The Role of Revenue Sharing in Optimal Stabilization Policy

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Abstract

Two recently popularized policy rules, price stabilization and nominal GNP stabilization, are analyzed in a model based on nominal wage contracting with wage indexation to price and firm nominal income. When there are only aggregate supply shocks, several alternative monetary policy-cum-indexation schemes are shown to be perfectly stabilizing. In the presence of both aggregate and firm-specific shocks, however, only a combination of nominal GNP stabilization and wage indexation to price is perfectly stabilizing. This result lends further support to advocates of nominal GNP stabilization. At the same time, it highlights the benefits and limits of indexing to firm nominal revenue, as indexing to firm revenue, coupled with price stabilization, is but one of several options that will perfectly stabilize the economy when firm-specific supply shocks are absent.

Introduction

The existence of wage rigidities due to nominal wage contracts suggests that monetary policy may play an important stabilizing role in responding to both demand and supply shocks. Fischer (1975) demonstrates the effectiveness of feedback monetary policy at counteracting past demand and supply shocks. His paper also demonstrates, however, that policy can not counteract current shocks completely. Gray (1976) looks at nominal wage contracts indexed to the price level in the first investigation of the stabilization possibilities via a combination of monetary policy and optimal wage indexation. The monetary policy–wage indexation schemes she investigates are capable only of partially offsetting the effects of current demand and supply shocks.

This initial work has been followed by a stream of studies examining the problem from a variety of perspectives. One important strand of this literature has investigated the relationship between the degree of indexing and the choice of monetary policy rule. Numerous studies have demonstrated that the choice

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among traditional policy rules (e.g., fixed money growth rule or interest rate peg) influences the degree of wage indexing, but that the combination of one of the traditional money rules with optimal indexing is not perfectly stabilizing.[1] For example, see Benavie and Froyen (1983, 1984), Fethke and Jackman (1984), Bradley and Jansen (1988b), and VanHoose and Waller (1989).

Another line of work has demonstrated a duality between wage indexing and contemporaneous monetary response to shocks. For example, see Aizenman and Frenkel (1985) and Turnovsky (1987). In these works, optimal monetary policy often renders wage indexing redundant. Aizenman (1986) demonstrates, however, that even a contemporaneous monetary response to price is suboptimal when the aggregate productivity shock is unobserved. He shows that when a contract labor market replaces an auction market for labor, two types of distortions occur. First, the resulting nominal wage rigidity reduces the ability of the labor market to respond optimally to shocks. This problem, by itself, can be resolved with indexing and monetary policy. Aizenman observes, however, that a second distortion is not mended as easily. This second distortion arises from the destruction of information that occurs when the spot wage no longer can be observed, due to the absence of an auction market. The information-revealing role of the real wage cannot be replaced when the monetary authority does not observe the aggregate productivity shock.[2]

Most of the papers in the literature, including those cited above, look at combinations of monetary policy and wage indexation to price. These investigations are motivated by the observation that wages sometimes are indexed to price (via COLA, cost-of-living adjustment clauses, for example). This has not precluded investigations of wider varieties of indexation agreements, but Karni's (1983) paper convincingly demonstrates that wage contracts indexed to a wide enough set of economic variables will be able to mimic perfectly the wages forthcoming in a competitive labor market and, hence, perfectly stabilize the economy. Since that paper, work on wage indexation has refocused on studies of the pragmatic case of wage indexing to price, and the papers have continued to conclude that wage indexing to price, coupled with assorted monetary policies, will not be perfectly stabilizing.

This paper examines the alternative indexation clause widely observed in empirical wage agreements. This indexation clause is indexation to firm nominal revenue. Many workers have wage agreements giving them a share of either firm

[1] In this work it typically is assumed that perfect stabilization occurs when the economy reaches the same output level as would occur in a pure auction market for labor. Aizenman (1986) discusses this assumption in detail.

[2] Turnovsky (1987) shows that when the policy maker can observe directly the contemporaneous productivity shock and wages are indexed optimally to the price level, a complicated monetary policy response equation can be derived that is perfectly stabilizing.

revenue or firm profit. Moreover, studies of share agreements have been popular in the last few years, with Weitzman (1983, 1985) being the most ardent champion. Finally, by indexing wages to firm revenue, it may be possible for indexation agreements coupled with the right monetary policy to offset shocks to the economy fully.

This investigation finds that in an economy with only aggregate supply shocks, revenue sharing and a monetary price stabilization rule are able to offset perfectly both the aggregate supply shock and the demand shock. The investigation also finds, however, that this is not a unique feature of revenue sharing. Wage indexing to price coupled with a monetary nominal GNP stabilization rule is also perfectly stabilizing, as is an indexation rule indexing wages to both price and firm revenue.[3] Thus, revenue sharing has some desirable properties in the case of only aggregate supply shocks, but these desirable properties are shared with alternative indexation agreements.

This paper also investigates revenue sharing in the presence of both aggregate and firm-specific supply shocks. In this case one might think that revenue sharing would allow a response of wages to the firm-specific shocks and, thus, be superior to the alternatives. The current research demonstrates, however, that revenue sharing and a monetary price stabilization rule will not be perfectly stabilizing in the case of both aggregate and firm-specific supply shocks. Wage indexing to both firm revenue and the price level will not be perfectly stabilizing in the situation. The combination of wage indexing to price and a monetary nominal GNP stabilization rule is perfectly stabilizing, however. This adds further support to previous studies by Bean (1983) and Bradley and Jansen (1989a, 1989b) extolling nominal GNP stabilization.

The Frictionless Economy

Consider an economy with N firms selling output in a competitive market, where each firm produces an infinitesimal share of total output. Output is produced via a log-linear production technology employing capital, a fixed factor, and labor, a variable factor. The supply of labor depends on the real wage. For expositional ease and without loss of generality, all variables are logarithmic deviations from stationary equilibrium, normalized to zero. All exogenous stochastic disturbances are zero mean, serially and mutually uncorrelated, white noise stochastic processes.

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[3]Bean (1983) shows that nominal income targeting is perfectly stabilizing if labor supply is perfectly inelastic. His demonstration does not consider indexing and considers only aggregate supply shocks. Bradley and Jansen (1989) show that nominal income targeting with optimal wage indexing to price is perfectly stabilizing regardless of the labor supply elasticity. They also limit their analysis to aggregate supply shocks, however.

The labor market is a competitive market with an economy-wide equilibrium price. Labor supply is given by:

(1) $n_t^s = \varepsilon(w_t - p_t)$, where $\varepsilon > 0$.

Firms are indexed by the variable z. The production function facing each firm is given by:

(2) $y_t^s(z) = \beta n_t(z) + \mu_t + \eta_t(z)$, where $0 < \beta < 1$.

Here μ_t is the aggregate shock to production, common to all firms, and $\eta_t(z)$ is the firm-specific shock. Firms maximize profits subject to the production function, and labor is the only variable factor. Profit maximization requires that firms hire labor until the marginal product of labor equals the real wage. This implies that the labor demand equation is given by:

(3) $n_t^d(z) = \sigma(p_t - w_t + \mu_t + \eta_t(z))$, where $\sigma = 1/(1 - \beta)$.

The aggregate demand for labor equation is given by averaging equation (3) over all firms z. This yields aggregate labor demand as:

(4) $n_t = \frac{1}{N}\sum_z n_t^d(z) = \sigma(p_t - w_t + \mu_t)$.

Similarly, the aggregate production function is found by averaging equation (2) over all firms z, yielding:

(5) $y_t = \frac{1}{N}\sum_z y_t(z) = \beta\sigma(p_t - w_t) + \sigma\mu_t$.

In the labor market, equilibrium between labor supply and labor demand yields the equilibrium real wage and equilibrium aggregate employment of labor. Using the superscript * to indicate competitive equilibrium values, the equilibrium real wage and aggregate employment satisfy:

$$(6)\ (w_t - p_t)^* = \frac{\sigma}{\varepsilon + \sigma}(\mu_t),$$

and

$$(7)\ n_t^* = \frac{\varepsilon\sigma}{\varepsilon + \sigma}\mu_t .$$

These values for the equilibrium real wage and quantity of labor are used to find the equilibrium quantity of labor used by each firm z as:

$$(8)\ n_t^*(z) = \frac{\varepsilon\sigma}{\varepsilon + \sigma}\mu_t + \sigma\eta_t(z).$$

Finally, the aggregate and firm-specific equilibrium quantities of labor (as given by equations (7) and (8), respectively) can be used to find the equilibrium aggregate and firm-specific supply equations via the firm-specific and aggregate production functions (equations (2) and (5), respectively). These supply equations are:

$$(9)\ y_t^* = \frac{\sigma(\varepsilon + 1)}{\varepsilon + \sigma}\mu_t$$

and

$$(10)\ y_t^*(z) = \frac{\sigma(\varepsilon + 1)}{\varepsilon + \sigma}\mu_t + \sigma\eta_t(z).$$

The demand side is specified simply. Aggregate demand is given by a quantity equation with random velocity. This equation is represented as a money demand equation:

$$(11)\ m_t^d = p_t + y_t + v_t.$$

Monetary policy is represented by a money supply equation, given as:

$$(12)\ m_t^s = \gamma_1 p_t + \gamma_2(p_t + y_t).$$

A money growth rule exists when $\gamma_1 = \gamma_2 = 0$, a price stabilization rule exists when $\gamma_1 \rightarrow \infty$, and a nominal GNP stabilization rule prevails when $\gamma_2 \rightarrow \infty$. For instance, a money growth rule is $m_t^s = 0$. (All variables are written as logarithmic deviations from stationary equilibrium values that are normalized to zero.) A price stabilization rule, with $\gamma_1 \rightarrow \infty$, is $p_t = 0$. Finally, nominal GNP stabilization, with $\gamma_2 \rightarrow \infty$, can be written as $p_t + y_t = 0$. Rearranging equation (11) and substituting for aggregate output using the aggregate supply equation (10), a price equation can be derived as:

$$(13)\ p_t^* = m_t^s - v_t - \frac{\sigma(\varepsilon + 1)}{\varepsilon + \sigma} \mu_t \ .$$

The Economy With Nominal Wage Contracting

In this economy, nominal wages at time t are governed by contracts signed at time t-1. Employment is determined by labor demand.[4] Wages may be indexed to firm nominal income or to price.[5] It is important that firms and workers in market z can observe at time t both the price of output, p_t, and nominal income, $(p_t+y_t(z))$. Thus, the nominal wage contract can be written conditioned on these variables. The nominal wage contracting equation is given by:

$$(14)\ w_t^c(z) = \bar{w} + b_1(p_t - p_{t/t-1}) + b_2[(p_t + y_t(z)) - (p_{t/t-1} + y_{t/t-1}(z))],$$

where:

$$\bar{w} = p_{t/t-1}.$$

That is, the contract wage w_t^c is set at the expected price level, $p_{t/t-1}$ and can be indexed to unexpected deviations from that price level, $p_t - p_{t/t-1}$, via the indexing parameter b_1. It also can be indexed to unexpected changes in firm nominal income, $p_t + y_t(z) - p_{t/t-1} - y_{t/t-1}(z)$, via the parameter b_2.

Employment is demand determined, so using equation (14) in the labor demand equation (4) yields:

[4]Barro (1977) makes clear that this contractual arrangement may not be pareto optimal. The use of this Fischer (1977)-Gray (1976) framework is justified by its descriptive relevance for real world labor markets. In such markets, it appears that workers and firms negotiate nominal wages and that firms determine employment. This paper does not pretend to explain why this framework may be the labor market institution of choice. Instead, the informational content of aggregate variables under alternative policy and indexation arrangements when the labor market institutions accord with those described here are examined. See the works of Espinosa and Rhee (1989), and Pohjola (1987) who provide further justifications for this framework.

[5]Previous authors (e.g., Weitzman, 1983, 1985; Holmlund, 1990) have considered the impact of revenue sharing schemes on labor demand. This research focuses instead on the informational aspects of revenue sharing for macroeconomic policy.

$$(15)\ n_t(z) = \frac{\sigma}{1 + \sigma\beta b_2} [(1 - b_1 - b_2)(p_t - p_{t/t-1}) + (1 - b_2)(\mu_t + \eta_t(z))].$$

From equation (15) and the firm production function (2), the supply equation for firm z is:

$$(16)\ y_t(z) = \frac{\sigma\beta}{1 + \sigma\beta b_2} (1 - b_1 - b_2)p_t + \frac{\sigma}{1 + \sigma\beta b_2} (\mu_t + \eta_t(z)).$$

To derive the aggregate equations for employment and output as functions of the price level, equations (15) and (16) are averaged over all firms z. This yields an aggregate employment equation and an aggregate output equation, given by:

$$(17)\ n_t = \frac{\sigma}{1 + \sigma\beta b_2} [(1 - b_1 - b_2)p_t + (1 - b_2)\mu_t]$$

and

$$(18)\ y_t = \frac{\sigma\beta}{1 + \sigma\beta b_2} (1 - b_1 - b_2)p_t + \frac{\sigma}{1 + \sigma\beta b_2} \mu_t.$$

Finally, in order to derive a reduced form for price, the money supply rule, equation (12), can be substituted into the equation for price, equation (13), to obtain:

$$p_t = \frac{(\gamma_2 - 1)y_t - v_t}{1 - \gamma_1 - \gamma_2}.$$

This expression and the aggregate output equation, equation (18), can be used to derive the reduced form for price as:

$$(19)\ p_t = \frac{(\gamma_2 - 1)\sigma\mu_t - (1 + \sigma\beta b_2)v_t}{(1 - \gamma_2)[1 + \sigma\beta - \sigma\beta b_1] - \gamma_1[1 + \sigma\beta b_2]}.$$

Finally, this reduced form for price can be substituted into equations (16) and (15) to yield reduced form equations for firm-specific output and employment, respectively:

$$(20)\ y_t(z) = \frac{\sigma\beta(1 - b_1 - b_2)}{1 + \sigma\beta b_2} \left[\frac{(\gamma_2 - 1)\sigma\mu_t - (1 + \sigma\beta b_2)v_t}{(1 - \gamma_2)[1 + \sigma\beta - \sigma\beta b_1] - \gamma_1[1 + \sigma\beta b_2]}\right]$$

$$+ \frac{\sigma}{1 + \sigma\beta b_2}(\mu_t + \eta_t(z)).$$

and

$$(21)\ n_t(z) = \frac{\sigma(1 - b_1 - b_2)}{1 + \sigma\beta b_2}\left[\frac{(\gamma_2 - 1)\sigma\mu_t - (1 + \sigma\beta b_2)v_t}{(1 - \gamma_2)[1 + \sigma\beta - \sigma\beta b_1] - \gamma_1[1 + \sigma\beta b_2]}\right]$$

$$+ \frac{\sigma(1 - \beta_2)}{1 + \sigma\beta b_2}(\mu_t + \eta_t(z)).$$

The welfare loss from wage contracting can be measured by the difference between employment under nominal wage contracting[6] and employment in a competitive labor market. Taking the competitive market as efficient, the nominal wage contracting economy deviates from the competitive ideal only due to wage contracting. Eliminating this inefficiency is the stabilization goal of macroeconomic policy. That is, the goal of monetary policy is to have the contracting economy respond to disturbances in the same way that the competitive economy would respond to the same disturbances. Formally, the monetary authority wants to minimize:

$$WL = E\left[\sum_{z=1}^{N} c(z)(n_t(z) - n_t^*(z))^2\right],$$

where:

$c(z)$ = The weight assigned to firm z, $0 < c(z) < 1$; and

$$\sum_{z=1}^{N} c(z) = 1.$$

Optimal policies minimize the expected welfare loss, conditional on the information available to the policy maker. It is assumed that firms can observe their nominal income and price, while policy makers can observe aggregate nominal income and price. In the presence of both aggregate and relative supply

[6] Aizenman and Frenkel (1985) discuss this welfare measure in more detail. For an alternative approach to partial price stabilization based on stochastic dominance rules, see Baye (1985).

shocks and random velocity, the aggregate supply shock μ is not known with certainty by the individual firm, although the policy maker is able to discover the aggregate supply shock from knowledge of p_t and y_t, which are functions of only μ_t and v_t.[7]

In this model, the goal of both policy makers and firms is to minimize the difference between employment under nominal wage contracting and that under competitive labor markets. This difference is given by:

$$(22)\ n_t(z) - n_t^*(z) =$$

$$\left[\frac{\sigma\{\sigma b_1(1-\gamma_2)[1-\beta(1-b_2)] - (1-b_2)\gamma_1(1+\sigma\beta b_2)\}}{(1+\sigma\beta b_2)\{(1-\gamma_2)\sigma[1-\beta b_1] - \gamma_1(1+\sigma\beta b_2)\}} - \frac{\varepsilon\sigma}{\varepsilon+\sigma}\right]\mu_t$$

$$+\left[\frac{-\sigma(1-b_1-b_2)}{\{(1-\gamma_2)\sigma[1-\beta(1-b_1)] - \gamma_1(1+\sigma\beta b_2)\}}\right]v_t$$

$$+\left[\frac{\sigma(1-b_2)}{1+\sigma\beta b_2} - \sigma\right]\eta_t(z).$$

Inspection of equation (22) reveals that as long as money demand is subject to stochastic shocks, a necessary but not sufficient condition for perfect stabilization is that the coefficient on v_t is zero. This requires:

- $1 - b_1 - b_2 = 0$; or
- $\gamma_2 \to \infty$ (nominal GNP stabilization); or
- $\gamma_1 \to \infty$ (price stabilization).[8]

Each of these is considered in turn.

Price stabilization, $\gamma_1 \to \infty$, is considered first. In this case, equation (22) becomes:

[7]This points out another policy arrangement. The monetary authority could set $m_t = t$ and announce μ_t. Armed with such an announcement, firms and workers could index to price, firms' income, and μ_t.

[8]These three cases are examined for pedagogical convenience. For $n_t(z) = n_t^*(z)$, it is necessary for the coefficients on μ_t, v_t, and $\eta_t(z)$ to be jointly zero. The approach of this research is to look at what is required to set the coefficient on v_t to zero and then to see if the coefficients on μ_t and $\eta_t(z)$ can be set to zero while satisfying these requirements.

$$(23)\ n_t(z) - n_t^*(z) = \left[\sigma(1 - b_2) - \frac{\varepsilon\sigma}{\varepsilon + \sigma}\right] \mu_t + \left[\frac{\sigma(1 - b_2)}{1 + \sigma\beta b_2} - \sigma\right] \eta_t(z).$$

Inspection of equation (23) indicates that the optimal setting for responding to aggregate supply shocks, μ_t, is $b_2^* = \sigma/(\sigma + \varepsilon)$. The optimal setting for responding to firm-specific supply shocks, $\eta_t(z)$, however, is $b_2^* = 0$. Thus, no setting for b_2^* is perfectly stabilizing in the presence of both aggregate and firm-specific supply shocks and a monetary policy of price stabilization.

Aizenman considered a model in which firm-specific supply shocks were absent. In that case, a perfectly stabilizing indexation rule that calls for indexation to firm nominal income can be provided. In the absence of firm-specific shocks, firm nominal income and (average) aggregate nominal GNP are the same. The indexing parameter b_1 has no effect on equation (23). This is just Aizenman's result that, with price stabilization, indexing to price is not effective.

Nominal GNP stabilization, $\gamma_2 \rightarrow \infty$ is considered next. In this case, equation (22) becomes:

$$(24)\ n_t(z) - n_t^* = \left[\frac{b_1\sigma(1 - \beta + \beta b_2)}{(1 + \sigma\beta b_2)(1 - \beta b_1)} - \frac{\varepsilon\sigma}{\varepsilon + \sigma}\right]\mu_t + \left[\frac{(1 - b_2)\sigma}{1 + \sigma\beta b_2} - \sigma\right] \eta_t(z).$$

In equation (24), the optimal response to aggregate supply shocks, μ_t, is to set $b_2^* = 0$ and $b_1^* = \varepsilon/(1 + \varepsilon)$. The optimal response to firm-specific supply shocks, $\eta_t(z)$, is to set $b_2^* = 0$. Thus, the indexation rule $\{b_2^* = 0, b_1^* = \varepsilon/(1 + \varepsilon).\}$ is perfectly stabilizing in the presence of both aggregate and firm-specific supply shocks and nominal GNP stabilization.

Finally, the third case considered is $b_1 + b_2 = 1$. That is, both price and firm income are used to index, but the indexation parameters must sum to unity. This restriction on the indexing parameters is necessary to eliminate the effect of the velocity disturbance on equation (22). Given this restriction, the question is what the optimal setting of the terms in the money supply equation is that will make equation (22) equal to zero. Imposing the restrictions on the indexation parameters, equation (22) becomes:

$$(25)\ n_t(z) - n_t^*(z) = \left[\frac{(\varepsilon + \sigma)b_1 - \varepsilon\sigma(1 - \beta b_1)}{(\varepsilon + \sigma)(1 - \beta b_1)}\right] \mu_t + \left[\frac{\sigma b_1}{1 + \sigma\beta - \sigma\beta b_1} - \sigma\right] \eta_t(z).$$

Notice first that the monetary policy parameters have no effect on this expression. Looking next at the firm-specific shocks, $\eta_t(z)$, the optimal value for the indexation parameter is $b_1^* = 1$. Looking at the aggregate shocks, μ_t, however, reveals that $b_1 = 1$ makes the coefficient on the aggregate shock:

$$\left[\frac{1}{1-\beta} - \frac{\varepsilon\sigma}{\varepsilon+\sigma}\right]\mu_t\,.$$

Thus, there is no setting for the indexation parameters and monetary policy parameters that both satisfies the necessary constraint on the indexation parameters and perfectly stabilizes the economy. Note, however, that with only aggregate shocks, $b_1^* = \varepsilon/(1 + \varepsilon)$ is perfectly stabilizing. Of course, this involves indexation to both price and firm nominal income, because $b_1 + b_2 = 1$. In this case, however, the absence of firm-specific shocks makes firm and aggregate nominal income identical. In the absence of firm-specific shocks, indexing to price and nominal income will be perfectly stabilizing.

The result that nominal GNP targeting and wage indexing to price is perfectly stabilizing is surprising, as there are three shocks but only two policy instruments required for perfect stabilization. This result occurs because, with a competitive output and input market, wages should be equalized across firms (as can be seen in equation 6). Neither the full information wage nor the contract wage will change with a relative production disturbance as long as there is no indexation to firm nominal income. Thus, the optimal setting of b_2 is zero.[9] When the monetary authority stabilizes nominal GNP, it offsets all velocity shocks (thereby eliminating aggregate demand shocks) and assures wage setters that any change in price is due to an aggregate production shock. This latter fact means that indexing to price essentially is indexing to the production shock—hence, the result that nominal GNP stabilization and optimal wage indexing to price is perfectly stabilizing.

Concluding Remarks

Two recently popularized policy rules, price stabilization and nominal GNP stabilization, are analyzed in a model based on nominal wage contracting with wage indexation to price and firm nominal income. When there are only aggregate supply shocks, several alternative monetary policy-cum-indexation schemes are shown to be perfectly stabilizing. In the presence of both aggregate and firm-specific supply shocks, however, only a combination of nominal GNP stabilization and wage indexation to price is perfectly stabilizing. This result lends further support to advocates of nominal GNP stabilization. It also shows the benefits and limits of indexing to firm nominal revenue, as indexing to firm

[9] This statement is, of course, conditional on optimal settings for other policy instruments.

revenue, coupled with price stabilization, is but one of several options that will stabilize the economy when firm-specific supply shocks are absent.

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