for more immigrants.

Admittedly, our model is a very simple one and we recognize its limitations. One such limitation is that immigration is a dynamic issue. Our static framework may therefore ignore some very important issues. For example, immigrant workers may join the union, increasing its size over time, or, if they care about other prospective immigrants, may choose to form a coalition with the firm in order to lobby.

We could have assumed that $L_I = h(y, x) \geq 0$, where $\partial h/\partial y > 0$ and $\partial h/\partial x < 0$. Here, we have assumed that the union's effort reduces the probability that the firm will be successful but does *not* affect the number of immigrants when the firm wins. When the union wins the contest, there is no increase in the number of immigrants. In our formulation, $h(y, x) = 0$, when the union wins and equals $h(y, 0) > 0$, when the firm wins. Note, however, that $L_I = h(y, x) \geq 0$ implies that the firm's valuation not be less than the union's valuation. Hence, our conclusions may not be affected by this new specification.

In spite of the paper's shortcomings, we hope that we have offered an understanding of the nature of the equilibrium in the immigration market.

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