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# Wage stickiness, offshoring and unemployment

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**Abstract**

This note investigates how the effect of offshoring on unemployment is influenced by the wage setting process. We assume staggered wage contracts in an otherwise standard search and matching model. In this setup, the contract wage depends also on expected future conditions. We show that more flexibility in the wage contracting process induces greater offshoring, a decrease in the worker's job-finding probability and higher worker's wage within job spells. Notably, less stickiness leads to a fall in the rents that firms can extract by producing domestically.

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# 1 Introduction

The impact of offshoring on domestic labor market outcomes is periodically at the forefront of political discussion and is intensely debated among academics. One aspect that has been widely overlooked, though, is how the wage contracting process shapes the effect of offshoring on wages and unemployment. Typically, models of offshoring (trade) with search frictions rely on period-by-period Nash bargaining between firms and workers (e.g. Davidson et al. 1999, Helpman and Itskhoki 2010, Mitra and Ranjan 2010). However, patterns of wage setting suggest that a significant share of establishments has a staggered contract-like behavior (Le Bihan et al. 2012), and firm-level survey data indicate that the degree of wage stickiness varies across countries (Druant et al. 2012). In view of this evidence, we depart from the conventional assumption of period-by-period Nash bargaining and build a two-country (West-East) general equilibrium model where unemployment arises in the West due to search costs, and allow for a staggered multi-period wage contracting structure in the spirit of Gertler and Trigari 2009. That is, only a fraction of firms and workers re-set wages in any given period, and employment terms are negotiated only periodically. This setup allows us to focus on the impact of wage stickiness on the hiring rate and the contract wage, and the role that these play in shaping the effect of offshoring on the worker's job-finding probability.

We show that less stickiness in wage setting (more frequent renegotiations) reduces firms share of the surplus a job generates[1] in the West, inducing more offshoring to the detriment of domestic employment. One main implication is that more flexibility in the wage setting process exacerbates the effect of offshoring on domestic unemployment. Another intriguing implication is that stickiness in the contract wage confers an advantage to firms, as it allows to extract more rents by producing domestically. Overall, our results have implications for the design and calibration of offshoring (trade) models with search-and-matching frictions. The wage contracting process differs across countries implying different labor market responses to offshoring (trade) shocks. An interesting avenue for future research would be to include a business cycle component into the model.

# 2 The Model

There are two countries East ($o$) and West ($d$), with $L$ identical households equally split across the two locations, $L = L_d + L_o$, and labor is immobile. In the East there is perfect competition in the labor market and full employment, while in the West there is unemployment due to search frictions. In the interest of conciseness, we concentrate on the characterization of firms and on the wage and hiring decisions.[2]

A final good $Y$ is manufactured by using a continuum of intermediate inputs $x_{ij}$, where $j \in \{h, o\}$ denotes whether $x_i$ is produced domestically, $h$, or offshored, $o$. The production

[1] This result is consistent with Gottfries 2017, which shows that in a model of on-the-job search, calibrated using US data, less frequent renegotiations are associated with lower workers bargaining power.

[2] Typically, this literature adopts a representative family setup, to ensure perfect consumption insurance. See Rogerson and Shimer 2011.

function is

$$Y = E\left(\int_0^{A_h} x_{id}^{\alpha}\mathrm{di} + \int_{A_h}^{A} x_{io}^{\alpha}\mathrm{di}\right)^{1/\alpha} \tag{1}$$

where $A_j$ is a measure of intermediates used from location $j$ and $\sigma \equiv \frac{1}{1-\alpha}$ is the elasticity of substitution between intermediates. Also, $E \equiv A^{\frac{2\alpha-1}{\alpha}}$ defines the state of technology in the final good sector. The latter is perfectly competitive. Profit maximization yields the (inverse) demand curve for intermediates

$$p_{ij} = PE^{\alpha}Y^{1-\alpha}x_{ij}^{\alpha-1} \tag{2}$$

where $P$ is the final good price index, which is the numeraire $1 = \left[\int_0^{A_h} p_{id}^{\frac{\alpha}{1-\alpha}} + \int_0^{A_h} p_{io}^{\frac{\alpha}{1-\alpha}}\right]^{\frac{\alpha-1}{\alpha}}$. Each intermediate manufacturer produces one variety $i$, using a constant returns to scale technology regardless of the location of production

$$x_{ij} = l_{ij} \tag{3}$$

where $l_{ij}$ is the number of workers employed by firm $i$ in location $j$.

While the labor market in the East is frictionless, in the West is imperfect due to wage rigidity/stickiness (as explained later). Therefore the wage in the East, $w_{io}$, equals marginal costs. In the West, firms hire workers at a rate $h_{id}$ and incur a quadratic cost. The marginal costs of a firm operating in the West is

$$\tilde{c}_{ij} = \begin{cases} w_{io} & \text{if } j = o \\ w_{id} + \frac{\gamma}{2}h_{id}^2 & \text{if } j = d \end{cases} \tag{4}$$

The firm intra-temporal profits maximization problem reads as, $\pi_{ij} = p_{ij}x_{ij} - \tilde{c}_{ij}l_{ij}$. From the f.o.c follows that firms charge at a mark-up over marginal costs ($\tilde{c}_{ij}$)

$$p_{ij} = \frac{\tilde{c}_{ij}}{\alpha} \tag{5}$$

Using (5), the profit function is

$$\pi_{ij} = (1-\alpha)p_{ij}x_{ij} = (1-\alpha)E^{\alpha}Y^{1-\alpha}x_{ij}^{\alpha} \tag{6}$$

Firms are subject to a fixed costs of entry $\mu$ and a fixed costs of offshoring $\zeta$ . Let $V_j$ be

the value of a firm located in country $j$. Assuming free entry in the domestic market and in the offshoring market implies, respectively

$$V_d \geq \mu \quad \text{and} \quad V_o - V_d \geq \zeta \tag{7}$$

The instantaneous return from owning the firm is $rV_j = \pi_j + \dot{V}_j$. Accordingly, in equilibrium

$$rV_d = \pi_d \quad \text{and} \quad rV_o = \pi_o \tag{8}$$

The above, together with (7), determines the return to entry into the domestic location and into the offshoring location, respectively

$$r = \frac{\pi_d}{\mu} \quad \text{and} \quad r = \frac{\pi_o - \pi_d}{\zeta} \tag{9}$$

Since the interest rate has to be equal for both entry conditions, it follows that

$$\frac{\pi_o}{\pi_d} = \frac{\zeta + \mu}{\mu} \tag{10}$$

Using (6) and (3) in (10), yields

$$\left(\frac{l_o}{l_d}\right)^{\alpha} = \frac{\zeta + \mu}{\mu} \tag{11}$$

In equilibrium the labor demand in the West must be equal to the number of employed workers in the West, i.e.

$$(1-u)L_d = \int_0^{A_d} l_{id} di = (1-k)Al_d \tag{12}$$

where $k$ represents the share of offshore production in total production, i.e. $k \equiv \frac{A_o}{A_o + A_d}$. Using (12) in (11), and $L_o = \int_0^{Ao} l_{io} di = kAl_o$, we obtain an expression relating equilibrium unemployment to the degree of offshoring

$$\left[\frac{L_o \frac{1-k}{k}}{(1-u)L_d}\right]^{\alpha} = \frac{\zeta + \mu}{\mu} \tag{13}$$

For future reference we derive the marginal product of labor

$$f_{lj} = \alpha E^{\alpha} Y^{1-\alpha} l_j^{\alpha-1} = \alpha E A^{\frac{1-\alpha}{\alpha}} \left[(1-k)x_d^{\alpha} + kx_o^{\alpha}\right]^{\frac{1-\alpha}{\alpha}} l_j^{\alpha-1} \tag{14}$$

Using (2) and (11), we can rewrite (14) as

$$f_{ld} = \alpha E A^{\frac{1-\alpha}{\alpha}} \left[1 + k\frac{\zeta}{\mu}\right]^{\frac{1-\alpha}{\alpha}} \tag{15}$$

which increases in the extent of offshoring.

**The Firm's Hiring Decision**

In the West, wage rigidities come from search costs a la Mortensen and Pissarides, however, we modify their approach to allow for multi period wage contracting. We follow Gertler and Trigari 2009 and assume that only a subset of firms and workers negotiate a per-period wage contract. Specifically, each period a firm and its workers face a fixed exogenous probability $1-\lambda$ that it may re-negotiate its wage, where the parameter $\lambda$ is a proxy of wage stickiness. Furthermore, each wage contract is negotiated between a firm and its existing workforce. By implication, workers hired in-between wage settlements receive the existing wage.

To ease notation, when unambiguous, we drop the subscript $d$, and define the hiring rate as

$$h_{i,t} = \frac{q_t v_t}{l_t} \tag{16}$$

where $q_t$ is the firm's probability to fill a vacancy and $v_t$ is the number of vacancies a firm posts. The workers employed in period $t$ by firm $i$ is

$$l_{i,t} = \rho l_{i,t-1} + q_{t-1} v_{t-1} \tag{17}$$

where $\rho$ is the exogenous job separation rate. Hence, from (17) and (16), the firm's employment equation equals

$$l_{i,t+1} = \rho l_{i,t} + h_{i,t} l_{i,t} \tag{18}$$

The value of a firm reads as

$$V_{it} = x_{it} p_{it} - w_{it} l_{it} - \frac{\gamma}{2} h_{it}^2 l_{it} + \beta E_t \Lambda_{t,t+1} V_{t+1} \tag{19}$$

where $\beta$ is the subjective discount factor, $\Lambda$ is the marginal rate of substitution and $\beta E_t \Lambda_{t,t+1}$ is interpreted as the firm's discount rate. Therefore, the term $\beta E_t \Lambda_{t,t+1} V_{t+1}$ is the expected discounted future value of the firm. The marginal benefit for the firm of adding an additional worker is

$$J_{it} = f_{lt} - w_{it} - \frac{\gamma}{2} h_{it}^2 + \beta(\rho + h_t) E_t \Lambda_{t,t+1} J_{it+1} \tag{20}$$

where $J_{it} \equiv \frac{\partial V_{it}}{\partial l_{it}}$. Then, the f.o.c for the hiring rate $\frac{\partial \frac{\partial V_{it}}{\partial l_{it}}}{\partial h_{it}} = 0$, implies $-\gamma h_{it} + \beta E_t \Lambda_{t,t+1} \frac{\partial V_{it+1}}{\partial l_{it+1}} = 0$, which using (17) in (16) yields the following forward looking difference equation for the hiring rate in the West

$$\gamma h_{idt} = \beta E_{dt} \Lambda_{t,t+1} \left[ f_{ldt+1} - w_{idt+1} + \frac{\gamma}{2} h_{idt+1}^2 + \rho \gamma h_{idt+1} \right] \tag{21}$$

The above depends on the discounted stream of future surplus from the marginal worker, that is the sum of net earning from a new hire plus savings on adjustment costs plus the future new hire times the survival rate.

**Wage Bargaining**

The bargaining problem is to choose the contract wage that maximizes the Nash product

$$H_{i,t}^{\eta} J_{i,t}^{1-\eta} \tag{22}$$

$$\text{s.t.} \quad w_{d,t+1} = \begin{matrix} w_{d,t} & \text{with probability } \lambda \\ w_{d,t+1}^{*} & \text{with probability } 1-\lambda \end{matrix}$$

where $w^*_{d,t+1}$ is the wage in the subsequent period if the firm is able to renegotiate. The term $J_{it}$ is the discounted expected marginal benefit of hiring a worker ( 20). The term $H_{it} = w_{it} - b + \beta E_t \Lambda_{t,t+1} \left[\rho H_{i,t+1} - s_t H_{x,t+1}\right]$ represents the worker's surplus at a firm $i$, where $b$ is the unemployment benefit, $s_t$ is the probability for an unemployed to find a job, and $H_{x,t+1}$. is the workers surplus conditional on being a new hire. The parameter $\eta$ denotes the bargaining power of the workers. The solution to the problem is

$$w^*_{d,t} = \chi \left[ f_{ld} + \frac{\gamma}{2} h^2_{id} \right] + (1 - \chi) \left[ b + s_t \beta E_t \Lambda_{t,t+1} H_{x,t+1} \right] \tag{23}$$

The contract wage is a convex combination of what a worker contributes to a match and what she looses by accepting a job, where the weight depends on the worker's *relative horizon-adjusted bargaining power*, $\chi \equiv \frac{\eta}{\eta + (1-\eta)\theta/\epsilon}$. The workers contribution is the marginal product of labor plus the savings on adjustment costs. The workers loss from accepting is the unemployment benefit plus the expected discounted gain of moving from unemployment this period to employment next period. Finally, the weight $\chi$ depends not only on the workers bargaining power $\eta$ but also on the differential firm/worker horizon, reflected in $\theta/\epsilon$. The term $\epsilon_t \equiv \frac{\partial H_t}{\partial w_t} = 1 + \lambda \beta \rho E_t \Lambda_{t,t+1} \epsilon_{t+1}$ is the worker's cumulative discount factor, and the term $\theta_t \equiv -\frac{\partial J_t}{\partial w_t} = 1 + \lambda \beta (\rho + h_t) E_t \Lambda_{t,t+1} \theta_{t+1}$ is the firm's cumulative discount factor. Since $h_t > 0$, it follows that $\theta_t > \epsilon_t$ and increases in $\lambda$ proportionally more. The key feature of (23) is that the contract wage depends also on the expected future conditions. And since firms care about the implication of the contract wage for future hires while workers do not, stickiness tilts the effective bargaining power towards the firm. As a result, firms share of the surplus a job generates increases with stickiness.

# 3 Equilibrium

We focus our analysis on the steady state. The key labor market relationships are the hiring condition and the wage bargain equation, which in steady state read as, respectively

$$\gamma h = \beta \left[ f_{ld} - w_d + \frac{\gamma}{2} h^2 + \rho \gamma h \right] \tag{24}$$

$$w_d = \chi \left[ f_{ld} + \frac{\gamma}{2} h^2 + s \gamma h \right] + (1 - \chi) b \tag{25}$$

In the vicinity of the steady state, the hiring rate (24) decreases in the wage, while equation (25) implies that the wage is increasing in the hiring rate.[3] Also, in steady state, new hires by firms equal the number of unemployed workers who find jobs

$$h(1 - u) = su \tag{26}$$

and the hiring rate is equal to the job separation rate

$$h = 1 - \rho \tag{27}$$

[3]Note that $w$ is in addition increasing in the probability of finding a job $s$.

Equations (24), (25) and (27) together determine $w_d$, $k$ and $s$. Given $w_d$ and $k$ the equilibrium value of $r$ is determined by (8). Given $s$ and $k$, the equilibrium unemployment rate and vacancies are pinned down, respectively, by (13) and the matching function $su = \sigma_m u^\sigma v^{1-\sigma}$. By use of (13) into the matching function we obtain an expression relating $s$ to $k$

$$s = \sigma_m h^{1-\sigma} \left[ \frac{\frac{1-k}{k}\frac{L_o}{L_d}\left(\frac{\mu}{\zeta+\mu}\right)^{1/\alpha}}{1-\frac{1-k}{k}\frac{L_o}{L_d}\left(\frac{\mu}{\zeta+\mu}\right)^{1/\alpha}} \right]^{1-\sigma} L_d^{1-\sigma} q^{\sigma-1} \tag{28}$$

The probability for an unemployed worker to find a job is decreasing in the degree of offshoring, while the unemployment rate $u = 1 - \frac{1-k}{k}\frac{L_o}{L_d}\left(\frac{\mu}{\zeta+\mu}\right)^{1/\alpha}$ is increasing in $k$.

# 4 Wage Stickiness and Offshoring

Equating (24) and (25), and differentiating with respect to $k$ and $l$ we obtain

$$\frac{dk}{d\lambda} = \frac{\left[f_{ld} + \frac{\gamma}{2}h^2 + s\gamma h - b\right]\frac{\partial\chi}{\partial\lambda}}{(1-\chi)\frac{\partial f_{ld}}{\partial k} - \chi\gamma h\frac{\partial s}{\partial k}} < 0 \tag{29}$$

implying that lower wage stickiness ($\lambda$) increases the degree of offshoring. Totally differentiating the wage equation (25) we obtain

$$\frac{dw_d}{d\lambda} = \left[f_{ld} + \frac{\gamma}{2}h^2 + s\gamma h - b\right]\frac{\partial\chi}{\partial\lambda} + \chi\left[\frac{\partial f_{ld}}{\partial k} + \frac{\partial s}{\partial k}\gamma h\right]\frac{dk}{d\lambda} \tag{30}$$

The first term on the r.h.s of (30) captures the effect of stickiness through the workers adjusted bargaining power ($\frac{\partial\chi}{\partial\lambda} < 0$) while the second term relates to the effect of stickiness through offshoring. The sign of the term in squared brackets pre-multiplying $\frac{dk}{d\lambda}$ depends on two opposing forces: the effect of offshoring on marginal product ($\frac{\partial f_{ld}}{\partial k} > 0$) and on the probability of finding a job ($\frac{\partial s}{\partial k} < 0$), respectively. By substituting (29) into (30), and simplifying, it can be easily checked that $\frac{dw_d}{d\lambda} = \frac{\partial\chi}{\partial\lambda}\left\{\frac{\left[f_{ld}+\frac{\gamma}{2}h^2+s\gamma h-b\right]\left(\frac{\partial f_{ld}}{\partial k}\right)}{(1-\chi)\frac{\partial f_{ld}}{\partial k}-\chi\gamma h\frac{\partial s}{\partial k}}\right\} < 0$. Finally, the effect on unemployment is measured by differentiating (13), i.e.

$$\frac{du}{d\lambda} = \frac{1}{k^2}\frac{L_o}{L_d}\left(\frac{\mu}{\zeta+\mu}\right)^{\alpha}\frac{dk}{d\lambda} < 0$$

Altogether our results suggest that less stickiness in the wage contracting process brings about greater offshoring to the detriment of local employment, while inducing increases in domestic wages. Intuitively, more frequent wage contracting leads to a reduction in the rents that firms can extract by producing domestically making offshoring more attractive, and eventually inducing higher domestic unemployment. It is worth noticing that these effects are amplified the closer we move to the case of period-by-period wage bargaining (

$\lambda = 0$). And that other changes in labor market institutions, for instance measures that reduce firms search costs or unemployment benefits, may help to counteract the negative effect of offshoring. Interestingly, stickiness in the contract wage confers an advantage to firms, as it allows to extract more rents by producing domestically.

# 5 Conclusions

In this note we have presented a tractable theoretical model to study the interaction between domestic wage agreements and employment when firms have the option to offshore production. We have shown that more flexibility in the wage contracting process induces greater offshoring, a decrease in the worker's job-finding probability and higher worker's wage within job spells. One intriguing result is that less stickiness in the wage contracting leads to a reduction in the rents that firms can extract by producing domestically. In this exercise, we have considered only one type of worker. Our conjecture is that with two types of workers the main mechanisms will carry over, reinforcing the effect of offshoring on the skill premium and on the sectorial composition of employment.

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