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CREDIBLE THREATS IN A WAGE BARGAINING MODEL WITH ON-THE-JOB SEARCH*

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Abstract

In standard equilibrium search models with strategic wage bargaining and on-the-job search, renegotiation is permitted without requirement of a credible threat. Workers trigger renegotiation whenever they have a new outside option that could raise their wages. In this note I modify the model to be consistent with renegotiation by mutual agreement and I show that estimating the model without imposing credible threats for renegotiation generates downward bias in the estimates of the bargaining power.

JEL Codes: J3, J64, C7.

KEYWORDS: Credible Threats, On-the-job search, Wage bargaining.

1 Introduction

In this note I discuss on threat points in equilibrium search models with strategic wage bargaining, on-the-job search and between firms Bertrand competition. If contracts are revised by mutual agreement, renegotiation occurs only if one party can credibly threaten to break the match. In order to limit the firm's impetus to renegotiate wages when the poaching firms are not more available, contract renegotiation by mutual agreement is a crucial ingredient to sustain wages determination by between firms Bertrand competition. I show that credible threats are not required for workers in equilibrium search models with strategic wage bargaining and on-the-job search in the current literature. Estimating the model without imposing credible threats for renegotiation may generate downward bias in the estimated worker bargaining power.

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Postel-Vinay and Robin (2002a) extend the idea by Burdett and Mortensen that labor market frictions and on-the-job search matter in wage determination. They propose an alternative wage setting mechanism that allows firms to compete for workers *à la* Bertrand in wages. Workers are allowed to search on the job, and when they receive an outside offer, they can use this offer to renegotiate wages. Outside offers are not supposed to be available forever, and so contracts which can only be renegotiated by mutual agreement are an essential component in this game. Through this kind of contracts, the firm is committing itself to pay the new bargained wage whenever the match is convenient for both parties. The contract constrains the firm to maintain the bargained wage also when the workers outside option becomes again the unemployment.

In this context, contract renegotiation is well defined in terms of mutual agreement. If the worker has a credible threat, ie: an outside option that provides him with higher utility than the current contract, he can trigger renegotiation. The firm may find it convenient to renegotiate to avoid the dissolution of match, which implies zero utility. As stated in Malcomson (1997, 1999), contracts that can only be renegotiated by mutual consent are a natural assumption, with strong empirical support. This kind of contracts is consistent with a number of legal and economic facts. Mutual agreement is indeed a prerequisite to wage renegotiation in many European countries. In the U.S. the empirical evidence reviewed in Malcomson (1997,1999) reveals that wage changes occur much less frequently than would be consistent with a strict application of the employment-at-will rule, suggesting that mutual consent, although not an explicit legal provision, may be common practice.

The wage setting mechanism proposed by Postel-Vinay and Robin (2002a) has been also used in Postel-Vinay and Robin (2002b), Postel-Vinay and Turon (2009), and other papers. However, a more interesting setup allows the worker to take some of the surplus through Nash negotiation, as proposed by Cahuc, Postel-Vinay and Robin (2006, CPVR henceforth) and Dey and Flinn (2006). This setting is appealing mainly due to two reasons: First, it is consistent with within firm wage increases, which have been shown to be empirically important (See Farber 1999). Second, it disentangles the wage negotiation from the expected duration of the match. Therefore, convexity of payoffs can be guaranteed and the Nash bargaining solution applies (see Shimer 2005). This wage setting scenario has been used in a number of recent papers; such as Flinn (2006), Lentz (2010), Yamaguchi (2010), and Flinn and Mably (2010).

In the model without surplus splitting (*ie*: with $\beta = 0$), every worker receives the value of his outside option. Therefore, any offer coming from a firm that is better than the firm currently used to set the wage, is a credible threat and generates renegotiation. When the surplus is split, the definition of a credible threat is less straightforward. If the worker has positive bargaining power, there is a gap between the value of the current job and the outside option used to set the wage. Therefore, there are some firms that are better than the firm used to set the wage, which are not good enough

to trigger renegotiation, because they do not represent credible threats.

In this note I apply a different definition of contracts¹ to the environment presented in CPVR. As in Postel-Vinay and Turon (2009), I argue that contracts stipulate a constant wage and are only renegotiable by mutual consent in continuing matches. In other words, no firm or worker can force their match partner to revise the wage against the latter's interest, unless the former has a credible threat to leave the match. The implications of this wage rule for wage dynamics were analyzed theoretically by MacLeod and Malcomson (1993): In continuing matches, if one party has a credible threat to dissolve the match, i.e. if the value of his outside option exceeds the value he gets from the existing relationship, the other party consents to wage renegotiation.

A numerical exercise shows that if the model that requires credible threats to trigger renegotiation, is the true data generating process, a structural estimation of the CPVR model would produce downward biased estimates of the worker bargaining power. This feature is particularly interesting in this context, because most of the estimates of the worker bargaining power in CPVR have been found to be surprisingly small.

To allow renegotiation only through credible threats has also implications on the effect over wages of shocks to productivity. Although this is not modeled in this note, it is a natural extension to the basic model. Postel-Vinay and Turon (2009) argues that within a standard job search model with on-the-job search, the requirement of credible threats for renegotiation acts as a quantitatively plausible "internal propagation mechanism" of i.i.d. productivity shocks into persistent wage shocks². Models with shocks to productivity where only workers (but not firms) are always able to renegotiate, are described in the literature on implicit contracts and downward wage rigidity.³ Downward rigid wages are a consequence of workers' risk aversion and firms' risk neutrality. To justify downward rigid wages is not straightforward in an environment where both players are assumed to be risk neutral.

The rest of the note is organized as follow. Section 2 presents the model. Numerical examples are presented in Section 3, and Section 4 concludes.

¹When CPVR describe the theory, they argue that their "wage contracts stipulate a fixed wage that can be renegotiated by mutual agreement only: renegotiations thus occur only if one party can credibly threaten the other to leave the match for good if the latter refuses to renegotiate" (p. 327). But below they state that renegotiation takes place if an offer from a firm better than the firm used as outside option to set the wage, arrives (p. 359). In Section 2, I show that both concepts may imply different sets of firms. In Yamaguchi (2010 p. 604), the wage setting is equivalent to the one presented in CPVR and contracts are also supposed to be renegotiated by credible threats.

²In Postel-Vinay and Turon (2009) credible threats do not imply different thresholds to start renegotiation between the incumbent and the poaching firm as in CPVR. Although the model by Postel-Vinay and Turon (2009) allows for Bertrand competition, it builds on the wage posting model presented in Postel-Vinay and Robin (2002). In the latter model the bargaining power is assumed to be zero, therefore every offer from a firm which is better than the current outside option represents a credible threat. In a recent paper, Robin (2011) the sequential auction model presented in the Postel-Vinay and Robin (2002) is extended to allow wage bargaining and productivity shocks. In the model presented in Robin (2011) credible threats are well defined because firms are assumed to be homogeneous.

³For example, papers by Azariadis (1975) and Harris and Holmstrom (1982).

2 The Model

I propose a model that builds on Cahuc, Postel-Vinay and Robin (2006), but assuming that wage contracts are only altered when one of the outside-option constraints becomes binding. The economy is assumed to be stationary and populated by infinitely lived firms and workers. Time is continuous, all agents are risk neutral and discount future income at rate $\rho > 0$.

When unemployed, workers receive a flow utility b . The original model presented in CPVR allows for worker heterogeneity related with the efficiency units each worker provides per unit of time. Worker heterogeneity is important to estimate the model but as the model is written at the match level, (ie: one worker-one firm) differences among workers have no implications over the model predictions that this note is interested on. In order to keep the model as simple as possible worker heterogeneity is not considered and workers are assumed to provide 1 efficiency unit per unit of time.

Every firm is characterized by its productivity (p). I assume that p is distributed across firms according to a given cumulative distribution function $\Gamma(p)$, which is continuously differentiable with support $[p_{\min}, p_{\max}]$. This source of heterogeneity is perfectly observable by every agent in the economy. The opportunity cost of recruiting a worker is zero. A worker working in a firm p , produces p .

Unemployed workers receive job offers at a Poisson rate $\lambda_0 > 0$. Employed workers may also search for a better job while employed and they receive job offers at a Poisson rate $\lambda_1 > 0$. Searching while unemployed as searching while employed has no cost. Employment relationships are exogenously destroyed at a constant rate $\delta > 0$, leaving the worker unemployed and the firm with nothing.

As in CPVR wages are set by Nash-Bargaining. When a worker comes from unemployment, his outside option is the unemployment. Let V_0 be the value of unemployment, and $V(p, w)$ be the lifetime expected utility of a worker employed at a firm with productivity p who receives a wage w . The surplus is the difference between the maximum value the worker can get in that job, $V(p, p)$, and the value of being unemployed, V_0 . Therefore, the bargained wage, $w_0(p)$, that a worker coming from unemployment receives in a firm with productivity p , satisfies:

$$V(p, w_0(p)) = \beta V(p, p) + (1 - \beta)V_0$$

When an employed worker receives an outside offer from a more productive firm with productivity p^+ , the worker changes firm and negotiates the new wage, $w(p^+, p)$, according to the new surplus. The surplus is defined as the difference between the maximum value that the worker can receive in the new firm, $V(p^+, p^+)$, and the maximum value that the worker could receive in the old firm, that is $V(p, p)$. $w(p^+, p)$ is implicitly defined by:

$$V(p^+, w(p^+, p)) = \beta V(p^+, p^+) + (1 - \beta)V(p, p)$$

When an employed worker, who is currently receiving a wage $w(p, p')$, contacts a firm with productivity p^- , and p^- is lower than the productivity of his current firm, p , he will not move to the new firm. but if the new firm is good enough (ie : p^- is higher than a threshold $q(p, p')$), the worker will renegotiate and set a new wage, $w(p, p^-)$, with the current firm. $w(p, p^-)$ solves:

$$V(p, w(p, p^-)) = \beta V(p, p) + (1 - \beta)V(p^-, p^-)$$

Therefore, the value of a job, in a firm with productivity p when the outside option is set according to an alternative firm with productivity p' , is:

$$\begin{aligned} & (\rho + \delta + \lambda_1 \bar{F}(q(p, p')))V(p, w(p, p')) & (1) \\ = & w(p, p') + \delta V_0 + \lambda_1 \int_{q(p, p')}^p V(p, w(p, x))dF(x) \\ & + \lambda_1 \int_p^{p \max} V(x, w(x, p))dF(x) \end{aligned}$$

The difference between the wage setting mechanism proposed in this note and the one presented in CPVR is in the definition of $q(p, p')$.

In this note, wage contracts stipulate a constant wage and are only renegotiable by mutual consent in continuing matches. In other words, no firm or worker can force their match partner to revise the wage against the latter's interest, unless the former has a credible threat to leave the match. According to this definition of wage contracts, the worker will be only able to trigger renegotiation if the maximum value than the poaching firm can offer him is higher than the value of the current job. Therefore the threshold $\tilde{q}(p, p')$, which defines *good enough* firms to start renegotiation, is implicitly defined by:

$$V(p, w(p, p')) = V(\tilde{q}(p, p'), \tilde{q}(p, p'))$$

According to wage contract in CPVR, and in the subsequent papers mentioned in the introduction, employees are allowed to renegotiate whenever they have a new outside option which provides them the opportunity to obtain a wage gain. As renegotiation takes place only if it is in the worker's interest, there will be renegotiation if the new poaching firm is better than the firm currently used to set the wage. The firm used as outside option to set the wage $w(p, p')$ is p' . Therefore their threshold which defines *good enough* firms to start renegotiation, is simply p' .

Lemma 1 *If $p' < p$ and $0 < \beta < 1$, under CPVR there are some firms which do not represent a credible threat, which may be used to trigger renegotiation (ie : $\tilde{q}(p, p') > p'$).*

Proof. The proof is straightforward. The wage that a worker receives in firm p with outside option p' is given by $V(p, w(p, p')) = (1 - \beta)V(p', p') + \beta V(p, p)$. The threshold that imposes credible threats for renegotiation is defined by $V(p, w(p, p')) = V(\tilde{q}(p, p'), \tilde{q}(p, p'))$. Therefore $V(\tilde{q}(p, p'), \tilde{q}(p, p')) = (1 - \beta)V(p', p') + \beta V(p, p)$. Given that $V(x, x)$ is strictly increasing in x ,⁴ if $0 < \beta < 1$ and $p' < p$, we have that $V(p', p') < V(\tilde{q}(p, p'), \tilde{q}(p, p')) < V(p, p) \Rightarrow p' < \tilde{q}(p, p') < p$ ■

The threshold used in CPVR says that workers will renegotiate whenever they obtain a higher wage, but it does not imply credible threats. When a worker contacts a firm with productivity p^- , and $p' < p^- < \tilde{q}(p, p')$, he will not permanently change employer, because the maximum utility he obtains in the poaching firm is smaller than the utility obtained in the current one (ie: $V(q^-, q^-) < V(\tilde{q}(p, p'), \tilde{q}(p, p')) = V(p, w(p, p'))$). Although the offer coming from p^- does not represent a credible threat, the worker could take that offer and switch to the firm with productivity p^- for an insignificant period of time, and contact again the old firm to set a new contract that takes $V(p^-, p^-)$ as the worker outside option. For the old firm it may still be profitable to keep the worker in the new situation (ie: because $p > p^-$) and therefore the new wage is negotiated considering the poaching firm as the outside option.

Although this scheme is efficient for the workers, if contracts do not explicitly ban this kind of threats, firms are going to follow the same strategy. After the outside option has disappeared,⁵ the firm would layoff the worker for an insignificant period of time and then renegotiate a new wage taking the unemployment as the outside option. This scenario implies that unemployment is always the outside option as in Bartolucci (2011) and Flinn and Mably (2011), and between firms Bertrand competition does not

⁴Note that if $p' = p$, the threshold $\tilde{q}(p, p')$ is equal to p . (ie: $V(p, p) = V(\tilde{q}(p, p'), \tilde{q}(p, p')) \Rightarrow p = \tilde{q}(p, p')$). Therefore simplifying (1):

$$\begin{aligned} & (\rho + \delta + \lambda_1 \bar{F}(p))V(p, p) \\ &= p + \delta V_0 + \lambda_1 \int_p^{p \max} [\beta V(x, x) + (1 - \beta)V(p, p)]dF(x) \end{aligned} \quad (2)$$

Rearranging (2)

$$\begin{aligned} & (\rho + \delta + \lambda_1 \beta \bar{F}(p))V(p, p) \\ &= p + \delta V_0 + \lambda_1 \int_p^{p \max} \beta V(x, x)dF(x) \end{aligned} \quad (3)$$

we can easily prove that $V(x, x)$ is strictly increasing in x applying the Leibniz integral rule in (3):

$$\frac{\partial V(x, x)}{\partial x} = \frac{1}{\rho + \delta + \lambda_1 \beta F(x)} > 0 \forall x \quad \blacksquare$$

⁵Outside offers do not last for ever, and so when jobs are exogenously destroyed, workers go to the unemployment and not to firm used as outside options when the wage was set.

hold⁶.

3 Numerical Exercise

This section presents a simple numerical exercise that illustrates the quantitative implications of omitting the requirement of credible threats for renegotiation in equilibrium search models with strategic wage bargaining and on-the-job search, in the estimation of the bargaining power.

In this particular model the estimation of the parameters that describe workers and firms productivity and frictions patterns, is not supposed to be affected by the choice of the threshold for renegotiation.⁷ This is because both models, with and without credible threats, generate the same set of constraints on the estimation of all the parameters excluding the bargaining power.⁸

The effect of the requirement of credible threats for renegotiation in the estimation of the bargaining power is particularly interesting also because the estimates of this coefficient produced by models without credible threats has been shown to be surprisingly low. Moreover, some of the estimates of β presented in CPVR are found to be significantly negative.

Both models are calibrated to match the empirical results presented in CPVR. The numerical exercise is simple, the bargaining power in CPVR model is calibrated to match the mean of log wages generated by the model that imposes credible threats. This exercise is replicated for a grid of β ranging between 0.05 and 0.5. The bargaining power recovered from the CPVR's, is finally compared with the true bargaining power used in the data generating process.

Both models are solved by value function iteration and wages are aggregated according to the steady state distribution of firms. The steady state distribution of firms is a function of the transition parameters, λ_1 , δ and the primitive distribution of firms $\Gamma(p)$, that is assumed to be log-normal.⁹

Figure 1 shows that the estimates of the worker bargaining power are biased. The *true* bargaining power is between 2 and 6 points higher than the bargaining power recovered if we use the model that does not impose credible threats to trigger renegotiation. This difference is higher when the bargaining power is between 0.2 and 0.4.

⁶Formally, between firms Bertrand competition may still hold, but only in the moment of the outside offer. As the model is considered in continuous time, it has no effect over wages.

⁷Cahuc, Postel-Vinay and Robin (2006) or Bartolucci (2010) propose to estimate the parameters related with the worker and the firm productivity, only using firm level data on output and productive inputs, but not wages. In these papers, parameters that describe frictions are also estimated without data on wages, only using duration data at the worker level.

⁸Same of these constraints are: no assortative matching between the worker type and the firm type, constant return to scale in the production function, efficient transitions between firms, among others. See Cahuc, Postel-Vinay and Robin (2006) for details

⁹MATA codes to solve both models are available from the author upon request.

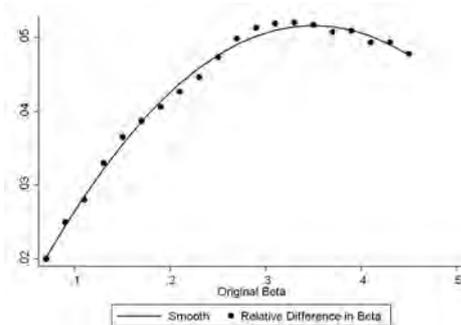


Figure 1: Potential Bias in the Estimated Bargaining Power

The later interval includes most of the current estimates in the literature.¹⁰

4 Conclusion

In this note I discuss on threat points in equilibrium search models with strategic wage bargaining, on-the-job search and between firms Bertrand competition. If contracts are assumed to be revised by mutual agreement, renegotiation occurs only if one party can credibly threat the other to break the match. This kind of contracts constrains the firm to maintain the bargained wage also when the workers outside option becomes again the unemployment. Therefore, contract renegotiation by mutual agreement is a crucial ingredient to sustain wages determination by between firms Bertrand competition.

In standard equilibrium search models with strategic wage bargaining and on-the-job search, employees are allowed to renegotiate whenever they have a new outside option that generates a wage increase. I show that within the groups of potential firms that may generate a wage gain, there is a non empty set of firms that do not represent a credible threat, in the sense that the maximum value that they can offer to the worker is strictly lower than the value of the current job.

I propose a modification to the environment presented in CPVR in the definition of contracts. I assume that contracts stipulate a constant wage and are only renegotiable by mutual consent in continuing matches. I finally show that estimating the model without imposing credible threats for renegotiation may generate downward bias in the estimated worker bargaining power.

References

- [1] Azariadis, C. (1975), “Implicit Contracts and Underemployment Equilibria ”The Journal of Political Economy 83(6), pp 1183-1202.
- [2] Bartolucci, C (2011), “Gender Wage Gaps Reconsidered: A Structural Approach using Matched Employer-Employee Data”, Carlo Alberto Notebook no.116.

¹⁰See Cahuc, Postel-Vinay and Robin (2006) or Flinn and Mablí (2011).

- [3] Cahuc, P., F. Postel-Vinay and J.-M. Robin, (2006), “Wage Bargaining with On-the-job Search: Theory and Evidence”, *Econometrica*, 74(2), 323-64.
- [4] Dey, M. and C. Flinn (2005), “An equilibrium model of health insurance provision and wage determination.”, *Econometrica* 73(2), pp. 571–62.
- [5] Farber, H., (1999), “Mobility and stability”, in O. Ashenfelter and D. Card (eds.) *Handbook of Labor Economics*, Vol. 3B, Amsterdam: Elsevier
- [6] Flinn, C. (2006), “Minimum Wage Effects on Labor Market Outcomes under Search, Bargaining, and Endogenous Contact Rates.” *Econometrica* 74 (4), 1013-1062.
- [7] Flinn, C and J. Mabili (2011), ”On-the-Job Search, Minimum Wages, and Labor Market Outcomes in an Equilibrium Bargaining Framework”, NYU mimeo.
- [8] Harris, M. and B. Holmstrom (1982), “A Theory of Wage Dynamics”, *The Review of Economic Studies*, 49(3), pp 315-333.
- [9] Lentz, R. (2011) “Sorting by Search Intensity”, forthcoming *Journal of Economic Theory*.
- [10] Malcomson, J. (1997), “Contracts, Hold-Up, and Labor Markets”, *Journal of Economic Literature* XXXV, 1916-57
- [11] Malcomson, J. (1999), “Individual Employment Contracts ”, in O. Ashenfelter and D. Card (ed.), *Handbook of Labor Economics*, chapter 35, vol. 3B, 2291-372, Elsevier Science
- [12] Postel-Vinay, F. and J.-M. Robin, (2002a), “Wage Dispersion with Worker and Employer Heterogeneity”, *Econometrica*, 70(6), 2295-350.
- [13] Postel-Vinay, F. and J.-M. Robin, (2002b), “The Distribution of Earnings in an Equilibrium Search Model with State-Dependent Offers and Counter-Offer”, *International Economic Review* 43(4), 989-1016.
- [14] Postel-Vinay, F. and H. Turon (2010), “On-the-job search, productivity shocks and the individual earnings process”, *International Economic Review*, 51(3) pp. 599–62.
- [15] Robin, J.M. (2011) “On the Dynamics of Unemployment and Wage Distributions”, forthcoming *Econometrica*.
- [16] Shimer, R. (2006), “On-the-Job Search and Strategic Bargaining”, *European Economic Review* 50, 811.830

- [17] Yamaguchi, S. (2010), “Job Search, Bargaining, and Wage Dynamics”, *Journal of Labor Economics*, 28(3), pp 595-631.