

LABOR CONTRACTS AND MACROECONOMIC PERFORMANCE[†]

Nominal Wage-Price Rigidity as a Rational Expectations Equilibrium

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Most recent studies of macroeconomic behavior fall into one of two categories. The first, often called the equilibrium business cycle approach, stems from the fundamental contribution of Robert E. Lucas (1972), and related work by Thomas Sargent and Neil Wallace (1975) and many others. These studies espouse the view that a positive correlation between output and the stock of paper assets can arise if households are unable to identify the source and, therefore, the permanence of price movements.

Employment and output responses in this view are driven by the intertemporal substitution effect, especially the substitution of current leisure for future consumption. Since cyclical fluctuations in employment are large relative to the corresponding real wage movements, substantial wage elasticity of labor supply is required to validate these models.

The equilibrium approach to business cycles implies certain restrictions on the conduct of monetary policy. In particular, rational expectations undermine the ability of the monetary authority to influence economic activity in a systematic manner; see Sargent-Wallace for an example.

Sticky wages and prices are the cornerstone of an alternative description of macroeconomic behavior. Rooted vaguely in Keynes, and more firmly in the “dual decision hypothesis” of Robert Clower (1984), this approach studies equilibria with quan-

tity rationing; see Edmond Malinvaud (1977). The rationing story lacks a precise specification of the *source* of price stickiness, offering very little guidance about the eventual causes of price change.

Considerable efforts were made in the 1970's to fill this lacuna in Keynesian macroeconomics. Beginning with work by Martin N. Baily (1974) and others, the implicit contracts literature focused on the incomplete insurability of human capital. Unable to find insurance against fluctuations in labor income elsewhere, workers demand insurance from those best placed to observe labor income—their own employers. Both wage inflexibility and layoffs, then, can be viewed as an outcome of a joint insurance-employment relationship between workers and firms; see Azariadis (1975).

Critics like George Akerlof and Hajime Miyazaki (1980) soon discovered that the original contracting models could not produce layoffs without prohibiting severance pay or otherwise limiting the terms of the contract. Others pointed out that these models were determinedly microeconomic, offering few insights into the stickiness of *nominal* wages or the effectiveness of stabilization policy.

Two quite distinct lines of research developed out of the original implicit contract ideas. One focuses on asymmetric information and implementability (see the *QJE* 1983 Symposium for original work and the review article by Oliver Hart, 1983) as a means of driving a wedge between the *ex post* marginal rates of substitution of the contractants. Under some technical assumptions, the outcome is “involuntary” underemployment or unemployment.

We are most concerned here with the other line of research, which sought to fit labor or

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commodity contracts into full-blown macroeconomic structures; see Stanley Fischer (1977), and Arthur Okun (1981). These authors apparently took their cue from the insurance arrangements stressed in the implicit contracts literature. Just as in the rationing approach mentioned above, the macro contracts literature does not fully derive the structure of trades from first principles; it asserts instead that money wages are predetermined and that employment is set by labor demand. This rule (see Robert Barro, 1977) is not in the best interest of the contractants for it requires laborers to be permanently off their offer curve. Consequently, macroeconomic contract models are not an entirely reliable guide for policy evaluation.

As we take stock of matters, it seems to us that the time is ripe to assess what role contracts play in macroeconomics. An ideal outcome would be a coherent story of money-wage stickiness, and of output response to stabilization policy.

This paper distills recent research, by ourselves and others, that pursues that ideal without quite reaching it. The presentation here favors intuition over technical detail as much as possible. The next section, in particular, discusses examples of intertemporal economies that possess competitive rational expectations equilibria in which wages and prices are predetermined, output is sensitive to policy shocks, and markets clear. Section II reports on the existence of Nash equilibria with similar properties when producers set both prices and wages.

I

We outline here some rational expectations equilibria of an overlapping generations economy that begins at time zero and goes on forever. The beginning of each time period $t = 0, 1, \dots$, coincides with the appearance of a generation, labeled "generation t ," that consists of $2N$ individuals, all of whom survive for two full periods: "youth" and "old age." Individuals specialize over their life cycle, participating in the production of a single, perishable commodity when young, saving their entire factor rewards to purchase a paper asset called "money," and

using their assets in old age to finance the consumption of the same commodity they helped produce in youth. We assume that no endowments exist of this valuable commodity—it must be produced before it is consumed.

Every generation consists of N identical, risk-neutral workers, and N identical, risk-neutral entrepreneurs. Each worker is endowed with $\bar{n} > 0$ units of divisible leisure in youth, and with a utility function $c_{t+1} - kn_t$ over old age consumption (c_{t+1}) and youthful work (n_t). The parameter k , interpreted here as a reservation wage, is the same for all workers in all generations, and lies in the interval $(0, 1)$.

Entrepreneurs own in youth the constant-returns technology $y_t = n_t$, the only means of production in this society. Denoting by p_t the money price of goods and by w_t the money wage, it is clear that a generation t entrepreneur consumes in old age $(p_t - w_t)n_t/p_{t+1}$.

Money is printed by the government to finance purchases of goods from private sellers. Real per capita government purchases are an independent, identically distributed random variable, \tilde{g}_t , with a probability measure defined over the positive interval $[a, b]$, and expected value $\mu > 0$. We assume $b < \bar{n}$, that is, government purchases never exceed the productive capacity of the economy.

If M_t is the nominal stock of money in period t and $m_t = M_t/p_t$ is its purchasing power, the government budget constraint can be written in either of the following two forms:

$$(1) \quad p_t g_t = M_t - M_{t-1}$$

$$p_{t-1}/p_t = (m_t - g_t)/m_{t-1}.$$

All agents, including the government, are wage and price takers. Commodities purchased by the government are used up with no effect on any household's preferences over private goods.

The constant returns to scale assumption means that the demand for labor (and supply of goods) is zero if $p_t < w_t$, and infinity if $p_t > w_t$. Competitive equilibrium is trivial in the former case, and nonexistent in the latter.

We focus therefore on the case $p_t = w_t$, which makes employment supply determined. In particular, $n_t \geq 0$ if the expected purchasing power of wages satisfies

$$(2) \quad w_t E_t(1/p_{t+1}) = p_t E_t(1/p_{t+1}) \geq k.$$

Also, $n_t = \bar{n}$ if (2) holds as a strict inequality. Here E_t is the expectations operator conditional on all events up to, and including, period t .

Equilibrium in the goods market requires goods supply n_t to equal goods demand. Demand is simply the real value of existing money balances m_t , held by retired individuals and by the government.

Combining the market-clearing condition $m_t = n_t$ with relations (1) and (2), we see readily that every competitive equilibrium satisfies

$$(3) \quad E_t m_{t+1} \geq k m_t + \mu,$$

with $m_t \leq \bar{n}$, and $m_t = \bar{n}$ if (3) is a strict inequality. As one may guess, inequality (3) admits many equilibria, the most interesting of which we present below (see also Roger Farmer and M. Woodford, 1984).

One class of equilibria worth noting features *flexible prices and predetermined quantities*: current events are reflected in current equilibrium prices but not in current equilibrium quantities. A member of this class is the full-employment equilibrium ($p_t = w_t$, $p_{t-1}/p_t = 1 - g_t/\bar{n}$, $m_t = \bar{n}$) for all t , which is easily seen to satisfy relations (1) and (3) provided that

$$(4) \quad \mu \leq (1 - k)\bar{n}.$$

A second class of equilibria has *predetermined prices and flexible quantities*: current events influence current quantities but not prices. One member of this class (and the only one existing in our simple economy) is ($p_t = w_t$, $p_{t-1}/p_t = k$, $m_t = k m_{t-1} + g_t$) for all t . This one, too, is consistent with relations (1) and (3). The implied path of output

$$(5) \quad m_t = k^t m_0 + \sum_{s=0}^{t-1} k^s g_{t-s},$$

stays in the interval $[a/(1-k), b/(1-k)]$ if it begins there, that is, if the initial parameter m_0 lies in that interval. Therefore, a predetermined wage-price equilibrium exists if

$$(6) \quad b \leq (1 - k)\bar{n}; \quad a > b(1 - k).$$

That is, if the aggregate demand for goods never exceeds the economy's productive capacity, and output never falls short of government consumption.

Both the full-employment and the under-employment equilibria are full rational expectations equilibria in cleared markets. But they differ substantially in what they predict about the economic consequences of policy shocks. The full-employment equilibrium has very classical properties: prices are flexible and complete crowding-out obtains. Government expenditure (g_t) displaces private consumption ($\bar{n} - g_t$) one-for-one.

The underemployment equilibrium possesses Keynesian features: predetermined wages and prices; no crowding-out in the short run, since private consumption is predetermined; and a long-run "multiplier" of $1/(1-k)$, which exceeds unity. To understand the last assertion, replace the random variable \tilde{g} by $\lambda \tilde{g}$, where λ is a positive constant. Then, clearly, the output path will stay in the interval $[\lambda a/(1-k), \lambda b/(1-k)]$ if it begins there.

Looking back at inequalities (4) and (6), one sees that neither equilibrium exists if government purchases are "too large" on average; in particular, a predetermined price-and-wage equilibrium is impossible if government purchases are "too dispersed." Wage rigidity is not a frequently observed phenomenon when macroeconomic policy is highly uncertain.

Full-employment equilibria here yield the highest possible consumption, net of the disutility of work, and therefore are superior to underemployment equilibria in the familiar sense of first-degree stochastic dominance. Nevertheless, full employment is but one of many possible equilibria in this model economy. The underdeterminate nature of equilibrium is a weakness of our model, and perhaps of actual intertemporal economies as well. To pin down the equilibrium, we need

an additional restriction, for example, a description of how a hypothetically independent monetary authority would react to government spending. Suppose, in particular, that the authority follows the rule

$$(7) \quad M_t - M_{t-1} = (p_{t-1}/k)g_t.$$

Then predetermined prices are validated and a predetermined quantity equilibrium is no longer tenable.

II

The above analysis suggests that contracts are not necessary for the existence of equilibria with predetermined wages and prices. In both the predetermined-price underemployment equilibrium and the flexible-price full-employment equilibrium, workers' old age consumption was independent of shocks in their youth. Hence, even if worker's preferences were strictly concave functions of $c_{t+1} - kn_t$, labor contracts could not improve the sharing of consumption risks. There are, of course, other spot equilibria in the model of the previous section for which old age consumption does depend on shocks in youth; introducing contracts will generally affect these equilibria in a way that need not concern us here.

A more interesting question is whether the old age consumption of risk-averse workers can be set independently of the government policy shocks realized in their *old age*. Since labor contracts can only protect workers against events in their youth, we consider both commodity and labor contracts to explore fuller lifetime insurance opportunities. This represents a merger of labor contracts with the "customer market" approach advocated by Okun. Using a variant of the model outlined above, we explore whether nominal wage rigidities may be the outcome of a game between wage-setting and price-setting agents.

Assume workers have lifetime utility functions of the form $u(c_{t+1} - kn_t)$ where u is increasing and strictly concave. Entrepreneurs of generation t are still risk neutral, but they are assumed to be born at the beginning of period $t-1$ and live for three

full periods, producing in the middle one and consuming in the last one. They are endowed with $\bar{e} > 0$ of commodities (or leisure) in middle age; \bar{e} is also the fixed cost of operating a firm.

The source of uncertainty here is slightly different from our first model. The period t money supply is $m_t = m_{t-1}\tilde{x}_t$ where \tilde{x}_t is a random variable with a stationary distribution over the interval $[1, \bar{x}]$. All money creation finances government purchases.

We assume that all *ex post* trades are mediated through contracts. A generation t entrepreneur is involved in *three* contracts. First, he supplies commodities to both old (generation $t-1$) agents and the government in period t , under a price schedule established in period $t-1$, before x_{t-1} is realized. Second, he signs a labor contract with generation t workers to produce the commodities demanded by the previous generation given the firm's price schedule. Finally, as a future consumer, the entrepreneur makes purchases from a generation $t+1$ firm. A generation t worker faces a period t wage schedule and a period $t+1$ price schedule at the very beginning of period t , before x_t is realized. This timing provides the maximal scope for insurance.

Firms must also coordinate output and employment levels across their commodity and labor agreements. We assume that firms meet all *ex post* demand given their pricing policy, so that demand determines employment. Hence fluctuations in demand generate movements in output and employment. The magnitude of this correlation depends upon the sensitivity of prices to past and present changes in the stock of money.

Consider a game between firms (both within and across generations) where the strategic variables are wage and price schedules. Workers and risk-averse consumers are nonstrategic players who exchange with a firm offering the most attractive wage and price schedules. The government and old age entrepreneurs purchase equal amounts from those firms that charge the lowest expected price. An equilibrium is then a sequence of wage and price functions (w_t, p_t) , dependent on events up to and including period t , which constitute a symmetric Nash equi-

librium in the game described above. Output in such an equilibrium is bounded by the productive capacity of the economy. Cooper (1984) discusses the detailed conditions for such equilibria in a closely related model.

Here we explore the possibility of a Nash equilibrium with wages and prices independent of policy shocks. Since realizations of x_t are public information, w_t will generally be indexed if p_{t+1} reflects x_t . Hence, we are searching for an equilibrium where both w_t and p_{t+1} are independent of x_t . Consider $w_t = \alpha M_{t-1}$ and $p_{t+1} = \beta M_{t-1}$, for all t , as a candidate equilibrium. If $\alpha/\beta = k$, workers receive full insurance. The parameters of the contract can be set so that the expected consumption of a generation t entrepreneur satisfies $E_{t-2} c_{t+1}^F = \bar{e}$ for all t . We expect this to emerge from the competition among firms.

A key issue here, as in the previous section, is the feasibility of such an equilibrium. Since quantities are demand determined, total employment (and hence output) in period t equals M_t/p_t . With $p_t = \beta M_{t-1}$, the maximal level of possible demand is $(\bar{x})^2/\beta$. Since the productive capacity of the economy is $N\bar{n}$, this predetermined wage/price equilibrium will exist iff $N\bar{n} \geq (\bar{x})^2/\beta$, where the parameter β turns out to be independent of \bar{x} and $N\bar{n}$. This condition reinforces our intuition that predetermined wage and price equilibria will not exist if policy is too "variable."

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