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ABSTRACT

The purpose of this paper is to compare the behavior of an economy subject to labor contracts with an economy where the labor market clears in an auction manner. Such a comparison is intended to reveal the information content of real wages in a flexible economy. The analysis reveals two distinct costs inflicted by nominal contracts and demonstrates that optimal macro policies can eliminate one of them.

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I. Introduction

Labor contracts that pre-set wages for a given period may introduce short-run wage rigidities. Those rigidities imply that macroeconomic stabilization policies may enhence welfare by using information that was unavailable at the time of the wage negotiation.[1] The purpose of this paper is to compare the behavior of an economy subject to labor contracts with an economy where the labor market clears in an auction manner. Such a comparison is intended to reveal both the information content of real wages in an auction-type economy and the appropriate benchmark at which optimal macro policies should aim.

In an economy where the labor market clears in an auction manner, the real wage is set so as to clear the labor market. In a contracting economy, however, there is no such a market. Thus by comparing an auction-type economy with a contracting economy we may assess the role of an additional market, and suggest how, in an environment that lacks a market, policies can be designed to substitute in part for its absence.

The analysis is conducted in an economy of the type put forward by Fischer and Gray. These authors consider the case of an economy where nominal wage contracts for period t are negotiated in period t-1, before prices of period t are known. The implicit assumptions of these models are that economic agents are risk neutral and that the existence of labor contracts reflects the cost of continuous wage re-negotiation.

We allow for two types of shocks. First, we have a monetary shock. Next, each producer is subject to a specific productivity shock. We consider the case in which a given producer observes his specific shock, but the aggregate real shock is not observed directly.[2] We consider a rational expectation environment, in which the available information set can be used by agents in order to infer the value of some of the shocks.

The analysis demonstrates that the effect of an auction labor market is to reveal through the resultant real wage the aggregate productivity shock. In a contracting economy we lack a market, consequently we have an equilibrium that fails to reveal the aggregate productivity shock. Thus, nominal contracts inflict two types of cost. The first relates to the deterioration in the aggregate information available to the decision maker, due to the presence of one less economy-wide market.[3] The second relates to the consequences of inflicting wage rigidity, which reduces the flexibility of wage adjustment to unforeseen shocks. The purpose of the paper is to study the interaction of these two costs and to assess the role of optimal macro policies in such an economy.

The paper is organized in the following manner: Section II describes the model. Section III solves it for the corresponding optimal policies. Section IV offers concluding remarks. The Appendix summarizes the notation used in the paper.

II. The Model

Let us consider a monetary economy composed of k producers. Those producers sell their output in a competitive market. Output is produced by means of a fixed input (capital) and labor. As in Fischer and Gray, we consider the case in which, due to the costs of continuous wage re-negotiation, wages and employment are governed by labor contracts. Nominal wage contracts for period t are negotiated in period t-1, before current prices are known, so as to equate expected labor demand to expected labor supply. But actual employment in period t is demand determined, and depends on the realized real wage. These models also allow for partial indexation, which is set according to certain optimizing criteria. The implicit assumptions of these models are that economic agents are risk neutral, and that the existence of labor contracts reflects the cost of continuous wage re-negotiation. The present paper shares these assumptions.

Suppose that the labor supply is given by:

$$(1) \qquad L_t^s = A_s \cdot \left(\frac{W_t}{P_t}\right)^{\varepsilon}$$

where W_t is the money wage at time t, and P_t is the price level. Labor is the only mobile factor, and output of producer i is given by:

$$(2) \qquad Y_t^s = L_{i,t}{}^{\beta} \cdot \exp \mu_{i,t}$$

where $L_{i,t}$ is the labor employed by producer i, and $\mu_{i,t}$ is the productivity shock effecting producer i. We consider the case in which $\mu_{i,t}$ is known to each producer.[4] μ_i is taken to be normally distributed, independently over producers and over time, with mean zero.

As a reference point, let us start with the "non-stochastic equilibrium", i.e., the equilibrium in the economy if the value of all the random shocks is zero. Let us denote by a lower-case variable the percentage deviation of the upper-case variable from its value in the non-stochastic equilibrium. Thus, for a variable X_t, $x_t = (X_t - X_o) / X_o$, where X_o is the value of X if all random shocks are zero. To simplify notation, we delete the time index. Thus, (x_t, x_{t+i}) are replaced by (x, x_{+i}). To facilitate discussion it is useful to take a log-linear approximation of the model around its non-stochastic equilibrium, writing the model in terms of percentage deviations. This is equivalent to the use of a first-order approximation of a Taylor expansion around the equilibrium. We proceed by assuming that the number of producers is sufficiently large for each producer to be a price taker.

Employment by producer $i(L_i)$ is determined by

$$(3) \qquad \underset{L_i}{\text{Max}}\ P(L_i)^{\beta} \cdot \exp(\mu_i) - W \cdot L_i.$$

Solving this equation we obtain that, using our shorter notation,

$$(4) \qquad l_i = \sigma[p - w + \mu_i]$$

where $\sigma = \frac{1}{1-\beta}$

In deriving eq. 4, we make use of the assumption that the productivity shock is observable by each producer. To simplify exposition, we take the case in which each small producer has the same infinitesimal share of the market. Thus, aggregate employment (l) and output (y) are given by

$$(5) \qquad l = \sigma[p - w + \mu]$$

$$(6) \qquad y = \sum_{i=1}^{k} \frac{1}{k}[\beta\sigma(p - w + \mu_i) + \mu_i] = \sigma[\beta(p-w) + \mu]$$

Where $\mu = \sum_{i=1}^{k} \mu_i$ denotes the aggregate productivity shock. Although producer i observes his own productivity shock (μ_i), aggregate shock μ is not observable directly, and the subsequent analysis will study the inference problem associated with the determination of the perceived value of the aggregate shocks. To close the model, we should specify the wage and price level determinations.

In a fully flexible economy, w corresponds to the wage that clears the labor market, i.e. $w = (\tilde{W}_t - W_o)/W_o$; where $\tilde{W}_t$ is the flexible equilibrium wage rate, and W_o is the equilibrium wage if all shocks are zero. Under the labor contract, the wage contract for period t is pre-set at time t-1 at its expected equilibrium level in a fully flexible regime, $E(\tilde{W}_t | I_{t-1}) \cdot E(| I_{t-1})$ is the expectation operator, conditional on the information available at time t-1 (I_{t-1}). Under a partial wage indexation the actual wage is allowed during the contract's duration to respond partially to unexpected changes in the price level:

$$\log W_t = \log E(\tilde{W}_t | I_{t-1}) + b[P_t - P_o]/P_o \tag{7}$$

or, in terms of our shorter notation[5]:

$$w = bp. \tag{7'}$$

The case where b is set to zero corresponds to nominal wage rigidity, whereas b = 1 is the case of real wage rigidity. The subsequent analysis studies the determinations of b.

To analyze the price level determinations, we should specify the money market. Let the demand for money balances be

$$M_t^d = P_t \cdot Y_t \cdot \exp(-\alpha \cdot \pi_t) \tag{8}$$

where π_t is the expected inflation:

$$\pi_t = [E(P_{t+1} | I_t) - P_t]/P_t. \tag{9}$$

Throughout the paper we proceed by invoking the assumption of rational expectations. Agents are assumed to know the model and to observe all prices. Each producer observes his own productivity shock (μ_i), but not the aggregate shock (μ). In case of need, agents would use the available information to generate inferences regarding the aggregate productivity shock (μ). I_t denotes the aggregate information set at time t, that includes all current prices and knowledge of the model.

The supply of money balances is given by:

$$\text{(10)} \qquad \log M_t^s = \log \bar{M} + m_t - \gamma \cdot p_t.$$

m_t is the stochastic shock to money balances, assumed to be generated by a white-noise process

$$\text{(11)} \qquad m_t \sim N(0, V_m),$$

where V_x(or $V(x)$) stands for the variance of x.

We would like to allow the monetary authorities to conduct a monetary policy by means of a feedback rule that adjusts the money supply with elasticity γ with respect to the deviations of prices from their non-stochastic level. Due to the nature of our model, we can focus our attention on the properties of the stationary equilibrium for which the current values of the stochastic shocks do not affect the expected values of future variables. Equilibrium in the money market $(M^d = M^s)$ allows us to derive the following condition:

(12) $$m = y + p(\alpha + \gamma + 1).$$

Thus:

(13) $$p = \frac{m - \mu \cdot \sigma}{1 + \alpha + \gamma + \beta\sigma(1-b)}$$

Consequently, real wage τ is given by

(14) $$\tau = w - p = \frac{(1-b)\ (\mu \cdot \sigma - m)}{1 + \alpha + \gamma + \beta\sigma(1-b)}\ .$$

Equation 13 implies that observing the price level provides us with information regarding the discrepancy between the monetary and the real shock.

III. Optimal Policies

Subject to our assumptions, for a given real wage (τ) employment is demand determined. This implies that if real wages deviate from their market clearing level we obtain a welfare loss. Assuming risk neutral agents, and the absence of other distortions, we can measure this welfare loss (for derivations, see Aizenman and Frenkel (1983)) by

(15) $$WL_t = c \cdot (\tau_t - \tilde{\tau}_t)^2$$

where $c = \frac{\sigma^2}{2}(\frac{1}{\varepsilon} + \frac{1}{\sigma})$, and $\tilde{\tau}_t$ denotes the real wage in a flexible economy, in which the labor market clears in an auction fashion. The welfare loss is proportional to the discrepancy between τ and $\tilde{\tau}$. Optimal policies are derived such as to minimize the expected value of the welfare loss conditional on the information available to the policy maker (I_t):

$$\min_{b,\gamma} H(b, \gamma | I_t) \qquad \text{where} \tag{16}$$

$$H = [(\tau_t - \tilde{\tau}_t)^2 | I_t]$$

Next, we turn to the derivation of real wages in a flexible equilibrium ($\tilde{\tau}$).

III a. Flexible Economy Equilibrium

In a flexible economy wages are determined such as to clear the labor market:

$$\varepsilon \tilde{\tau} = 1 \tag{17}$$

where $\tilde{x}$ denotes the value of x in a flexible, auction type equilibrium. In such an economy output is given by

$$\tilde{y} = \sigma[\beta(\tilde{p} - \tilde{w}) + \mu] \tag{6'}$$

Equations 5, 6', 12, 17 can be applied to derive the real wage ($\tilde{\tau}$) for a flexible economy, yielding:

$$\tilde{\tau} = \frac{\mu \cdot \sigma}{\sigma + \varepsilon} \tag{18}$$

Equation 18 reveals that subject to clearing the labor market, real wages would reveal the aggregate productivity shock, μ.[6] Furthermore, the real wage and employment are free from monetary consideration. In the absence of clearing the labor market, we obtain only partial information because the aggregate productivity shock (μ) is not revealed. Instead, we observe only the sum of the monetary and real shocks, as embodied in the price signal. Thus, the distinction between nominal and real shocks plays an important role in our subsequent discussion because of the absence of labor market clearing. Combining eq. 7', 16 and 18 we obtain the value for the welfare loss as perceived by the policy maker (conditional on I_t):

(19) $$H(b, \gamma | I_t) = E\left[\left\{\frac{\mu\sigma}{\sigma+\varepsilon} + (1-b)p\right\}^2 | I_t\right].$$ Alternatively:

(19') $$H = V\left(\frac{\mu\sigma}{\sigma+\varepsilon} \mid I_t\right) + \left[\frac{\sigma}{\sigma+\varepsilon} E(\mu | I_t) + (1-b)p\right]^2$$

The aggregate productivity shock is not observable in our economy. Yet, its perceived value $(E(\mu | I_t))$ enters the considerations of the decision maker as one of the determinants of the perceived welfare loss (H). His knowledge of the price (p) allows him to infer a value for μ [7]:

(20) $$E(\mu_t | I_t) = p \cdot \rho$$

where

(21) $$\rho = \mathrm{cov}(\mu, p)/V(p)$$

Alternatively:

(20') $$E(\mu_t | I_t) = -\frac{p}{\sigma}(1 + \alpha + \gamma + \beta\sigma(1-b))\,\psi$$

where $\psi = V(\mu\sigma)/[V(m) + V(\mu\sigma)]$. ψ is a measure of the importance of the real shock relative to the monetary shock. Eq. 20' allows us, after some manipulations, to present H as

$$(19'') \qquad H = \{p(\frac{\psi(1 + \alpha + \gamma + \beta\sigma(1-b))}{\sigma+\varepsilon} - (1-b))\}^2 + V(\frac{\mu\sigma}{\sigma+\varepsilon} | I_t).$$

From this it is evident that optimal policies are given by

$$(22) \qquad [\frac{1-b}{1+\alpha+\gamma+\beta\sigma(1-b)}]^* = \frac{\psi}{\sigma+\varepsilon} .$$

Or, alternatively

$$(22') \qquad b^* = 1 - (1+\alpha+\gamma)/[(\sigma+\varepsilon) \frac{V_m}{V_{(\sigma\mu)}} + 1+\varepsilon]$$

Where * refers to the optimal value of the parameter in question.

Several observations are in order. Inspection of equation 22 reveals that for a stable covariance structure, the value of optimal policies is time independent. This condition holds despite the use of currently available information in deriving the various policies. Furthermore, it can be shown that the same outcome for optimal policies for period t would be obtained if one used the information available in the previous period (i.e., if one derived $\underset{\gamma,b}{\text{Min}}\ E(WL_t | I_{t-1})$). As has been reported elsewhere (Aizenman and Frenkel (1983)), optimal outcome can be obtained by monetary policy alone, or by wage indexation. Thus, equation 22 defines a negative trade-off between optimal monetary policy and optimal indexation.[8] For a given monetary policy (γ_o), optimal indexation rises with the relative importance of monetary to real shocks, having properties similar to the optimal indexation obtained by

Gray.

Optimal macro policies equate the contract real wage to the expected clearing real wage, as perceived by the policy maker. I.e., subject to optimal policies the real contract wage, τ_t^*, is:

$$(23) \qquad \tau_t^* = E(\tilde{\tau}_t | I_t)$$

Optimal policies do not eliminate the welfare loss due to the absence of a flexible labor market. To appreciate this point notice that, subject to optimal policies, the real contract wage diverges from the market clearing wage $(\tau_t^* \neq \tilde{\tau}_t)$. This is because optimal policies are based upon the information available to the policy maker, which does not include in our case knowledge of the productivity shock. The market clearing wage, however, depends upon the aggregate productivity shock, which is observable in a flexible economy via the equilibrium market clearing wage. Subject to optimal policies, the discrepancy between the real contract wage (τ_t^*) and flexible equilibrium real wage $(\tilde{\tau}_t)$ is orthogonal to the information available to the policy maker. Thus, we cannot reach a more favorable outcome by macro policies alone.[9]

Subject to optimal policies, employment is given by:

$$(24) \qquad l^* = \sigma[\mu - E(\tilde{\tau}_t | I_t)].$$

The supply of labor, however, corresponds to

$$(25) \qquad \varepsilon \cdot E(\tilde{\tau}_t | I_t)$$

Using equation 18 we obtain that the discrepancy between the two is given by

$$(26) \qquad (\sigma + \varepsilon)\ [E(\tilde{\tau}_t | I_t) - \tilde{\tau}_t].$$

This entails a welfare loss (relative to the case of a flexible equilibrium) equal to

$$(27) \qquad WL_t^* = c[E(\tilde{\tau}_t | I_t) - \tilde{\tau}_t]^2$$

This loss occurs because in our case optimal macro policies cannot clear the labor market. Such a situation is attributable to the asymmetric nature of our framework in which the producer bases his employment decision upon a productivity shock that is observable to him but not to the policy maker.[10] The non-observability of the aggregate shock is the consequence of the missing market. Thus, nominal contracts inflict two types of costs. The first relates to the deterioration in the aggregate information available to the decision maker as a result of having one less economy-wide market. The second relates to the consequences of inflicting wage rigidity. This rigidity reduces the flexibility of wage adjustment to shocks that were unforeseeable at the contract negotiation. Optimal macro policies can eliminate only the second source of costs, by generating a real wage that would adjust appropriately to those shocks that the policy maker can observe (or infer). Such optimal policies can not eliminate the cost caused by nominal contracts due to deteriorated aggregate information. If nominal contracts generates non-revealed asymmetric information, as is the case in the present model, then optimal macro policies will not generate equilibrium in the labor market. This, however, is the <u>combined</u> result of nominal contracts and asymmetric information.

A formal statement of this argument can be summarized in the following manner: let us measure the expected welfare loss at period t generated by the contract relative to the flexible equilibrium. We do so conditionally on the basis of information available to the policy maker (I_t):

$$(28)\qquad E(WL_t|I_t) = c \cdot E[(\tilde{\tau}_t - \tau_t)^2|I_t] =$$

$$c \cdot E[(\tilde{\tau}_t - E(\tilde{\tau}_t|I_t))^2|I_t] + c \cdot E[(E(\tilde{\tau}_t|I_t) - \tau_t)^2|I_t]$$

$$+ 2 \cdot c \cdot E[(\tilde{\tau}_t - E(\tilde{\tau}_t|I_t)) \cdot (E(\tilde{\tau}_t|I_t) - \tau_t)|I_t]$$

Due to a missing market, aggregate information available to the decision maker at time t deteriorates to I_t. The first term measures the welfare consequences of the deteriorated information set. This term is also equal to $E(WL_t^*|I_t)$ (i.e., the expected welfare loss subject to optimal macro policies). Next, subject to nominal contracts real wages may diverge from their perceived optimal value ($E(\tilde{\tau}_t|I_t)$); due to wage rigidity introduced by the contract. This cost is measured by the second term. The third term represents the cost resulting from the interaction between the first two costs. Optimal macro policies enable the elimination of the second type of cost, nullifying the second and the third terms in eq. 28. Optimal macro policies cannot, in general, eliminate the costs due to information that is asymmetric and non-revealed because of the missing market.

Thus, the first term in equation 28 measures the welfare loss due to a missing economy-wide clearing labor market. It can be shown to be equal to

(29) $$E(WL_t^* \mid I_t) = c \cdot V_{(\mu\sigma)} \cdot [1-\psi]$$

This welfare loss increases with the relative importance of unanticipated monetary volatility $(1-\psi)$ and with the volatility of aggregate productivity shocks. This loss may not reflect a distortion if the costs of clearing the labor market in an auction fashion exceed the costs caused by the absence of an auction labor market (eq. 29).[11]

IV. Concluding Remarks

This paper has compared a flexible economy, in which the labor market clears continuously, with a contracting economy, of the Fischer Gray type. The comparison reveals that in a contracting economy we have one less economy-wide market, implying that information that is revealed in a flexible economy equilibrium may be missing in a contracting economy. In our model, this applied for the aggregate productivity shock. Consequently, wage contracts inflict two types of cost. The first relates to the possession of less aggregate information, whereas the second refers to the wage rigidity introduced by a wage contract. Optimal macro policies eliminate the second type of cost, generating real wages that adjust appropriately to the shocks that the policy maker can infer. If nominal contracts generate asymmetric, non-revealed information, optimal macro policies will not eliminate the first cost. Subject to optimal macro policies we find that the resultant deviation from the flexible equilibrium are non-systematic (i.e., they are orthogonal to the information set guiding the policy maker).

Footnotes

1. For a discussion of such policies in a rational expectation setting, see Gray (1976) and Fischer (1977). For a more recent discussion see Karni (1983); Canzoneri, Henderson and Rogoff (1983), Aizenman and Frenkel (1983) and Marston and Turnovsky (1983).

2. A framework with a similar menu of shocks was applied by Marston and Turnovsky (1983) to assess the stabilizing role of taxation and indexation.

3. On the role of an economy-wide capital market in revealing information see Barro (1980).

4. The case in which a uniform productivity shock is not observable directly has been studied by Aizenman and Frenkel (1983).

5. In deriving equation 7' we use the fact that in our model $W_o \simeq \log E(W_t | I_{t-1})$.

6. Notice that once that μ is revealed, we can infer m from the price signal, thereby obtaining full information.

7. This is a short cut to the more lengthy computation following the undetermined coefficient method. An analogous short cut is adopted in Canzoneri, Henderson and Rogoff (1983) in the context of an analysis of the information content of interest rates.

8. In Aizenman and Frenkel (1983) we evaluate optimal policies for the case in which producers do not directly observe a uniform productivity shock. The resultant values for optimal macro policies have similar characteristics to those obtained in the present paper. They are derived in a symmetric information setting, where they are shown to clear the labor market.

9. Further welfare improvement may be achieved by invoking policies that use information which is available to the firm at the micro level [see Marston and Turnovsky (1983)], or policies that attempt to improve the aggregate information set. In both cases, the marginal benefit should be weighted against the marginal cost of implementing those policies.

10. For a related discussion regarding the information content of interest rates, in the context of asymmetric information, see Canzoneri, Henderson and Rogoff (1983).

11. For further details regarding such an argument in the context of re-contracting, see Aizenman (1983).