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HIRSCHEL KASPER, Section Editor

Monetary Policy Rules, Supply Shocks, and the Price-Level Elasticity of Aggregate Demand: A Graphical Examination

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The conduct of monetary policy is an important and much-debated topic in macroeconomics. Although some economists today favor discretionary monetary policy, many other economists regard a monetary policy based on rules as more stabilizing, and therefore, more appropriate. Our purpose in this article is to demonstrate the role of the price-level elasticity of aggregate demand[1] with respect to alternative monetary policy rules when the aggregate supply of goods and services changes randomly. We find that when the target problem is considered within a generalized macroeconomic model involving aggregate demand and aggregate supply and the latter exhibits random shocks or disturbances, the price level elasticity of aggregate demand assumes a major role in the evaluation and conduct of alternative monetary policy rules. The analysis is couched in static terms and relies on graphical proofs. We present the analysis of various monetary policy strategies in response to aggregate supply shocks. We conclude with a summary of our findings and some suggestions for future research.

THE ANALYSIS

Our analysis is anchored by five primary assumptions. First, although the aggregate demand for goods and services is assumed to depend negatively on the price level, its elasticity with respect to the price level may take on different val-

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ues.[2] Second, the structural demand functions that underlie this "reduced form" aggregate demand curve, that is, demand in the commodity and money markets, are assumed to be stable, preventing exogenous changes in aggregate demand for these reasons. Thus, the only factor that could shift the aggregate demand curve would be a central-bank-induced change in the nominal supply of money.[3]

The third assumption is that the aggregate supply of goods and services is a positive function of the general price level. This assumption casts the model in terms of the so-called neoclassical synthesis, that is that there is some degree of wage and price rigidity or money illusion in the macroeconomy. Fourth, for brevity of discussion, we limit the article to examinations of monetary strategies in an environment of adverse aggregate supply shocks.[4]

Finally, we assume that the monetary authorities consider four alternative strategies in dealing with the disturbance to aggregate supply. In particular, the central bank may target or attempt to stabilize (1) the general price level, (2) real gross domestic product, (3) the nominal money supply, or (4) nominal gross domestic product. Within this framework, the importance of the price-level elasticity of aggregate demand is considered for each of the monetary targets.

Targeting the Price Level

Simons (1936) was the first to advocate a monetary policy based on rules rather than discretionary authority because of the potentially superior economic stabilization properties of the former. In particular, he supported the idea that the monetary authority should target the general price level and keep it constant.[5] As long as aggregate demand is negatively sloped, an adverse supply shock will cause the price level to rise regardless of the price-level elasticity of aggregate demand. The direction of monetary policy is, therefore, clear: the nominal money supply must decrease in order to restore the original price level. The degree of monetary restraint, however, depends crucially on the price-level elasticity of aggregate demand.

Two original aggregate demand curves are shown in Figure 1. Because these curves pass through the common point E_0, the flatter of the two demonstrates the greater elasticity with respect to the price level and is labeled AD_0^E. The relatively inelastic aggregate demand is shown as AD_0^I. The initial aggregate supply curve, AS_0, is drawn to intersect both aggregate demand curves at the targeted price level P_*. Suppose that aggregate supply decreases to AS_1. If aggregate demand is price-level inelastic, the supply shock increases the price level from P_* to P_1^I and the nominal money supply must be decreased sufficiently to shift aggregate demand from AD_0^I to AD_1^I—or vertical distance E_0B^6—in order to intersect the new aggregate supply curve at E_1 and maintain the price level at its targeted value, P_*. If aggregate demand is relatively price-level elastic, however, both the increase of the price level, $P_1^E - P_*$, and the amount of monetary restraint required to extinguish this price inflation is smaller. As shown, the price-level elastic aggregate demand curve must be shifted from AD_0^E to AD_1^E, shown by the vertical distance E_0A.

FIGURE 1
Price Level Targeting
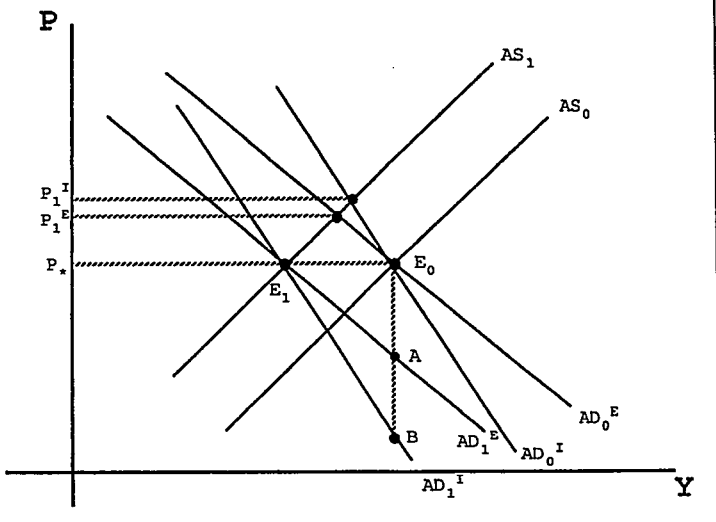
Because $E_0 B > E_0 A$, it is clear that for given changes in aggregate supply, a lower price-level elasticity of aggregate demand requires that a greater change of the nominal money supply must be executed in the same direction to stabilize the price level at its targeted value. More generally, when the monetary authorities attempt to target the price level in the face of supply shocks, the direction of monetary policy will be known and the degree of policy change depends on the price-level elasticity of aggregate demand.

Targeting Real GDP

The central bank may alternatively attempt to target real GDP. This strategy is supported primarily by Keynesian and new-Keynesian theorists who believe a chief characteristic of the economy is that prices (and nominal wages) are inherently sticky, whereas real output is variable and needs to be stabilized.[7] With this monetary scheme, a given disturbance to aggregate supply will unambiguously reveal the proper direction of monetary policy and the degree of policy change will be independent of the price-level elasticity of aggregate demand. This conclusion is demonstrated in Figure 2, in which two original aggregate demand curves are again drawn and labeled as before, and the initial aggregate supply curve intersects both aggregate demands at the targeted level of real GDP, Y_*, presumably the full-employment level.
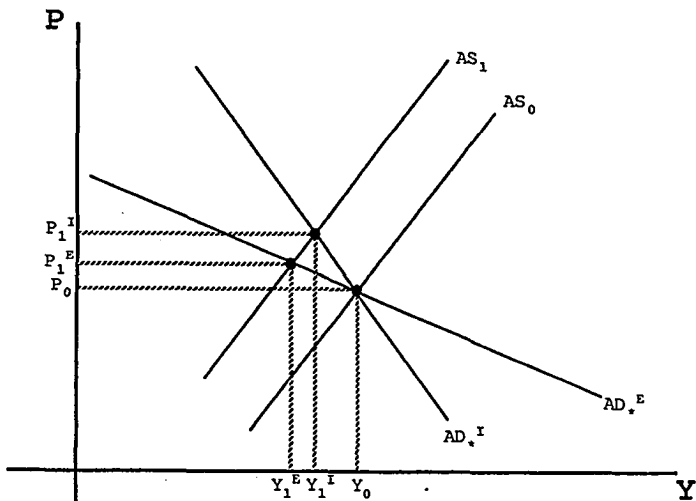
FIGURE 2
Real GDP Targeting
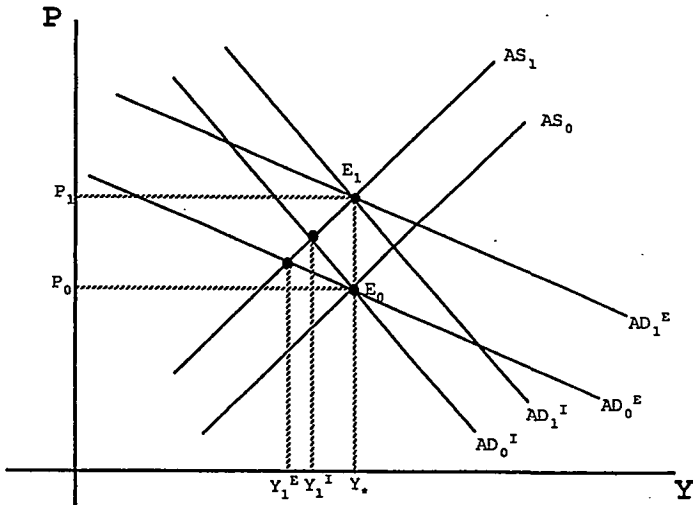
Again suppose that aggregate supply decreases to AS_1. For any exogenous decrease in aggregate supply with a negatively sloped aggregate demand, real GDP decreases and monetary policy must be expansionary to restore it to its targeted level. Referring to Figure 2, if aggregate demand is price-level elastic, the supply shock decreases real GDP from Y_* to Y_1^E. Therefore, the money supply must be increased sufficiently to shift aggregate demand from AD_0^E to AD_1^E—shown by the vertical distance E_1E_0—in order to intersect the new aggregate supply at E_1 and return real GDP to its targeted level, Y_*. When aggregate demand is price-level inelastic, the same aggregate supply shock decreases GDP from Y_* to Y_1^I, and the amount of monetary stimulus required to shift AD_0^I sufficiently to restore real GDP to its targeted level is also the vertical distance E_1E_0. Therefore, when the monetary authorities attempt to target real GDP in the face of supply shocks, the direction of monetary policy is known and the degree of change in the nominal money supply required to return real GDP to its targeted level is independent of the price-level elasticity of aggregate demand.

Targeting the Nominal Money Supply

When the Federal Reserve chooses the standard monetarist prescription of targeting the nominal supply of money,[8] they in effect fix the position of the aggregate demand curve in a static analysis. In this case, the price-level elasticity of

FIGURE 3
Nominal Money Supply Targeting

aggregate demand determines the extent to which an aggregate supply shock is distributed between price level and real GDP changes.

Referring to Figure 3, the original equilibrium price and real GDP levels are P_0 and Y_0, respectively. Assume first that aggregate demand is relatively price-level inelastic and the money supply target determines its position at AD_*^I. An exogenous supply decrease would then result in an increase in the price level to P_1^I and a decrease in real GDP to Y_1^I. If aggregate demand is more elastic with respect to the price level and its targeted position is AD_*^E, the same adverse supply shock will cause a relatively smaller increase of the price level because $(P_1^E - P_0) < (P_1^I - P_0)$, and a comparatively larger decrease in real GDP, $|Y_1^E - Y_0| > |Y_1^I - Y_0|$. It follows that for nominal money supply targeting, the greater (lesser) the price-level elasticity of aggregate demand, the greater (lesser) the decrease in real GDP and the lesser (greater) the increase in the price level in response to an adverse aggregate supply shock.
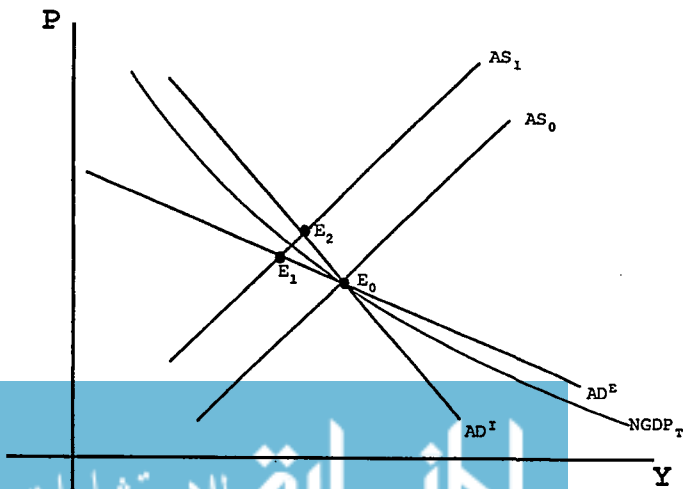
Targeting Nominal GDP

In recent years, many economists have advocated targeting the level of nominal gross domestic product.[9] This idea for monetary policy has received much support because, according to Barro (1990, 25), it is

an attempt to unite the principal warring factions of macroeconomists. The new classicists are supposed to be happy because monetary policy is governed by a rule, and that rule does entail stabilization of some nominal magnitude. . . . Keynesians are supposed to be happy with the scheme because it allows for an active response of money to recessions and booms.

Knowledge of the price-level elasticity of aggregate demand is perhaps most important for the conduct of monetary policy in this case because its magnitude determines the direction of change of nominal GDP and, therefore, the direction of monetary policy in response to a given aggregate supply shock.

In Figure 4, we again draw two original aggregate demand curves with different price-level elasticities to intersect an original aggregate supply curve at E_0. By definition, nominal GDP is equal to real GDP multiplied by the price level, and, therefore, any given level of nominal GDP may be represented in a P-Y plane as a rectangular hyperbola.[10] The hyperbola of Figure 4, $NGDP_T$, is drawn to intersect the aggregate demand and aggregate supply curves so that the economy is initially in equilibrium at the targeted level of nominal GDP. With an adverse supply shock and a negatively sloped aggregate demand curve, the price level will increase, real GDP will decrease, and the ultimate effect on nominal GDP depends on the price-level elasticity of aggregate demand. For example, if aggregate demand is price-level elastic and aggregate supply decreases to AS_1, the new equilibrium occurs at E_1. Because this point is below or to the left of the $NGDP_T$ line, nominal GDP must be below its targeted level, and monetary poli-

FIGURE 4
Nominal GDP Targeting

cy must therefore be expansionary in order to shift aggregate demand to the right and return nominal GDP to its targeted value.

Alternatively, if aggregate demand is inelastic with respect to the price level, the same supply shock would cause the economy to move to point E_2 and nominal GDP to rise above its targeted level. In this scenario, monetary policy should be restrictive. It follows that with a nominal GDP target, the price-level elasticity of aggregate demand determines the direction of monetary policy in response to aggregate supply shocks. In particular, when the central bank targets nominal GDP and a supply shock occurs, monetary policy should be in the same (opposite) direction as the supply change when aggregate demand is inelastic (elastic) with respect to the price level.[11]

SUMMARY AND CONCLUSIONS

Many economists with diverse theoretical beliefs regarding the operation of the macroeconomy advocate a monetary policy based on rules. In this article, we have presented within a generalized macroeconomic model a graphical evaluation of four of these rules when aggregate supply shocks occur and have demonstrated the relevance of a neglected macroeconomic concept, the price-level elasticity of aggregate demand.

In our analysis, we reached four conclusions. First, when monetary authorities establish a price-level target, the direction of monetary policy for a given supply shock will be known and the degree of change of the nominal money supply will depend inversely on the price-level elasticity of aggregate demand. Second, the price-level elasticity of aggregate demand does not affect either the direction or degree of monetary policy when the central bank adopts a real GDP target in an environment of aggregate supply shocks. Third, when the Federal Reserve targets the nominal money supply and hence the position of the aggregate demand curve, the price-level elasticity of aggregate demand determines the relative changes of the price and real GDP levels when aggregate supply changes. Our final conclusion is that when the monetary authority establishes a nominal GDP target, the price level elasticity of aggregate demand determines the direction of monetary policy in the face of a supply shock.

Future research on this particular topic might focus on two general areas. First, this article is obviously an application of static equilibrium analysis. A dynamic examination of the topics that evaluated the time paths of adjustment could prove interesting. Second, a simulation of the simple aggregate demand/aggregate supply model used in this article that incorporated different assumptions about price-level elasticities for the alternative policy rules might help students better understand the interrelationship of policy targets, policy rules, and the price level elasticity of aggregate demand.

NOTES

1. This concept has been largely ignored in macroeconomics. Gambs (1974) has shown that the classical school, from its emphasis on the quantity theory of money, implied that aggregate demand was unit elastic with respect to the price level. Keynes (1936) and his early followers

believed that aggregate demand was perfectly price-level inelastic for the liquidity-trap situation. In separate papers, Havrilesky (1975) and Purvis (1975) derived expressions for the price-level elasticity of aggregate demand within the standard price-flexible *IS-LM* model. Using an expanded *IS-LM* framework to include the Pigou effect, Kyer and Maggs (1992) also derived an expression for the price level elasticity of aggregate demand. Kyer and Maggs (1994) have also demonstrated the relevance of the price-level elasticity of aggregate demand for the validity of supply-side economics.

2. In our 1992 article, we show that the price-level elasticity of aggregate demand is influenced by the real money supply, real income, and real assets, as well as by the income elasticities of saving and money demand, the interest elasticities of investment and money demand, and the real asset elasticity of saving. For more detail, see Kyer and Maggs (1992, 374). Gordon (1993) has discussed how financial deregulation has affected the economy's *IS* and *LM* functions. More specifically, he concluded that the changing financial structure, such as the removal of deposit rate ceilings, the introduction of adjustable rate mortgages, and NOW and Super NOW accounts, has steepened both the *IS* and *LM* curves. For more detail, see Gordon (1993, 463–66). With Gordon's conclusions, it is relatively easy to demonstrate that, ceteris paribus, a steeper *IS* curve results in a steeper or less price-level elastic aggregate demand curve, whereas a steeper *LM* curve, ceteris paribus, yields a flatter aggregate demand function. The net effect on the price-level elasticity of aggregate demand of the changing financial structure within the economy is theoretically ambiguous.

3. We do not address the issue of expectations-induced changes in aggregate demand, that is, how the public's perception of future monetary policy impacts policy effectiveness. We ignore the effects of expectations in order to focus exclusively on the price-level elasticity of aggregate demand.

4. Aggregate demand shocks are not analyzed in this article. The classic analysis of alternative monetary policy rules for different types of aggregate demand shocks is Poole (1970).

5. More recent support for a price-level rule includes Gavin and Stockman (1988 and 1991). Fischer (1984) has discussed in detail the costs of inflation, which he argues result in inefficiency and lower standards of living. Kahn (1994) has evaluated the Federal Reserve's performance in relation to achieving the goal of price stability. Other price rules that have been advocated include targeting the price of gold, the prices of specific commodities, the exchange rate, and the interest rate.

6. We remind readers here of the relationship between changes in the nominal money supply and shifts of the aggregate demand curve from the basic *IS-LM* macroeconomic model, that is, that a proportionate change in the nominal money supply results in an equal proportional vertical shift of the economy's aggregate demand function. This relationship assumes either that bonds are not part of wealth or that they are fully discounted by their future tax liability and, as such, do not affect total wealth. For an in-depth consideration of these underlying issues, see Patinkin (1965, 288–310).

7. For more detail on new Keynesian macroeconomics, see Akerlof and Yellen (1985), Fischer (1977), Gray (1976), Mankiw (1985), and Taylor (1979).

8. The primary proponent of this view is, of course, Friedman. He concludes that because "there is much evidence that monetary changes have their effect only after a considerable lag over a long period of time and that the lag is rather variable . . . the stock of money seems to me the relevant magnitude in terms of which to formulate monetary rules and the behavior of which should be a criterion of policy performance" (Friedman 1960, 84–91).

9. See, for example, the papers by Bean (1983), Bradley and Jansen (1989a and 1989b), Dueker (1993), Jansen and Kim (1993), and McCallum (1987, 1988). McCallum (1987) proposed an approach to nominal GDP targeting that uses a four-year moving average of previous growth in the velocity of the monetary base to predict its growth in the next quarter. Given this forecast, the central bank is then supposed to adjust the growth of the monetary base in order to close the gap between the actual and the target levels of nominal GDP.

10. These hyperbolas are "everywhere dense" in the *P-Y* diagram. Lower levels of nominal gross domestic product are therefore represented by hyperbolas that lie closer to the origin of the diagram.

11. The efficacy of McCallum's technique for targeting nominal GDP has been empirically investigated by Judd and Motley (1991, 1992), McCallum (1987, 1988), and Rasche (1993) with models that assumed constant coefficients in the equation for the velocity of money. Dueker (1993) performed simulations for nominal GDP targeting with models of velocity in which the parameters varied stochastically over time. He concluded that "McCallum's approach to nominal GDP targeting proves to be simple yet robust to velocity behavior that is quite complex" (p. 27).

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