

Macroeconomic effects of product market competition in a dynamic efficiency wage model

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This version: July 2001

Abstract

This paper proposes a model of monopolistic competition where wages are set according to a dynamic efficiency wage mechanism. We show that increased product market competition boosts labour turnover, widens wage differentials across sectors, and amplifies employment adjustments following adverse shocks.

JEL: E24, J41, J63, L13

Keywords: labour turnover, efficiency wage, imperfect competition.

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1 Introduction

Understanding the joint macroeconomic effects of deregulation on product and labour markets has become a crucial issue in recent economic debates.¹ This paper contributes to the debate by studying the effects of monopolistic competition in a dynamic efficiency wage framework. As shown by Saint-Paul [1995] and Fella [2000], in the absence of binding contracts, perfectly competitive firms that set wages according to a dynamic efficiency wage mechanism generate a suboptimally high level of labour turnover. We show that even when binding contracts are available, the intensity of product market competition through rising labour turnover may negatively affect welfare.²

2 The model

We consider an economy with a single final good and a continuum of intermediate goods indexed over $[0; 1]$. The final good is produced competitively, but there is monopolistic competition on the intermediate goods market. Such a specification leads to a derived demand addressed to firm j equal to $Y_j = \frac{P_j}{P} \int_0^1 \dots$ where P_j is the price of intermediate j and P is the final good's price.³ Each firm j has an identical linear production function which uses labour as its sole input : $Y_{jt} = \theta_{jt} L_{jt}$ where L_j measures effective labour. Firms are subject to productivity shocks which are specified as in Bertola [1990]. The shock's realisations are denoted θ_{jt} for firm j at

¹Nickell [1999]. Blanchard-Giavazzi [2000], Spector [2000].
²The results that follow hold a fortiori in a context where binding contracts are not available (see Amable-Gatti [2001]).
³This can easily be derived under the assumption that the final good is produced according to a constant returns to scale technology using all the intermediate goods, such as $Y = \int_0^1 Y_t(s)^{\frac{\sigma-1}{\sigma}} ds^{\frac{\sigma}{\sigma-1}}$; $\sigma > 1$ is the absolute value of the elasticity of substitution between intermediates. One further has: $P = \int_0^1 P_j^{\frac{\sigma-1}{\sigma}} dj^{\frac{\sigma}{\sigma-1}}$;

time t and are independent across firms. More specifically, the θ 's follow a two-state Markov chain with symmetric transition probability p :

$$\theta_{jt+1} = \begin{cases} \theta_G & \text{with probability } p \text{ if } \theta_{jt} = \theta_B \text{ and with probability } 1-p \text{ if } \theta_{jt} = \theta_G \\ \theta_B & \text{with probability } 1-p \text{ if } \theta_{jt} = \theta_B \text{ and with probability } p \text{ if } \theta_{jt} = \theta_G \end{cases}$$

and $\theta_G > \theta_B > 0$. We further assume some degree of persistence in the shocks' realisation: $p < \frac{1}{2}$. There are thus two states for the technology: the long-run probability for a given firm to be in either a good or a bad state is 0.5. In the following, we will assume that at each time t , 50% of the firms are in the good state while 50% are in a bad state.⁴ Therefore, there will be no aggregate fluctuations in either output or employment.

2.1 Wage setting

The economy is populated by a fixed number N of agents who supply labour inelastically. Instantaneous utility of individual workers depends on the real wage w_t^i and effort e_t : $u_t = w_t^i - e_t$ with $i = G, B$; e_t can take two values: 0, when the worker is 'shirking' or alternatively e . The contribution of a shirker to effective labour is nil, whereas an individual working at the expected effort level contributes one unit to effective labour. Each firm has a monitoring device that detects a shirking worker with probability x_t . A worker who is caught shirking immediately loses his job.⁵ We enrich this basic setup of efficiency wage models by considering an additional source of job loss, as in Fella [2000]: firms are subject to productivity shocks that force them to adjust their labour forces. If L_G (L_B) is the employment of a representative firm in a good (bad) state and we denote q_t the probability of losing one's job following

⁴We assume that the number of firms is large enough. This also means that firms will not consider the impact on the aggregate price index when maximising profits.

⁵This simple specification will allow us to consider an efficiency wage model in the spirit of Solow [1979], Shapiro and Stiglitz [1984] or Saint-Paul [1996].

an adverse shock, then:

$$q_t = \frac{L_{Gt} + L_{Bt}}{L_{Gt}} = \frac{\mu}{1} + \frac{1}{l_t} \quad (1)$$

with $l = \frac{L_{Gt}}{L_{Bt}}$:

We assume that workers have an infinite horizon and discount future utility at the rate r . The discounted utility of a worker who shirks at time t in a type-G firm is V_{St}^G , and is V_{NSt}^G when he does not shirk. The utility levels associated with working in a type-B firms are likewise V_{St}^B (shirking) and V_{NSt}^B (not shirking). The utility of being unemployed is U_t . We then have:

$$\begin{aligned} r \psi U_t &= a \psi V_t^G + U_t \\ r \psi V_{St}^G &= w_t^G + (x + p \psi q) \psi U_t + V_{St}^G + p \psi (1 - q) \psi V_t^B + V_{St}^G \\ r \psi V_{NSt}^G &= w_t^G + e + p \psi q \psi U_t + V_{NSt}^G + p \psi (1 - q) \psi V_t^B + V_{NSt}^G \\ r \psi V_{St}^B &= w_t^B + x \psi U_t + V_{St}^B + p \psi V_t^G + V_{St}^B \\ r \psi V_{NSt}^B &= w_t^B + e + p \psi V_t^G + V_{NSt}^B \end{aligned}$$

The real wage level in each firm must be set at a level such that workers have an incentive not to shirk. These no-shirking conditions are $V_{NSt}^j = V_{St}^j$, $j = G, B$. The conditions $V_{NSt}^j = V_{St}^j = V_t^j$, $j = G, B$ yield two limit wage levels $w_{it}^G = w_{it}^B$; $w_{it}^B = w_{it}^G$. Since we are dealing with constant values for all variables at the steady-state equilibrium, we may dispense with the time subscripts from now on. Both $w_i^G = w_i^B$ and $w_t^B = w_t^G$ are affine functions. Denoting V_t^B and V_t^G the equilibrium levels associated with working in a B firm and in a G firm respectively, we obtain⁶ $V^G = V^B$, which ensures that workers are indifferent as regards working in a type-G or a type-B firm. Solving $w_e^G(w_B) = w_i^G = w^B$ and plugging into $w_t^B = w_t^G$ yields the equilibrium values for

⁶In fact, it can be shown that $V_S^G = V_{NS}^G + x \psi U_t + V^G = e + V_S^B = V_{NS}^B + x \psi U_t + V^B = e + V^B$; this implies that the arbitrage condition always holds at the equilibrium.

w^B and w^G :

$$w^G = e^{-\frac{a + p + r + x}{x}} \quad (2)$$

$$w^B = e^{-\frac{a + r + x}{x}} \quad (3)$$

2.2 Labour demand under binding contracts

We assume that firms may propose binding contracts to workers, but only prior to knowing the initial state of nature.⁷ Firms maximise ex-ante expected profits $\frac{w^G + w^B}{2}$:

The first-order conditions are given by $\frac{\partial \pi^j}{\partial w^i} + \frac{\partial \pi^j}{\partial w^j} = 0$, $j = G; B$, $i = B; G$. We have:

$\frac{\partial \pi^j}{\partial w^j} = \frac{P_j}{P} \left(1 + \frac{\partial P_j}{\partial Y_j} \right) \frac{Y_j}{P_j} - i \frac{1}{w_j} \left(w^j + \frac{\partial w^j}{\partial L_j} \right) L_j$ and $\frac{\partial \pi^j}{\partial w^i} = i \frac{1}{w_i} \left(\frac{\partial w^i}{\partial L_j} \right) L_i$. $\frac{\partial w^j}{\partial L_j}$ and $\frac{\partial w^i}{\partial L_j}$ capture the impact of firms' labour demand on the separation rate and thus on real wage schedules; this effect only concerns the efficiency wage schedule for type-G

firms as $\frac{\partial w^B}{\partial q} = 0$. Because firms have market power within their sector, the price of an intermediate good depends on whether the firm producing it is type-G or type-B: we denote it respectively P_G and P_B . Normalising by $P = 1$, the first-order conditions are now:

$$\frac{\partial \pi^G}{\partial P_G} \left(1 + \frac{\partial P_G}{\partial Y_G} \right) \frac{Y_G}{P_G} = w^G + (1 - q) e^{-\frac{p}{x}} \quad (4)$$

$$\frac{\partial \pi^B}{\partial P_B} \left(1 + \frac{\partial P_B}{\partial Y_B} \right) \frac{Y_B}{P_B} = w^B - i e^{-\frac{p}{x}} \quad (5)$$

It immediately follows that $w^G + (1 - q) e^{-\frac{p}{x}} = e^{-\frac{a + p + r + x}{x}}$ and $w^B - i e^{-\frac{p}{x}} = e^{-\frac{a + r + x}{x}}$: The price setting equations relate the price of intermediate goods to the real wage level in each sector of the economy. From the aggregate price index and aggregate production we can derive the expression for intermediate goods' prices.

⁷The 'veil of ignorance' hypothesis.

We denote Y_B and Y_G as total output of firms in a bad state and in a good state, respectively. As within the economy at any given time, half of the firms will be in a bad state and half in a good state, we obtain that $Y_t = \frac{1}{2} Y_B + \frac{1}{2} Y_G$. Since $Y_j = P_j^{1-\sigma} Y$, defining $\theta = \frac{P_G}{P_B}$ we have:

$$P_B = \frac{1}{2} \frac{1 + (\theta \zeta)^{\frac{1}{1-\sigma}}}{2} A \quad (6)$$

and:

$$P_G = \frac{1}{2} \frac{1 + (\theta \zeta)^{\frac{1}{1-\sigma}}}{2} A \quad (7)$$

Moreover, an expression for the relative price of intermediates $\frac{P_B}{P_G}$ can also be derived from the demand curves. We easily obtain:

$$\frac{P_B}{P_G} = \frac{Y_G}{Y_B} = (\theta \zeta)^{\frac{1}{1-\sigma}} \quad (8)$$

2.3 Macroeconomic equilibrium

At time t , half the firms experience a favourable shock while the other half experience a bad shock: a fraction p of the type-G firms switch positions with a fraction p of the type-B firms. The formerly type-G turned type-B firms have to shed labour and adjust their labour force to its contract value, while formerly type-B now type-G firms need to make the opposite adjustment. Laid-off workers join the ranks of the unemployed while some unemployed workers find new employment with firms having switched from B to G. At the steady state equilibrium, the unemployment rate stays constant and the flows in and out of unemployment balance each other out. Recalling that a is the flow probability out of unemployment, we have $a \zeta N = \frac{L_G + L_B}{2}$

$\frac{p}{2} \leq q \leq L_G$:

Since $q = 1 - \frac{1}{\tau}$, this flow equilibrium condition defines aggregate employment as a function of the separation and hiring rates. Hence, we can solve the model by deriving the equilibrium values of the latter two endogenous variables. To do so, we first combine the two first-order conditions to obtain $\frac{P_B}{P_G} = \theta \left(\frac{a_i p+r+x}{a+p+r+x} \right)$. Then, using

(8) to substitute for $\frac{P_B}{P_G}$, we derive $\theta \left(\frac{a_i p+r+x}{a+p+r+x} \right) = (\theta \tau)^{\frac{1}{\mu-3}}$. Solving (4), we further have $(\theta \tau)^{\frac{1}{\mu-3}} = 2 \tau e^{\frac{a+p+r+x}{\theta G x}} \left(\frac{1}{\tau} \right)^{\frac{1}{\mu-3}} \left(\frac{1}{i} \right)^{\frac{1}{\mu-3}}$:

Holding $\theta \left(\frac{a_i p+r+x}{a+p+r+x} \right) = 2 \tau e^{\frac{a+p+r+x}{\theta G x}} \left(\frac{1}{\tau} \right)^{\frac{1}{\mu-3}} \left(\frac{1}{i} \right)^{\frac{1}{\mu-3}}$ allows us to determine the equilibrium value of the hiring rate $a^*(\cdot)$. If we plug $a^*(\cdot)$ into (4), we are able to determine the equilibrium value for relative employment l . This leads us to the following proposition:

Proposition 1 There exists a unique equilibrium for the model if

$$\frac{1}{\theta} \left(\frac{p+r+x}{i p+r+x} \right)^{\frac{1}{\mu-3}} > 2 e^{\frac{p+r+x}{\theta G x}} \left(\frac{1}{\tau} \right)^{\frac{1}{\mu-3}} \left(\frac{1}{i} \right)^{\frac{1}{\mu-3}}$$

and

$$\frac{1}{\theta} \left(\frac{1+p+r+x}{i p+r+x} \right)^{\frac{1}{\mu-3}} < 2 e^{\frac{1+p+r+x}{\theta G x}} \left(\frac{1}{\tau} \right)^{\frac{1}{\mu-3}} \left(\frac{1}{i} \right)^{\frac{1}{\mu-3}}$$

Proof. The value of a is given by $\frac{1}{\theta} \left(\frac{a+p+r+x}{i p+r+x} \right)^{\frac{1}{\mu-3}} = 2 e^{\frac{a+p+r+x}{\theta G x}} \left(\frac{1}{\tau} \right)^{\frac{1}{\mu-3}} \left(\frac{1}{i} \right)^{\frac{1}{\mu-3}}$.
 1: Denoting $S_1(a; \tau) = \frac{1}{\theta} \left(\frac{a+p+r+x}{i p+r+x} \right)^{\frac{1}{\mu-3}}$ and $S_2(a; \tau) = 2 e^{\frac{a+p+r+x}{\theta G x}} \left(\frac{1}{\tau} \right)^{\frac{1}{\mu-3}} \left(\frac{1}{i} \right)^{\frac{1}{\mu-3}}$, we can show that $\frac{\partial S_1}{\partial a} < 0$ and $\frac{\partial S_2}{\partial a} > 0$: The first condition ensures $S_1(0; \tau) > S_2(0; \tau)$ and the second $S_1(1; \tau) < S_2(1; \tau)$: Hence, there exists a unique solution $a \in]0; 1[$.

■

Building on this, we can now move on to the analysis of the macroeconomic consequences of an increase in competition on the product market.

3 Some unexpected consequences of increased product market competition

Recalling our previous definition of the equilibrium value $a^*(\hat{\tau})$, we can show that the following proposition holds.

Proposition 2 An increase in $\hat{\tau}$ raises the probability of finding a job when unemployed.

Proof. We have $\frac{da}{d\hat{\tau}} = \frac{\frac{\partial S_1}{\partial a} \frac{\partial S_2}{\partial \hat{\tau}} - \frac{\partial S_2}{\partial a} \frac{\partial S_1}{\partial \hat{\tau}}}{\frac{\partial S_1}{\partial a} \frac{\partial S_2}{\partial \hat{\tau}} - \frac{\partial S_2}{\partial a} \frac{\partial S_1}{\partial \hat{\tau}}}$. We know that $\frac{\partial S_1}{\partial a} \frac{\partial S_2}{\partial a} < 0$: The sign of $\frac{ds}{d\hat{\tau}}$ thus depends on $\frac{\partial S_1}{\partial \hat{\tau}} \frac{\partial S_2}{\partial a}$. From the price setting equations we know that $e \frac{a+p+r+x}{x} \frac{\hat{\tau}}{1-\hat{\tau}} < 1$ and $\frac{a+p+r+x}{a} \frac{1}{p+r+x} < 1$, therefore both $S_1(a; \hat{\tau})$ and $S_2(a; \hat{\tau})$ are monotonically decreasing functions of $\hat{\tau}$; moreover, both $\frac{\partial^2 S_1}{\partial a^2} > 0$ and $\frac{\partial^2 S_2}{\partial a^2} > 0$. We can further note that $S_1(a; 1) = 0 > 1 = S_2(a; 1)$. Hence, for the two curves to cross and define a positive integer $a(\hat{\tau})$; it must be that $\frac{\partial S_1}{\partial a} > \frac{\partial S_2}{\partial a}$ around the equilibrium: ■

Given that $q = 1 - \frac{1}{\hat{\tau}}$, we can prove a similar result concerning the separation rate.

Proposition 3 An increase in $\hat{\tau}$ always raises the equilibrium value of the separation rate.

Proof. Define $l_1 = \frac{a+p+r+x}{a} \frac{\hat{\tau}}{1-\hat{\tau}}$, then $\frac{dl_1}{d\hat{\tau}} = \frac{\partial l_1}{\partial \hat{\tau}} + \frac{\partial l_1}{\partial a} \frac{da}{d\hat{\tau}}$. Since $\frac{\partial l_1}{\partial \hat{\tau}} > 0$ and $\frac{\partial l_1}{\partial a} > 0$, the result immediately follows from $\frac{da}{d\hat{\tau}} > 0$: ■

The rationale of these results follows. A higher value of $\hat{\tau}$ tends to compress relative intermediate prices $\frac{P_B}{P_G}$ which, since $\frac{P_B}{P_G}$ is a function of relative employment l , calls for an increase in l for any given level of wages. This change in prices also requires

an adjustment of wage levels. More intense competition pushes labour demand up and calls for higher real wages: in order for the efficiency wages to keep up with price increases, the endogenous hiring rate a also has to increase.

Proposition (3) immediately leads us to the following corollary:

Corollary 4 An increase in τ raises the wage differential between hiring and hiring firms.

Proof. Recalling that wages are set according to (2) and (3), this result simply derives from $w^G - w^B = e^{-\tau} \frac{a + p\tau q + r + x}{x} - e^{-\tau} \frac{a + r + x}{x} = \frac{e^{-\tau} p}{x} \tau q$. ■

The reduced job security associated with increased competition raises the wage paid by (potentially) hiring firms relative to the wage paid by (potentially) hiring firms. The results on the separation and hiring rate taken together lead us to the following corollary:

Corollary 5 For a given size of shocks, the adjustments in the level of employment are larger when product market competition is stronger.

Proof. Employment adjustments are then given by $\Delta L = \frac{L_G - L_B}{2} = \frac{a\tau(l_i - 1)\tau N}{a\tau(1+l) + (l_i - 1)\tau p}$. We can finally show that $\frac{\partial \Delta L}{\partial a} = \frac{a\tau(l_i - 1)^2 \tau N}{(a\tau(1+l) + (l_i - 1)\tau p)^2} > 0$ and $\frac{\partial \Delta L}{\partial l} = \frac{a^2 \tau(l_i - 1)\tau N}{(a\tau(1+l) + (l_i - 1)\tau p)^2} > 0$. ■

This result contradicts the common view that more competition, associated with larger price adjustments, should lead to smaller quantity adjustments. What distinguishes our result is that efficiency wage requirements prevent large changes in real wages, which would not respect the incentive compatibility constraint for workers. As a result, the only adjustment variables left are quantities. To simply illustrate the contrasted effects of these changes on welfare, let us define static welfare as $W = i^G P_G - \frac{e^{-\tau}}{2} L_G + i^B P_B - \frac{e^{-\tau}}{2} L_B$. From (4) and (5) we have

$\frac{P_G}{P_B} = \frac{a_i p + r + x}{a + p + r + x} = \frac{P_B}{P_G}$ with $\frac{a_i p + r + x}{a + p + r + x} = \frac{1}{\theta} (\theta l)^{\frac{1}{\theta}}$: Hence, we obtain $W = L_G \left(\frac{P_G}{P_B} \right)^{\frac{1}{2}} + X$ where $X = \frac{1}{\theta} \theta l^{\frac{1}{\theta}}$ is positive but tends to zero as competition increases pushing l up⁸.

4 Conclusion

This paper has proposed a dynamic efficiency wage model with monopolistic competition on the goods market. In this framework, increased competition is associated with stronger turnover on the labour market. Hence, a strict correlation is established between the structure of the product market and the structure of the labour market: more competitive product markets are associated with more de facto flexible labour markets. Our main result is that if wages are set according to an efficiency wage mechanism, increased competition comes at a price, i.e. the widening of wage differentials and employment differentials across sectors of the economy.

⁸ Indeed, aggregate employment may itself fall as competition increases, under some parametrical assumptions (see Amable-Gatti, [2001])

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