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AGGREGATION AND STABILIZATION POLICY IN A MULTI-CONTRACT ECONOMY

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ABSTRACT

This paper presents a model of a multi-sector economy in which each sector is characterized by a different type of wage or price stickiness. The various sectors experience the same exogenous shocks and have the same money supply. The analysis shows demand shocks pose no serious problems for stabilization policy. In contrast, supply shocks force the policymaker to choose between stability in one sector and stability in another. The analysis also shows the economy cannot be usefully aggregated into a single sector model. Such an aggregation misleads the economist as to the economy's underlying structure and obscures the tradeoffs the policymaker must confront. In particular, a feedback rule chosen on the basis of an aggregate model could be better or worse than a passive policy.

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1. Introduction

Considerable controversy rages over how best to model the wage-price mechanism in macroeconomic theory. It is well-known that different assumptions about which markets clear in an auction-like manner, which prices are "sticky," and what form that stickiness takes, lead to important differences in how model economies react to external shocks and to policy.

This debate is important. But, in a sense, it is also arid since it seems most unlikely that there is one "correct" model of the labor and product markets in any economy of moderate complexity. For example some markets may behave like auctions, some may have multi-period nominal contracts, others may have multi-period real contracts, and so on.

We show in this paper that the variety of possible forms of contracting poses problems for the econometrician and for the policymaker that do not arise in models where all contracts are of one type. And we show that these aggregation problems are particularly severe in the presence of supply shocks.

2. Pure Economies

We view the economy as comprised of a number of distinct sectors, each of which employs one type of labor and produces a single, nonstorable output.[1] In this section, we consider a

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[1]If output is storable, additional complexities arise, most of which are beside the point for present purposes. For a look at some of these issues, see, among others, Blinder (1981a, 1982).

variety of simple models of one-sector economies and derive some elementary results which are later used in our discussion of multi-sector economies. Each of our pure economies is characterized by the following four equations:

(1) $m_t + v_t = p_t + y_t^D$

(2) $y_t^S = a\ell_t + s_t$

(3) $\ell_t^D = -bw_t + \beta s_t$

(4) $\ell_t^S = cw_t$,

where:

m_t = log of the money stock

p_t = log of the price level

y_t = log of real output

ℓ_t = log of employment

w_t = log of the real wage

v_t = a random demand shock (log of velocity)

s_t = a random supply shock

It is assumed that all parameters--a, b, c, and β--are positive and that units are chosen to make the Walrasian equilibrium values of each endogenous variable unity (hence its log is zero) when the money supply is unity and the shocks v_t and s_t are zero. This eliminates inessential constants from all equations.

Equation (1) is the quantity theory of aggregate demand. Complications having to do with interest rates and fiscal policy are suppressed because they are tangential to the concerns of the paper and would only cloud the issues.

Equation (2) is a production function; the shock s_t is a stochastic productivity term indicative of such factors as weather, technology, or oil prices. Equation (3) is the labor demand function implied by the production function. The log-linear forms of (2) and (3) are best viewed as approximations. If the shock is <u>exactly</u> multiplicative, as (2) suggests, then $b = \beta$ in (3).

Equation (4) is the labor supply function, which we take to be non-stochastic for simplicity. In addition, we do not distinguish between short-run and long-run wage elasticities of labor supply, also for simplicity.

The remainder of this section considers five different pure economies which close the above model with different assumptions about which markets clear and which do not clear (and why).

The Type 1 Economy: Classical

In the Type 1 economy, the real wage and the price level adjust instantly to clear the two markets. Equating $y^S = y^D = y$ and $\ell^S = \ell^D = \ell$, we can derive the following solutions for the four endogenous variables:

$$(5) \quad y_t^* = \gamma s_t$$

$$(6) \quad p_t^* = m_t + v_t - y_t^*$$

$$(7) \quad w_t^* = \frac{\beta}{b+c} s_t$$

$$(8) \quad \ell_t^* = \frac{c\beta}{b+c} s_t$$

where:

$$(9)\quad \gamma \equiv \frac{ac\beta+b+c}{b+c} > 1 \quad .$$

Henceforth, an asterisk indicates the Walrasian market-clearing equilibrium value for any variable.

Naturally, the real variables (y_t, w_t, and ℓ_t) are independent of demand factors (m_t and v_t), and monetary policy is, consequently, neutral. An adverse supply shock--a negative value of s_t--lowers employment, output, and real wages below their no-shock levels, and raises the price level. Thus, even in this simple classical economy, an "energy shock" leads to many of the symptoms of stagflation. The one missing symptom is unemployment, since the labor market always clears.

The Type 2 Economy: Nominal Wage Contracts

The Type 2 economy differs in a way that is usually considered "Keynesian." The money wage, x_t, is set in advance, making it possible that, at this wage, the quantities of labor supplied and demanded are not equal. Following Fischer (1977), we assume that labor cedes to management the right to determine the volume of employment *ex post*. So the labor demand equation remains in force, while the labor supply equation is replaced by:

$$(4')\quad w_t + p_t = x_t \quad .$$

To figure out how x_t is set, notice that employment *ex post* will be:

$$\ell_t = -b(x_t - p_t) + \beta s_t \ ,$$

so that by (2) output will be:

$$y_t = -ab(x_t - p_t) + (1+a\beta)s_t \ ,$$

and consequently by (1) the price level will be:[1]

$$p_t = \frac{1}{1+ab}[m_t + v_t + abx_t - (1+a\beta)s_t] \ .$$

Suppose the nominal wage for period t is determined in period $t-j$. Then, under rational expectations, the expected value of p_t when the contract was written was:

$${}_{t-j}p_t = \frac{1}{1+ab}[\ {}_{t-j}m_t + {}_{t-j}v_t + ab\ x_t - (1+a\beta)\ {}_{t-j}s_t] \ ,$$

implying that the expected real wage was:

$${}_{t-j}w_t = x_t - {}_{t-j}p_t = \frac{1}{1+ab}[x_t - {}_{t-j}m_t - {}_{t-j}v_t + (1+a\beta)\ {}_{t-j}s_t] \ .$$

If we assume that the contract sets x_t so as to make this last expression equal to the anticipated Walrasian equilibrium wage as given by (7),[2] then simple algebra establishes that:

$$x_t = {}_{t-j}m_t + {}_{t-j}v_t + \frac{\beta(1-ac)-b-c}{b+c}\ {}_{t-j}s_t \ .$$

If this solution for the nominal wage is plugged back into the previous expressions the following solutions emerge:

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[1] The goods market is assumed to clear instantly.

[2] A more sophisticated treatment would assume Pareto optimal wage bargaining rather than expected market clearing.

$$(10)\quad y_t^2 = \frac{ab}{1+ab}(z_t - {}_{t-j}z_t) + \frac{1+a\beta}{1+ab}(s_t - {}_{t-j}s_t) + \gamma_{t-j}s_t$$

$$(11)\quad p_t^2 = z_t - y_t^2$$

$$(12)\quad w_t^2 = -\frac{1}{1+ab}(z_t - {}_{t-j}z_t) + \frac{1+a\beta}{1+ab}(s_t - {}_{t-j}s_t) + \frac{\beta}{b+c}\ {}_{t-j}s_t$$

$$(13)\quad \ell_t^2 = \frac{b}{1+ab}(z_t - {}_{t-j}z_t) + \left(\frac{\beta-b}{1+ab}\right)(s_t - {}_{t-j}s_t) + \frac{\beta c}{b+c}\ {}_{t-j}s_t\ ,$$

where, to economize on notation, we have defined a new variable:

$$(14)\quad z_t \equiv m_t + v_t\ .$$

The intuition behind these equations is straightforward. A fully anticipated change in aggregate demand ($z_t = {}_{t-j}z_t$) and a fully anticipated supply shock ($s_t = {}_{t-j}s_t$) have the same effects as in the classical model because, at the time of the contract, the nominal wage adjusts fully to anticipated events.

However, unanticipated changes in demand have real effects--for the usual reasons. An unanticipated drop in demand, for example, will make prices lower than expected at the time of the contract. With a contractual nominal wage, this means that the real wage will be higher than expected and, consequently, employment and real output will be lower than expected.

An unanticipated decline in productivity lowers both output and real wages. However, the effect on employment is ambiguous because two conflicting forces are at work: the lower marginal product of labor reduces the quantity of labor demanded, but the lower real wage increases it.[1]

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[1] In the case of a multiplicative shock ($b=\beta$), employment is unaffected.

Because of the sticky wage, unanticipated shocks cause disequilibrium in the labor market. For convenience, define the unemployment rate as $\ell^S - \ell^D$. Then, using the solution equations (12) and (13) and the labor supply function (4), we compute that:

$$(15)\quad \ell^S - \ell^D = -\frac{(b+c)}{1+ab}(z_t - {}_{t-j}z_t) + \frac{b+c-\beta(1-ac)}{1+ab}(s_t - {}_{t-j}s_t) .$$

Clearly, an unanticipated drop in demand causes unemployment. An unanticipated drop in productivity has an ambiguous effect on unemployment. In the special multiplicative case (β=b), the coefficient of $s_t - {}_{t-j}s_t$ is $c > 0$, so adverse shocks reduce unemployment. (Employment is fixed while notional labor supply falls.)

The Type 3 Economy: Nominal Price Contracts

Goods as well as labor are often supplied at nominal prices determined in advance. In the Type 3 economy, the wage is free to adjust, but the nominal price level is set in advance by a contract. Specifically, firms are assumed to commit themselves to supply whatever quantity consumers demand at a pre-set price, p_t, and to hire whatever labor is necessary to make good on this commitment.[1] Thus, returning to the original system (1)-(4), equations (1), (2), and (4) continue to hold, but (3) is replaced by:

[1] In a more complicated model with inventories, firms would presumably use inventory draw-downs and buildups to buffer production from fluctuations in demand.

$$(3') \quad \ell_t^D = \frac{y_t^D - s_t}{a} \quad .$$

The wage rate is assumed to move so as to equate $\ell_t^D = \ell_t^S = \ell$, and firms are assumed always to produce the quantity demanded so $y_t^S = y_t^D = y$.

To complete the model, we must determine the contractual price level. We assume that firms at time $t-j$ set prices that they expect will clear the market at time t . If the pre-set price level is p_t, firms will (rationally) expect to sell:

$$_{t-j}y_t = {}_{t-j}z_t - p_t$$

To produce this much output, labor demand will have to satisfy (3'), and hence, according to the labor supply function (4), the expected real wage will have to be:

$$_{t-j}w_t = \frac{_{t-j}z_t - p_t - {}_{t-j}s_t}{ac} \quad .$$

Firms will pick p_t to make this expected real wage fall on their notional demand curve for labor--equation (3), viz.:

$$_{t-j}\ell_t^D = \frac{_{t-j}z_t - p_t - {}_{t-j}s_t}{a} = -b\left[\frac{_{t-j}z_t - p_t - {}_{t-j}s_t}{ac}\right] + \beta\,{}_{t-j}s_t .$$

Solving for the requisite p_t gives:

$$(16) \quad p_t^3 = {}_{t-j}z_t - \gamma\,{}_{t-j}s_t \ ,$$

and from this the rest of the solution follows:

(17) $y_t^3 = z_t - {}_{t-j}z_t + \gamma\, {}_{t-j}s_t$

(18) $\ell_t^3 = \frac{z_t - {}_{t-j}z_t}{a} - \frac{s_t - {}_{t-j}s_t}{a} + \frac{c\beta}{b+c}\ {}_{t-j}s_t$

(19) $w_t^3 = \frac{z_t - {}_{t-j}z_t}{ac} - \frac{s_t - {}_{t-j}s_t}{ac} + \frac{\beta}{b+c}\ {}_{t-j}s_t$.

Once again, the effects of fully anticipated shocks are the same as in the classical model, and for the same reason. An unanticipated demand shock cannot raise the price level, which is predetermined, and so instead raises output, employment, and the wage rate (both nominal and real).

The effects of an unanticipated drop in productivity are interesting in this model. Because the price level is predetermined, aggregate demand is unaffected by such a shock. And, since the obverse of Say's law holds in this economy (demand creates its own supply), output cannot be affected (see equation (17)). Employment must rise to compensate for the drop in productivity (equation (18)), and real wages must rise to attract the requisite volume of employment (equation (19)). There is no unemployment. These are not the sort of reactions usually thought to characterize an energy shock.

The Type 4 Economy: Real Wage Contracts

The Type 4 economy is extremely simple to analyze, and is sometimes thought to characterize advanced European economies.[1] Wages are assumed to be fully indexed, and the real wage to prevail in period t is set in period $t-j$. However, the price level is assumed to adjust to clear the goods market.

As usual, we assume that w_t is set at its expected Walrasian market-clearing level which, by (7) is:

$$(20) \quad w_t^4 = {}_{t-j}w_t^* = \frac{\beta}{b+c}\, {}_{t-j}s_t \; .$$

As was the case in the Type 2 economy, the wage is predetermined and the firm gets to select the level of employment. Hence we suspend the labor supply function and use the labor demand function (3) to conclude that employment will be:

$$\ell_t = -bw_t + \beta s_t = -b[\frac{\beta}{b+c}\, {}_{t-j}s_t] + \beta s_t \; ,$$

or

$$(21) \quad \ell_t^4 = \beta(s_t - {}_{t-j}s_t) + \frac{\beta c}{b+c}\, {}_{t-j}s_t \; .$$

Output then follows directly from the production function:

$$(22) \quad y_t^4 = (1+a\beta)(s_t - {}_{t-j}s_t) + \gamma\, {}_{t-j}s_t \; ,$$

and the price level adjusts to make consumers demand this much output:

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[1]See, for example, Branson and Rotemberg (1980) or Sachs (1979).

$$(23) \quad p_t^4 = z_t - y_t^4 \ .$$

In this model, there are no <u>nominal</u> rigidities, and so changes in aggregate demand cannot affect any real variables. Money is again neutral. If an unanticipated drop in productivity--an "energy shock"--occurs, the real wage is fixed, and so labor supply is also fixed. But labor demand declines--see equation (21), and so there is unemployment. Specifically, unemployment is:

$$(24) \quad \ell^S - \ell^D = -\beta(s_t - {}_{t-j}s_t) \ .$$

As always, an energy shock lowers output and raises prices.

<u>The Type 5 Economy: Both Wage and Price Contracts</u>

The Type 5 economy is a hybrid in which neither wages nor prices are free to clear markets; both are predetermined by contracts. It is immaterial whether we consider the labor contract to fix the nominal wage or the real wage; since the price level is also fixed, the two amount to the same thing.

For convenience of exposition, we will consider the Type 5 economy to be a combination of Type 3 (fixed price level) and Type 4 (fixed real wage). Hence the price level is given by (16):

$$(25) \quad p_t^5 = p_t^3 = {}_{t-j}z_t - \gamma_{t-j}s_t \ ,$$

while the real wage is given by (20):

$$(26)\quad w_t^5 = w_t^4 = \frac{\beta}{b+c}\ {}_{t-j}s_t\ .$$

In this economy, we imagine that firms agree to provide whatever quantity is demanded at the predetermined price level, and workers agree to supply enough labor to produce this quantity at the predetermined real wage. Thus it follows directly from (1) that output is:

$$(27)\quad y_t^5 = (z_t - {}_{t-j}z_t) + \gamma\ {}_{t-j}s_t\ ,$$

and it follows directly from (2) that employment is:

$$(28)\quad \ell_t^5 = -\frac{1}{a}(s_t - {}_{t-j}s_t) + \frac{1}{a}(z_t - {}_{t-j}z_t) + \frac{c\beta}{b+c}\ {}_{t-j}s_t\ .$$

In this hybrid economy, unanticipated demand shocks do affect real output and employment (they cannot affect the real wage, which is predetermined) because of nominal rigidities. Unanticipated supply shocks cannot affect wages or prices, which are predetermined. Instead, an energy shock lowers output and <u>raises</u> employment (see equations (27) and (28)). Since, under a fixed real wage, notional labor supply is unaffected, an unanticipated energy shock here causes over-employment, viz.:

$$(29)\quad \ell^S - \ell^D = \frac{1}{a}(s_t - {}_{t-j}s_t) - \frac{1}{a}(z_t - {}_{t-j}z_t)\ .$$

Summary

The preceding analyses of the five types of economies can be easily summarized for future reference. The deviation of output from its Walrasian equilibrium level ("natural rate") can always be expressed as:

$$(30) \quad y_t - y_t^* = \psi_z^i (z_t - {}_{t-j}z_t) + \psi_s^i (s_t - {}_{t-j}s_t) ,$$

where the coefficients ψ_z^i and ψ_s^i depend on the type of economy (i) and are given in Table 1. Analogously, the unemployment rate can always be written in the form:

$$(31) \quad \ell_t^S - \ell_t^D = \lambda_z^i (z_t - {}_{t-j}z_t) + \lambda_s^i (s_t - {}_{t-j}s_t) ,$$

where the coefficients λ_z^i and λ_s^i are as indicated in Table 2. Finally, the rate of unanticipated inflation (we assume that anticipated inflation is costless, and hence of no concern) takes the form:

$$(32) \quad p_t - {}_{t-j}p_t = \pi_z^i (z_t - {}_{t-j}z_t) + \pi_s^i (s_t - {}_{t-j}s_t) ,$$

where Table 3 gives the relevant coefficients for each economy.

3. Policy Reactions to Demand Shocks

It is probably transparent from the structure of the model that the policymaker's problem is trivial when demand shocks occur. This section shows that optimal monetary policy will fully offset anticipated movements in velocity.

TABLE 1

Effects of Shocks on Output

Economy Type	Demand Shock (ψ_z^i)	Supply Shock (ψ_s^i)
1. Classical	0	0
2. Nominal Wage Contracts	$\frac{ab}{1+ab} > 0$	$\frac{1+a\beta}{1+ab} - \gamma$?
3. Nominal Price Contracts	1	$-\gamma < 0$
4. Real Wage Contracts	0	$1 + a\beta - \gamma = \frac{ab\beta}{b+c} > 0$
5. Both Wage and Price Contracts	1	$-\gamma < 0$

TABLE 2

Effects of Shocks on Unemployment

Economy Type	Demand Shock (λ_z^i)	Supply Shock (λ_s^i)
1. Classical	0	0
2. Nominal Wage Contracts	$\frac{-(b+c)}{1+ab} < 0$	$\frac{b+c-\beta(1-ac)}{1+ab} = \frac{b+c}{ab}(\gamma - \frac{1+a\beta}{1+ab})$?
3. Nominal Price Contracts	0	0
4. Real Wage Contracts	0	$-\beta < 0$
5. Both Wage and Price Contracts	$-\frac{1}{a} < 0$	$\frac{1}{a} > 0$

TABLE 3

Effects of Shocks on Unanticipated Inflation

Economy Type	Demand Shock (π_z^i)	Supply Shock (π_s^i)
1. Classical	1	$-\gamma < 0$
2. Nominal Wage Contracts	$\frac{1}{1+ab} > 0$	$-(\frac{1+a\beta}{1+ab}) < 0$
3. Nominal Price Contracts	0	0
4. Real Wage Contracts	1	$-(1+a\beta) < 0$
5. Both Wage and Price Contracts	0	0

For this section only, assume that all movements in productivity are fully anticipated so that $s_t - {}_{t-j}s_t = 0$ every period. Suppose the monetary authority is planning to use a lagged feedback rule of the form:

$$m_t = -g\ {}_{t-1}v_t ,$$

and wants to choose g so as to minimize the variance of y_t around y_t^*. Under the assumed policy rule, $z_t - {}_{t-j}z_t$ can be written:

$$\begin{aligned} z_t - {}_{t-j}z_t &= (-g_{t-1}v_t + v_t) - (1-g)_{t-j}v_t \\ &= (1-g)({}_{t-1}v_t - {}_{t-j}v_t) + (v_t - {}_{t-1}v_t) \end{aligned}$$

To simplify the notation, denote the first term by η_t. It indicates the new information about velocity that the monetary authority has, but that was not available to labor and management when they wrote contracts at time t-j. Call the second term the innovation, ε_t. Then we have simply:[1]

$$z_t - {}_{t-j}z_t = (1-g)\eta_t + \varepsilon_t$$

and using (30) it follows immediately that:

$$E(y_t - y_t^*)^2 = (\psi_z^1)^2[(1-g)^2\sigma_\eta^2 + \sigma_\varepsilon^2] .$$

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[1]If contracts are only one period long (j=1), there is no information and no stabilization is possible.

In Type 1 (classical) or Type 4 (real wage rigidity) economies, ψ_z^i is zero and this expression is zero regardless of monetary policy. Money is neutral in these economies. In any of the other three types of economies, the variance of output around the natural rate is minimized by setting $g=1$, that is, by offsetting fully any anticipated fluctuations in velocity.[1]

The important point to note is that full offset is optimal <u>regardless</u> of the numerical value of ψ_z^i. Furthermore, referring to equations (31) and (32) and Tables 2 and 3, we see that the variance of either unemployment or unanticipated inflation, where nonzero, is always strictly proportional to the variance of unanticipated demand. Hence $g=1$ is always the optimal stabilization policy, regardless of the specific goals or coefficients involved.

This rule ($g=1$) is a familiar one. It implies that ${}_{t-1}(m_t + v_t) = 0$, and hence by (1) that ${}_{t-1}(y_t + p_t) = 0$. In words, the policy is to try to stabilize nominal GNP.[2]

The main finding of this section, however, is that insofar as demand shocks are concerned, the policymaker need not worry about which type of economy he is trying to stabilize. Every

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[1]If v_t were observed before m_t has to be set, the monetary authority would offset $v_t - {}_{t-1}v_t$ as well.

[2]Recall, however, that only demand shocks have been considered so far.

variance with which he is concerned is either zero regardless of what he does,[1] or is minimized by setting $g=1$. Consequently, if the economy is composed of a variety of sectors which have different types of contracts but experience the same shocks, the optimal demand-management policy for any one sector $(g=1)$ will also be optimal for all the others. As we shall see in the next section, this happy circumstance evaporates when there are supply shocks.

4. Policy Responses to Supply Shocks

In this section, we turn to supply shocks and, for simplicity, assume that $v_t = 0$ every period.[2] Hence we can replace the variable z_t by m_t, so output is given by:

$$(30') \quad y_t - y_t^* = \psi_z^i(m_t - {}_{t-j}m_t) + \psi_s^i(s_t - {}_{t-j}s_t) .$$

Consider monetary feedback rules of the form:

$$m_t = -\delta \; {}_{t-1}s_t .$$

Since, under this rule:

$$m_t - {}_{t-j}m_t = -\delta({}_{t-1}s_t - {}_{t-j}s_t) ,$$

we have:

$$(33) \quad y_t - y_t^* = \psi_s^i(s_t - {}_{t-1}s_t) + (\psi_s^i - \delta\psi_z^i)({}_{t-1}s_t - {}_{t-j}s_t) .$$

As we did in the last section, call the first term the <u>innovation</u>,

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[1]This statement leans heavily on the notion that anticipated inflation is costless, so policymakers are not concerned with the variance of p_t.

[2]The previous section shows that this assumption is inessential.

e_t , and the second term the new information, u_t . It follows from (33) that:

$$(34)\quad E(y_t - y_t^*)^2 = (\psi_s^i)^2\,\sigma_e^2 + (\psi_s^i - \delta\psi_z^i)^2\sigma_u^2 \ ,$$

which is minimized by setting:

$$(35)\quad \delta_i = \frac{\psi_s^i}{\psi_z^i} \ .$$

This defines the optimal setting of δ for output stabilization so long as ψ_z^i is not zero.[1]

Specifically, in a Type 2 economy (nominal wage rigidity), the optimal feedback parameter is:

$$(35')\quad \delta_2 = \frac{1+a\beta\ -\gamma(1+ab)}{ab} = \frac{1+ab}{ab}\left[\frac{1+a\beta}{1+ab} - \gamma\right] = \frac{1+ab}{ab}\,(\psi_s^2)\ ,$$

which is of indeterminate sign in general. Notice, however, that δ_2 has the same sign as the effect of the supply shock on output (ψ_s^2). In the case we normally think of, where output falls below the natural rate in response to an "energy shock," the optimal monetary policy is to increase the money supply, that is, to accommodate the shock. In the other case, where output falls less than the natural rate after an energy shock, the optimal policy is to decrease the money supply.

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[1]As Table 1 shows, ψ_z^i is zero in Type 1 and Type 4 economies. In these economies money is neutral, and there is no possibility of a monetary stabilization policy.

The optimal monetary policy is the same in Type 3 (nominal price contracts) and Type 5 (both wage and price contracts) economies, and is defined by:

$$(35'') \quad \delta_3 = \delta_5 = -\gamma < 0 .$$

In these economies, output does not fall after an energy shock (though the natural rate does), so it is optimal to <u>contract</u> the money supply in order to lower output.

In brief, if stabilization of output around its natural rate is the goal, the only possibility for an accommodating monetary policy to be optimal arises in an economy with rigid nominal wages, and even here is is only a possibility, not a certainty.[1]

Other stabilization goals lead to somewhat different optimal policies. If the authorities wish to stabilize the unemployment rate around zero, for example, policy is fruitless in Type 1, 3, and 4 economies. In Types 1 (classical) and 3 (rigid prices), unemployment never arises. In Type 4 (rigid real wages), unemployment is possible but monetary policy is powerless to do anything about it. An analysis identical to that just done for output stabilization shows that unemployment stabilization leads to the same optimal policy rule (δ given by (35')) in a Type 2 economy (rigid nominal wages), whereas the optimal policy in a Type 5 economy (rigid wages and prices) is now $\delta = -1$, that is, $m_t = {}_{t-1}s_t$. Decreases in

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[1]This issue is treated in greater depth in Blinder (1981b), where it is suggested that stabilization around the "natural rate" might not be optimal if supply shocks are transitory.

productivity thus call for equiproportionate declines in the money supply.

A parallel analysis can be conducted when the objective is to minimize the variance of unanticipated inflation. In economies of Type 3 (rigid prices) or Type 5 (rigid prices and wages), the issue does not arise because unanticipated inflation is impossible. In any of the other types, inflation stabilization naturally calls for a <u>reduction</u> in the money supply when productivity declines.

Obviously, more complex stabilization objectives--such as weighted averages of the three variances already considered--can be handled in the usual way. The optimal policy will depend on the welfare weights attached to output, unemployment and unanticipated inflation, and will differ across economy types. In a Type 2 economy (nominal wage rigidity), the optimal monetary response to an adverse supply shock <u>might be</u> accommodative. In each of the other economy types, however, some contraction of the money supply following an energy shock is optimal.

The most important point for our purposes, however, is that the optimal policy response to a supply shock is <u>different</u> in each of the five pure economies. This stands in stark contrast to the case of demand shocks, where the same policy (full offset) was optimal for all.

5. An Archipelago Economy

Real economies are not of any of our five pure forms. They consist of a variety of interrelated markets characterized by a variety of contracts of different types and different lengths. To model such a complex economy in full detail is an intractable task. However, it is possible to construct a rather simple model economy which nonetheless includes a variety of contract forms.

Consider an archipelago economy consisting of N islands. Each island has one labor market and one goods market, like one of our pure economies, and is isolated from the others. Neither goods nor labor can move from one island to another. However, the islands form a single economy in that they experience the same monetary policy (m_t) and the same shocks (v_t and s_t).

We know that velocity shocks are easily handled; so ignore them. And assume that the government of this archipelago economy wishes to minimize the variance of output around the natural rate. Output relative to the natural rate on each island is given by (30'), and so aggregate output in the archipelago is:[1]

$$(36)\quad Y_t - Y_t^* = [\sum_{i=1}^{5} \theta_i \psi_z^i](m_t - {}_{t-j}m_t) + [\sum_{i=1}^{5} \theta_i \psi_s^i](s_t - {}_{t-j}s_t)$$

$$\equiv \psi_z(m_t - {}_{t-j}m_t) + \psi_s(s_t - {}_{t-j}s_t) ,$$

where θ_i is the weight of each type of island in the total economy.

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[1] Aficionados of rational expectations models are used to playing fast and loose with Jensen's inequality and so will not mind defining national product as the sum of the logs of output on the individual islands.

Similar aggregate equations can be derived for the model's other variables, and some have interesting implications. Consider, for example, the cyclical behavior of real wages in a world of demand shocks only. On a Type 1 (classical) island, neither w_t nor y_t display any cyclical fluctuation. On a Type 2 (rigid money wage) island, positive demand shocks raise output and lower real wages; the real wage is countercyclical. On a Type 3 (rigid prices) island, an increase in demand raises both output and real wages; real wages move procyclically. On islands of Type 4 (rigid real wages) or Type 5 (rigid prices and wages), shocks do not change the real wage. Hence, in the archipelago economy, there is no *a priori* prediction about the cyclical covariation of real wages and output.

Let us concentrate, however, on equation (36) for output. Notice that it has a form identical to equation (30') for a pure economy. Consequently, a macroeconomist might build a theoretical model with a single aggregate labor market and a single aggregate goods market, based on one of the pure contract types considered in Section 2. If the weights, θ_i, were reasonably constant over time, he would obtain good results when estimating equation (36), and be led to conclude that aggregation did not greatly distort reality. However, we know that the archipelago economy cannot really be aggregated.

At any point in time, some labor markets may be on their notional supply curves, some may be on their notional demand curves, some may be on both, and some may be on neither. That the aggregate output equation is similar to the output equation for a single sector does not imply that aggregation across markets is permissible.

If the weights attached to the different types of islands were changing through time, the equation would show symptoms of "parameter drift." This explanation of parameter drift is an alternative to, but in no sense denies or excludes, Lucas' (1976) famous explanation of the same phenomenon.

Stabilization policy in the face of supply shocks poses even more formidable problems.[1] Even if we assume that every island in the archipelago has the same structural parameters (a, b, c, and β) and experiences identical supply shocks (s_t), our previous analysis has taught as that policies which are optimal for one type of island may not be optimal for an island that handles contracts differently. The directions of the optimal policies might even differ. Hence policymakers have to face up to a new kind of tradeoff in addition to the usual tradeoffs between inflation and unemployment, between internal and external balance, etc.--a tradeoff between stability on one island and stability on another. A proper approach to the stabilization problem may require the policymaker to assign relative welfare weights to stability on the various islands.

But what if these differences among islands are not recognized, or thought unimportant? We just suggested that an econometrician might mistakenly believe that the archipelago can be aggregated

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[1]As noted earlier, stabilization of demand shocks in the archipelago economy remains simple.

into a single goods market and a single labor market. He might offer his estimates of the aggregated economy to the policymaker, who might use them in the design of an "optimal" policy. Will such a procedure lead to disaster? Maybe and maybe not. In the remainder of this section we offer two examples of archipelago economies that illustrate some of the possibilities.

First Example

In our first example, the "optimal" policy calculated under the mistaken assumption that aggregation is permissible is nonetheless stabilizing on every island. The archipelago consists of a Type 2 island (nominal wage contracts) and a Type 3 island (nominal price contracts) of equal size, with $b=\beta=c$. Hence the two output equations are:

$$y_t^2 - y_t^* = \frac{ab}{1+ab}(m_t - {}_{t-j}m_t) - \frac{ab}{2}(s_t - {}_{t-j}s_t)$$

$$y_t^3 - y_t^* = m_t - {}_{t-j}m_t - (1 + \frac{ab}{2})(s_t - {}_{t-j}s_t) .$$

While both islands require contractionary monetary policy following a supply shock, the quantitative dimensions of the optimal policies differ $(\delta_2 = -\frac{1+ab}{2}, \delta_3 = -(1 + \frac{ab}{2}))$.
If the data are aggregated as before, we obtain

$$Y_t - Y_t^* = (\frac{1+2ab}{1+ab})(m_t - {}_{t-j}m_t) - (1+ab)(s_t - {}_{t-j}s_t) .$$

The "optimal" policy for the aggregated economy is readily computed to be:

$$\delta = -\frac{(1+ab)^2}{1+2ab} .$$

It turns out that, with this stabilization rule, the variance of output on each island is:

$$E(y_t - y_t^*)^2 = (\psi_s^i)^2\sigma_e^2 + (\frac{ab}{2})^2(\frac{1}{1+2ab})^2\sigma_u^2 \qquad i=2,3$$

whereas with no stabilization policy it would be:

$$E(y_t - y_t^*)^2 = (\psi_s^2)^2\sigma_e^2 + (\frac{ab}{2})^2\sigma_u^2$$

on island 2 and:

$$E(y_t - y_t^*)^2 = (\psi_s^3)^2\sigma_e^2 + (1 + \frac{ab}{2})^2\sigma_u^2$$

on island 3. Thus, in this example, though the two types of island have rather different individually-optimal stabilization policies, a common policy which is "second-best" on all islands is nevertheless better than nothing.

Second Example

Things are quite different in our second example, in which the stabilization policy believed to be optimal for the aggregated economy actually destabilizes some islands while stabilizing none. To construct this example, we assume that the archipelago consists of a Type 2 island and a Type 4 island. We again assume $b=\beta$, but now assume inelastic labor supply (c=0).

On the Type 2 island, output is given by:

$$y_t - y_t^* = \frac{ab}{1+ab}(m_t - {}_{t-j}m_t) ,$$

and so with no stabilization policy (and no demand shocks), the variance of output would be zero. On the Type 4 island, output is:

$$y_t - y_t^* = ab(s_t - {}_{t-j}s_t) ,$$

so that with or without stabilization policy,

$$E(y_t - y_t^*)^2 = (ab)^2(\sigma_e^2 + \sigma_u^2) .$$

Now consider aggregation. Output in the archipelago will be:

$$Y_t - Y_t^* = \frac{ab}{1+ab}(m_t - {}_{t-j}m_t) + ab(s_t - {}_{t-j}s_t) .$$

If this equation is used to design policy, the allegedly "optimal" stabilization rule will be thought to be:

$$\delta = \frac{\psi_s}{\psi_z} = 1+ab .$$

Straightforward calculations show that, with this choice of δ, the variance of output on island 2 will be:

$$E(y_t - y_t^*)^2 = (ab)^2\sigma_u^2 .$$

A totally passive monetary policy (δ=0) is clearly optimal for this economy because δ=0 is optimal on island 2. and δ is irrelevant on island 4. But an economist using the aggregate equation would design a "stabilization" policy that actually offsets declines in production (due to supply shocks) on island 4 with rises in production (due to demand stimulus) on island 2.

These examples do not exhaust the possibilities. We have also developed an example in which the "optimal" policy for the aggregated economy stabilizes output on some islands but destabilizes output on others. The only general conclusion is that there is no general conclusion. In an archipelago economy, stabilization policy for supply shocks that is designed on the (false) assumption of a single labor market and a single goods market may be unambiguously helpful, unambiguously harmful, or a little of each!

6. The Structure of Contracts

In what has been said so far, the type and duration of contracts has been taken as fixed. But in the long run the type or duration of contracts observed in an economy may well depend on the policy rule being followed. For example, consider an island choosing between real wage contracts and nominal wage contracts. As is well-known, with only supply shocks, agents will prefer nominal wage contracts; and with only velocity shocks, they will prefer real wage contracts.[1] However, if both types of shocks are present, the choice will depend on the relative variances of the two types of shocks and on the stabilization policy that agents expect. A change in stabilization policy can, in principle, lead to a change in the contract structure.

7. Summary

Real world economies probably consist of many sectors which handle contracts differently. As a consequence, important

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[1]See Gray (1976).

variables like output, prices, real wages, and employment may respond differently in different sectors even if all sectors experience the <u>same</u> external shocks.

Despite these differences, the optimal policy response to a purely nominal disturbance is the same in every sector: the money supply should fully offset any anticipated movement in velocity so as to stabilize expected nominal income completely.

But things are much more complicated where supply shocks are concerned. The optimal policy response to a supply shock is different in different sectors. <u>Quantitative</u> differences in the optimal policy are to be expected; <u>qualitative</u> differences are possible. A stabilization policy which appears optimal when the economy is (wrongly) aggregated may (but need not) actually destabilize some sectors.

Finally, whereas this paper emphasizes how the form of contracting influences the optimal stabilization policy, the choice of stabilization policy may also affect the choice of contract type.

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