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# Expectations and NGDP Targeting: Supply-Side Problems with Demand-Side Policy

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**Abstract**
This paper considers the effects of changing expectations under macroeconomic policies that rely on targeting nominal variables, such as NGDP targeting. These proposals, in line with a dynamic conception of the equation of exchange, argue that the monetary authority can achieve any dynamic monetary equilibrium, provided favorable public expectations. The problem of changing public expectations, however, cannot be assumed away. Because the public may only find a subset of dynamic monetary equilibria attainable, attempts to coordinate around an equilibrium perceived to be unobtainable can have unintended consequences. We demonstrate in a New Keynesian model that demand-side stabilization policy can shift inflation expectations, resulting in supply-side difficulties. This problem serves as a warning against demand-side fundamentalism in macroeconomic policy.

*JEL Codes*: E32, E52, E58, E66
*Keywords*: aggregate demand stabilization, expectations, monetary equilibrium, monetary policy, NGDP targeting, stagflation, supply side

## I. Introduction

The aftermath of the Great Recession has revived the debate over macroeconomic stability and monetary policy. Some economists, such as John Taylor (2008, 2014), believe the Federal Reserve's monetary policy was too expansionary during the crisis, while others, such as Scott Sumner (2012a), believe it was not expansionary enough. Taylor and Sumner agree, however, that Fed policy would be improved by abandoning discretion and adopting a rules-based monetary policy. One such proposal is that the Fed should target nominal income (NGDP) rather than inflation and GDP growth separately. The goal of stabilizing nominal income was recommended

by F. A. Hayek as early as the 1930s,[1] but has recently been revived as a promising proposal for rules-based monetary policy.[2]

NGDP targeting can be thought of as the attempt by a monetary authority, typically a central bank, to provide a stable nominal anchor for the economy. Market forces are solely responsible for choosing the level of real variables, resulting in allocatively neutral demand stabilization. This situation minimizes the need for costly wage adjustments and other price adjustments across the economy in the event of a shock. If the shock is nominal (demand side), NGDP targeting reverses it. If the shock is real (supply side), NGDP targeting facilitates the least-cost transition to new equilibrium levels of familiar macroeconomic variables. In theory, NGDP targeting improves on existing programs for macroeconomic stability such as inflation (or price level) targeting, which yields suboptimal results in the presence of supply shocks, or variations on the Taylor rule, which place a significant knowledge burden on monetary policy makers and confine them to "steering the car while looking through the rear window."

This paper discusses one potential problem with NGDP targeting. This problem is theoretical, rather than practical.[3] In other words, it has to do with NGDP targeting regimes at their most general, rather than any particular strategy for implementing such a regime (with one possible exception, discussed further in the conclusion). Stated briefly, the problem is that NGDP targeting has left unidentified the form of market-actor expectations necessary for it to achieve its intended purpose. If, for some reason, market actors have a different mental model of the economy than the monetary authority does, a given NGDP target can shoehorn the economy into a suboptimal inflation-growth breakdown. The purpose of this paper is to describe the problems that expectations asymmetry creates for NGDP targeting. Within the institutional framework of central

[1] For discussion, see White (1999) and Hogan and White (2016).

[2] See, for example, Cachanosky (2014), Hendrickson (2012), Nunes and Cole (2013), Salter (2014), Sumner (2012), and Woodford (2012). In addition, scholars such as Hall and Mankiw (1994), Clark (1994), and McCallum and Nelson (1999) have rigorously analyzed NGDP targeting.

[3] Bernanke and Woodford (1997) and Garrison and White (1997) point out some practical difficulties with all nominal variable targeting schemes. In fact, our critique is also applicable to other level targeting regimes, such as price level targeting, which enjoys greater academic support. We will limit our discussion to NGDP targeting, given its newfound popularity, but readers should keep in mind that the critique is generalizable to other attempted demand-stabilizing regimes.

banking, an NGDP targeting rule might be the best choice of policy, but as with any policy, it is important to fully understand the benefits and costs.

The remainder of this paper is organized as follows. In section 2, we briefly recap the theoretical foundations of NGDP targeting in monetary equilibrium theory. This discussion is important for understanding why proponents of NGDP targeting believe that, in the event of shocks, a return to the preshock trend path is credible to market actors. Section 3 introduces supply-side concerns, which potentially cause the system developed in section 2 to break down due to market actors' structural beliefs about the economy. In section 4, we illustrate this issue in a simple three-equation New Keynesian model. Finally, in section 5, we conclude by discussing regimes that are least sensitive to these problems and the importance of understanding the link between the demand side and the supply side of the economy.

## II. Monetary Equilibrium, NGDP Targeting, and Trend Paths

To understand why NGDP targeting can be effective in ameliorating shocks, but why this effectiveness is sensitive to market actors' expectations, it is necessary to briefly discuss the theory behind NGDP targeting. Monetary equilibrium theory—really just the extension of Marshallian insights to individuals' decisions to hold money balances—is the key to understanding NGDP targeting. Individuals chose to hold a portion of their income as cash balances; economy-wide, this translates into nominal money demand equaling a fraction of total nominal income:

$$M^D = kPy$$

where $k \in (0,1)$ and $Py$, the price level multiplied by real income, yields nominal income. The nominal money supply under current monetary institutions is set by the central bank and is invariant with respect to the price level:

$$M^S = M$$

Equilibrium requires $M^D = M^S$ and hence:

$$M = kPy$$

When monetary equilibrium prevails, individuals hold as much cash as desired at the current price level in a given time period. In monetary equilibrium, money is neutral. The existence of a medium

of exchange facilitates mutually welfare-enhancing trade but does not alter the structure of relative prices in the economy, and hence does not affect the allocation of resources.

Preserving monetary equilibrium, and hence monetary neutrality, is the goal of stabilization policy. Aggregate demand deficiencies occur when individuals attempt to build up their money balances. The Walrasian logic is that an excess supply of goods and services across the economy—a general glut—can only prevail if there is an excess demand for money (Yeager 1997). Prices (especially wages) are only imperfectly adjustable. Changing prices to match new economic realities is itself costly, so it is unrealistic to expect producers to engage in costly price-updating behavior beyond that dictated by their private interests. However, monetary equilibrium can be preserved not only by the (quite costly) process of letting economy-wide prices adjust in the event of an excess demand for money, but also by meeting individuals' desire to hold additional money balances through expansionary monetary policy. Achieving monetary equilibrium in a low-cost way is precisely the goal of NGDP targeting.

The relationship between NGDP targeting and monetary equilibrium can be seen by modifying slightly the monetary equilibrium equation above. Importantly, $k$, the fraction of nominal income individuals desire to hold as cash balances, is by definition, the inverse of velocity:

$$k \equiv \frac{1}{V}$$

Substituting into the monetary equilibrium equation, we arrive at the familiar equation of exchange:

$$MV = Py$$

This equation suggests formulating the problem in a way that is more intuitively appealing to agents of the monetary authority. Effective stabilization policy requires offsetting changes in $V$ with corresponding and opposite changes in $M$. If velocity declines (and hence money demand increases), the monetary authority should engage in expansionary monetary policy up until the point where the injections of new money offset the fall in velocity. If velocity increases (and hence money demand falls), the monetary authority should engage in contractionary policy up until the point where the subtraction of money offsets the increase in velocity. Since changes

in the money supply exactly offset changes in velocity, the result is a constant level of nominal income—that is, a targeted level of NGDP.

Because the economy is generally growing, most proponents of NGDP targeting do not endorse a constant level of NGDP. Rather, they endorse a rule for NGDP targeting that sees NGDP grow at a constant rate in every time period, with the target level being the level of NGDP in a given time period consistent with that growth rate. It is fairly straightforward to see that this proposal is still consistent with the underlying theory of monetary equilibrium.

Above, we assumed a *static* monetary equilibrium, but monetary equilibrium can also be *dynamic*: So long as market actors' expectations are in line with the rate of variable changes, monetary equilibrium can prevail with constant growth rates in each of the variables. In terms of the equation of exchange, the dynamic version reads:

$$gM + gV = gP + gy$$

where $g$ denotes growth rates. In this case, the monetary authority's job is to adjust the growth rate of the money supply such that it interacts with the growth rate of velocity to produce a constant level of nominal income growth (inflation plus real income growth) in every time period. This dynamic NGDP target is the general form of a static NGDP target, where the latter is just a version of the dynamic target with NGDP growth equal to zero. So long as market actors' expectations match the decision rule for the monetary authority, any breakdown between $gP$ and $gy$ is consistent with monetary equilibrium, and thus any NGDP growth rate is theoretically compatible with preserving dynamic monetary equilibrium at the micro level.[4]

Proponents of a constant-NGDP growth rule argue that, in the event of a negative demand shock, the monetary authority conduct expansionary policy to return the economy "to the trend path." Since no monetary authority currently operates using a formal nominal income target,[5] the recommendation amounts to using the current

[4] There can still be costs such as shoe-leather costs associated with an NGDP target that requires high inflation rates. This is a different problem than expectations asymmetry but could lead to theoretically similar results.

[5] On the other hand, the governor of the Bank of England, Mark Carney, has explicitly endorsed NGDP targeting, and some believe the Central Bank of Israel, and perhaps Australia, operated with something like an NGDP targeting norm, which allowed them to avoid the worst of the global 2008–2009 recession.

trend growth of nominal income as the target rule—in the United States, somewhere between 4.5 percent and 5 percent—and returning the economy to the *level* of nominal GDP consistent with this trend, in effect approaching the counterfactual scenario where the shock never happened. Returning to trend by closing the (nominal) output gap between post-shock NGDP and counterfactual-trend NGDP is necessary because failing to do so would require adjusting to a new dynamic monetary equilibrium. This would require expectations adjustment, which in turn would require the costly price adjustments that NGDP targeting is supposed to obviate.

The above explication relies on the concept of "correct" expectations on the part of market actors in making the case for NGDP targeting. In particular, the argument for returning to a preshock NGDP trend growth path depends crucially on market actors' expectations being such that they perceive a return to the old path as credible. However, this may not be the case. For example, what monetary policy makers perceive to be a purely nominal shock—demand-side only—may be perceived by market actors to be a mixture of demand-side and supply-side factors. This, in turn, is more easily appreciable by keeping in mind the Phillips relationship, which is itself subject to change.

## III. Expectations and Supply-Side Considerations

Expectations asymmetries are most likely in situations where a macroeconomic shock is not easily decomposable into real and nominal factors. Consider the recent financial crisis and its aftermath. The bursting of global asset bubbles is obviously a negative shock, but how much of this shock is due to purely demand- or supply-side factors? At first, it may seem that the resulting economic slowdown was predominantly a factor of sharply declined aggregate demand, as reflected in falling velocity, a shrinking money supply, or both. If this were the case, the unambiguous optimal policy response would be, as NGDP proponents have repeatedly claimed, monetary offset to keep aggregate demand growth as close to its trend level as possible.

It is unlikely, however, that supply-side factors played a negligible role in this situation. The bursting of the asset bubble revealed fundamental weaknesses in asset markets, linked also to projects in industry, especially construction, that in retrospect were ill-advised. The troubling realization that actual wealth was less than perceived wealth—that activity previously thought to be wealth-enhancing was in fact disguised capital consumption—undoubtedly would cause

some market participants to reevaluate whether current patterns of specialization and trade were, in fact, sustainable (Kling 2011). These concerns, having to do with fundamental structural soundness, manifest themselves in revised expectations as to the economy's ability to produce real goods and services. In other words, the short-run relationship between inflation and deviations from trend output growth may be unclear; the public may have one set of expectations, and the monetary authority another.

The situation becomes even more complicated once we realize it is impossible to ascertain whether the direction of causality in expectations revision runs from nominal to real variables, or vice versa. Must causality even be unidirectional? Codetermination is a prominent concept in explaining the links between economic variables, and we have no reason *a priori* to rule it out in expectations formation and revision. Both the content and the process governing expectations thus remain woefully underidentified.

At first, it may not be clear what problem this underidentification poses for an NGDP targeting regime. To see the difficulty, consider the case where a negative shock causes nominal income to drop below its trend. We assume an expectation asymmetry between the monetary authority and the public. The monetary authority believes the shock is purely nominal, and hence the old trend path of NGDP, with its underlying dynamic monetary equilibrium, is still achievable. The monetary authority thus sees its task—rightly, from its own point of view—as getting the economy back to the old trend path. However, market actors take a different perspective from the monetary authority in this case. While they perceive the shock as partly nominal, it has a nontrivial real factor as well. If this is the case, the public will necessarily have to revise its expectations. The preshock dynamic monetary equilibrium, in particular its breakdown in inflation and real output growth for a given combination of money supply and velocity growth, no longer holds. The additional money injected by the monetary authority, rather than serving as a buffer that prevents the necessity of costly price adjustments, itself can become a destabilizing factor.[6]

[6] The consequences of new money injection are less problematic if the public is aware of the monetary authority's expectations. If the public's information set contains the correct view of how the monetary authority reads the situation, they will anticipate even higher inflation. If information is perfect and relative prices adjust with ease, there is no problem. But it is precisely because these assumptions do not hold that the expectations asymmetry matters.

Since the public has revised its expectations in the aftermath of the shock due to its perception on structural matters that differ from the monetary authority's, the monetary injection will manifest itself not in restoring monetary equilibrium, but as an excess supply of money, and hence monetary disequilibrium. In a world of perfectly informed market actors, this disequilibrium will translate into an upward revision in inflation expectations, with no corresponding improvement in real output and employment. Of course, market actors are never this well-informed, and the actions of the monetary authority, intended to stabilize the economy, may instead result in costly resource misallocations. Furthermore, market actors' attempts to solve this "signal extraction" problem are costly (Lucas 1972).

This is just one example of how expectations asymmetries between the monetary authority and the public can undermine the intended effects of an NGDP targeting regime. Without an explicit theory of expectations formation and revision, there is a very real possibility that attempted stabilizing actions on the part of the monetary authority will amount to nothing more than adding further difficulties to an already-difficult adjustment process. We believe the burden of correctly identifying how and when market actors shift their expectations is so immense that no central authority, monetary or otherwise, can fairly be delegated this task and be expected to succeed. Unfortunately, this point may weaken the case for NGDP targeting implemented by the monetary authority.

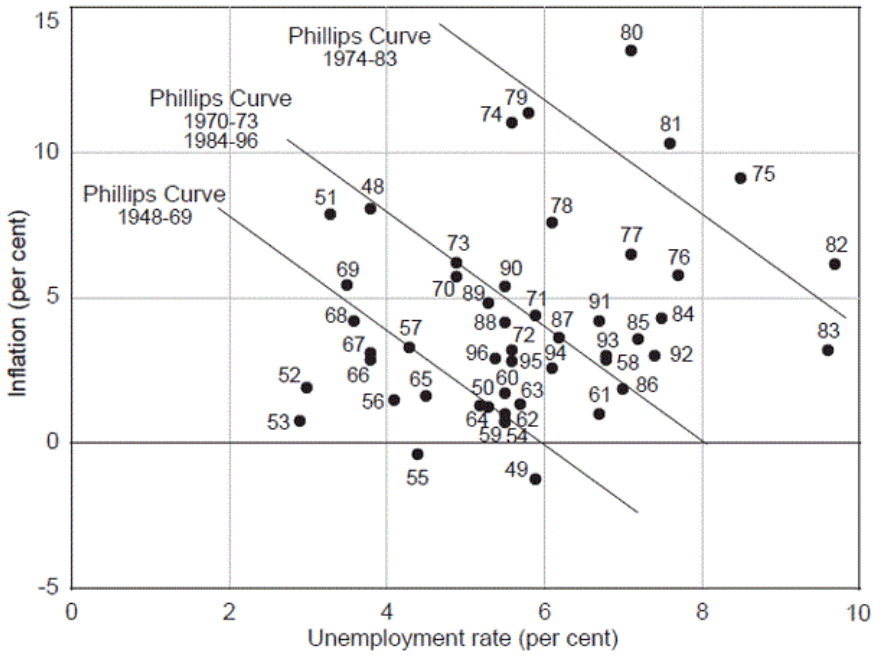
## IV. A Simple Illustrative Model

This section provides an example of how demand-side policy might affect aggregate supply through a shift in the Phillips curve. Using a simple model of NGDP targeting, we analyze how the rates of inflation and RGDP growth might respond to an economic shock if inflation following the shock were to cause a shift in the Phillips curve. Even low rates of inflation can hinder economic growth and might lead to shifts in inflation expectations and the Phillips curve. If the Fed can predict expected inflation but cannot predict shifts in the Phillips curve, then an NGDP targeting policy may lead to prolonged recessions and slow the return to the long-run growth path.

A monetary authority targeting NGDP will respond to a negative shock by increasing inflation, which could have negative supply-side effects, especially if not expected by the public. Recent evidence indicates that even short-lived inflation shocks continue to have negative impacts on both employment and GDP growth. Gillman et

al. (2004) find a negative relationship between short-run inflation and economic growth in OECD countries that is marginally higher when their rates of inflation are lower. Similar effects can be seen in most developing countries. Manamperi (2014, p. 140) finds "a significant negative short-run relationship [between inflation and growth] for Brazil, Russia, China and South Africa while a positive short-run relationship is found for India." Baglan and Yoldas (2014, p. 93) analyze developing countries and "find that inflation is associated with significantly lower growth only after it reaches about 12 percent."

**Figure 1. Shifts in the Phillips curve, 1948–1996**




*Source*: Mishkin 1997, p. 11.

We analyze the effects of unexpected inflation using a three-equation New Keynesian model similar to those discussed by McCallum (2002, pp. 75–83), except that we employ an NGDP target rather than a Taylor rule to dictate monetary policy. Equation (1) shows a standard Phillips curve where the rate of inflation $p_t$ is an inverse function of the unemployment rate $u_t$ as shown in figure 1,

where $\delta$ is the natural rate of unemployment and $\varphi$ is the marginal decrease in unemployment from any increase in inflation.[7]

Equation 2 represents Okun's Law, which describes the change in the unemployment rate from period $t-1$ to period $t$ based on the RGDP growth rate $y_t$, and any economic shock $\varepsilon_t$.[8] Although Okun's Law is sometimes given in terms of the differences of unemployment and RGDP growth from their long-run potential rates, we use the dynamic version from Knotek (2007, p. 78), which estimates the change in the unemployment rate $u_t$ based on expected RGDP growth $y_t$. Finally, equation 3 is the formula for an NGDP target $\theta$ which determines the Fed's reaction function for influencing the money supply.

$$(1) \qquad u_t = \delta - \varphi \times p_t$$

$$(2) \qquad u_t - u_{t-1} = a - \beta \times (y_t + \varepsilon_t)$$

$$(3) \qquad \mathrm{E}(y_{t+1}) + \mathrm{E}(p_{t+1}) = \theta$$

Using equations 1 through 3, we can solve for the equilibrium rates of $p_t$ and $y_t$ and analyze the response to economic shocks. First, we combine equations 1 and 2 and rearrange them to solve for $y_t$, as shown in equation 4.[9]

$$(4) \qquad y_t = \frac{\phi(p_t - p_{t-1})}{\beta} - \frac{\alpha}{\beta} - \epsilon_t$$

Next, by combining equation 4 with its NGDP target given in equation 3, the Fed can solve for the optimal rate of inflation to create in order to hit its NGDP target. First, we assume the Fed can predict RGDP growth through its normal means.[10] We also assume

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[7] Research on money illusion (Shafir, Diamond, and Tversky1997; Fehr and Tyran 2001) emphasizes that only *unexpected* changes inflation have important effects on economic activity. In this case, we might need to adjust equation 1 to account for the expected rate of inflation in any given year. Most studies of the Phillips curve, however, continue to analyze the simple relationship between the rates inflation and unemployment as in Mishkin (1997) and McCallum (2002).

[8] The term "Okun's Law" is, of course, a misnomer since this equation is merely a rule of thumb rather than an economic law.

[9] This equation shows an equilibrium condition for real GDP. It does not imply that the monetary authority has control over real variables. Rather, the monetary authority adjusts the rate of money growth until the rates of inflation and RGDP growth attain their equilibrium values.

[10] Bernanke (2007) describes the current methods used by the Fed to predict future inflation and GDP growth. These tools typically include a variety of surveys, market indicators, and internal models. As argued by market monetarists, we

the Fed creates the optimal amount of inflation through open market operations, reducing the rate of interest on reserves, or some other policy. Second, we assume the Fed can respond to changes in real time, so the expected future rates can be considered as actual rates in the current period. Based on these assumptions, we replace the expected future rates $E(y_{t+1})$ and $E(p_{t+1})$ in equation 3 with the actual rates in the current period $y_t$ and $p_t$. We then substitute $\theta - p_t$ from equation 3 into $y_t$ in equation 4 and solve for the optimal rate of inflation $\widehat{p_t}$ as shown in equation 5.

The Fed can use equation 5 to calculate the optimal amount of inflation $\widehat{p_t}$ needed in each period in order to hit its NGDP target. Based on this rate of inflation, we can calculate using equation 4 or 3 the corresponding rate of RGDP growth $y_t$ that will be created in each period. To be clear, this disaggregation of NGDP into components of inflation and RGDP growth is not likely to be the process by which the monetary authority would target NGDP in practice. Rather, it could simply adjust the monetary base until the expected rates of inflation and RGDP growth were consistent with the target rate $\theta$. Since we have assumed that the monetary authority is capable of achieving its target, we can calculate the equilibrium rate of inflation $\widehat{p_t}$ that is consistent with the target as seen in equation 5.

$$(5) \qquad \widehat{p_t} = \frac{\theta + {}^{\phi P_{t-1}}/_{\beta} - {}^{\alpha}/_{\beta} + \epsilon_t}{1 + {}^{\phi}/_{\beta}}$$

Given some parameter values for the variables in equation 5, we analyze how the Fed and the economy will respond to real shocks. We assume an NGDP target of $\theta = 0.05$, which seems consistent as the sum of the long-run rate of RGDP growth $y^* = 0.03$ and the Fed's approximate inflation target during the Great Moderation of $p^* = 0.02$. For Okun's Law, we assume $\beta = 0.35$ based on the US data from Knotek (2007, p. 78), and to be consistent with our assumption for $y^*$ in the NGDP target, we assume $a = 0.03$. Finally, we assume a slope for the Phillips curve $\varphi = -2$, which is consistent with all three Phillips curves shown in figure 1.

Based on these parameter values, we can estimate the responses in $y_t$ and $p_t$ following an economic shock $\varepsilon_t$. Figure 2 shows a chart where $y_t$ and $p_t$ start off at their long-run values $y^*$ and $p^*$ but then

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presume that a futures market for targeting nominal GDP would provide a superior method for guiding monetary policy that may negate the need for predicting inflation altogether.

experience an RGDP shock of $\varepsilon_t = -0.08$ in period $t = 0$. Since we have assumed the Fed can respond in real time, the Fed immediately increases the rate of inflation, so RGDP falls by only 4 percentage points during the period to –0.01 rather than the full shock of $\varepsilon_t = -0.08$. In the following periods, the Fed continues to create inflation that is above the long-run rate but declining each year. The rate of RGDP growth is negative in the year of the shock, but it rises each year thereafter and within only three years is already close to the long-run rate of 3 percent.

**Figure 2. Responses of inflation and RGDP growth to an economic shock**

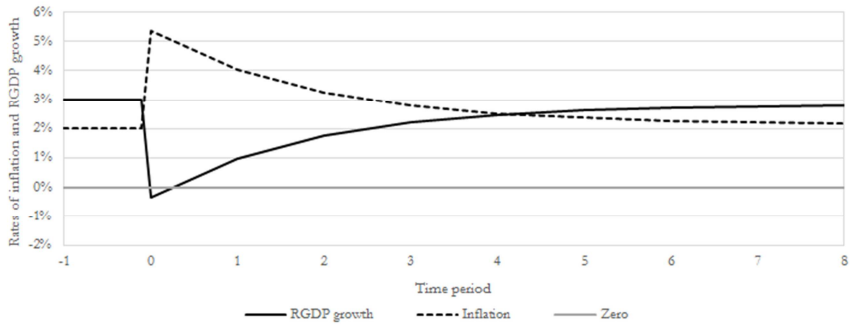



Figure 2 illustrates how NGDP targeting can be useful in minimizing economic shocks. However, there may also be a potential downside to NGDP targeting if the inflation created by the Fed following an economic shock can have detrimental economic impacts as described in the previous section. Equations (1), (4), and (5) assume a stable Phillips curve, but how might stability be affected if the rates of inflation following the economic shock cause the Phillips curve to shift? Equations 4 and 5 can be adjusted to account for a shift in the Phillips curve. It is often assumed that such a shift is unlikely to occur under an NGDP targeting regime, but this is where the public's expectations of inflation come into play. If consumers expect low variation in inflation or react more adversely to inflation than expected by the monetary authority, then an unexpected inflation shock might shift their expectations, represented in our model by a shift in the Phillips curve. This is shown in equation (6), where $\Delta\delta_t$ represents the change in the constant from the Phillips curve equation $\Delta\delta_t = \delta_t - \delta_{t-1}$.

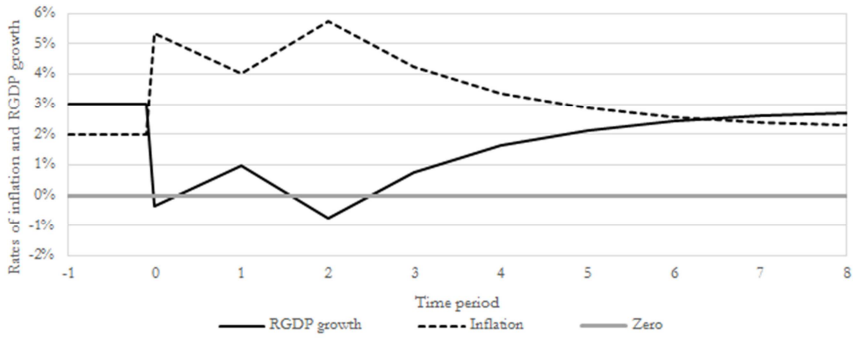
$$(6) \qquad y_t = \frac{\phi(p_t - p_{t-1})}{\beta} - \frac{\alpha + \Delta\delta_t}{\beta} - \epsilon_t$$

Given this change, we can calculate that the new value of $\widehat{p_t}$ represents the optimal rate of inflation for the Fed to hit its NGDP target shown in equation (7).

$$\widehat{p_t} = \frac{\theta + {\phi p_{t-1}}/{\beta} - {(\alpha + \Delta\delta_t)}/{\beta} + \epsilon_t}{1 + {\phi}/{\beta}} \tag{7}$$

Figure 3 shows the responses in inflation and RGDP growth to an economic shock based on equations (6) and (7). Again, we see an RGDP shock of $\varepsilon_t = -0.08$ at time $t = 0$. The Fed responds accordingly, creating the optimal rate of inflation $\widehat{p_t}$ in each period. In this case, however, we assume that after two years of higher-than-expected inflation, the Phillips curve will shift. Since inflation in years 0 and 1 is roughly 3 percent above the expected rate of 2 percent, we assume the constant $\delta$ in the Phillips curve shifts by $\Delta\delta_t = 0.03$. This magnitude seems realistic since it is in between the historical shifts of approximately 2 percent and 4 percent found by Mishkin (1997), as seen in figure 1. Figure 3 shows the effects of a shift in the Phillips curve in year 2 of $\Delta\delta_t = 0.03$ following two years of close to 5 percent inflation. This change reduces the amount of RGDP growth created by the Fed's inflation in that year and pushes the rates of $y$ and $p$ further from their long-run rates. Because of the shift in the Phillips curve, it takes more than six years to return to normal long-run rates where RGDP growth exceeds the rate of inflation rather than about four years as seen in figure 2. The resulting economic disruption due to the shift in the Phillips curve is even greater than the original real shock $\varepsilon_t$.

**Figure 3. Responses of inflation and RGDP growth to an economic shock and subsequent shift in the Phillips curve**



Is it reasonable that the Phillips curve might shift after only a few years of inflation around 5 percent? First, such a shift is consistent with figure 1, which shows that just a few years of higher-than-expected inflation in the late 1960s caused the Phillips curve to shift by 1970. Second, some studies argue the public has an irrational fear of inflation (Tella et al. 2001). Since the Phillips curve shifts based on changes in expected inflation, a small change in inflation or an increase in uncertainty might trigger a shift in the curve. Leduc et al. (2007, p. 434), for example, find that inflation shocks can shift inflation expectations, and that "expectations shocks are much more important for the variability of inflation and the unemployment rate than monetary policy shocks." Third, we have assumed the Fed can calculate the optimal rates of inflation and GDP growth based on a simple formula, but reality is much messier. The state of the economy is in constant flux, and the Fed must anticipate these many changes and respond with the optimal mix of open market operations, information to manage expectations, the rate of interest paid on reserves, and any other tools at its disposal.

Under a discretionary regime, the monetary authority might respond to shocks suboptimally by creating too much inflation or too little. Rules such an NGDP target and market guidance such as an NGDP futures market may help guide Fed policy, but we caution that the Fed must also pay attention to the potential costs of inflation and potential changes in inflation expectations. Our simple model uses only two equations, the Phillips curve and Okun's Law, to represent the complex economy. We hope future studies will consider this matter in greater detail.

## V. Conclusion

We argue that expectations asymmetry between the public and the monetary authority can result in monetary policies having undesirable unintended consequences. If the monetary authority is working with one mental model of the economy and the public another, the monetary authority can inadvertently hamper economic coordination by trying to return the economy to an equilibrium the public no longer finds credible. If so, what appears to be a rate of inflation consistent with dynamic monetary equilibrium is actually suboptimally high, creating real welfare losses.

The preceding assumes that the monetary authority implemented an NGDP target, much in the same manner as it implements its current mandates. Expectation problems arise precisely because of

the asymmetry in beliefs between independently acting monetary policy makers and market actors. However, one proposal for an NGDP targeting regime theoretically sidesteps this difficulty by merging the two roles: market actors become the implementers of monetary policy. The monetary authority's structure is radically adjusted such that it limits its activities to maintaining and implementing a futures market, based off of contracts whose payoff depends on future levels of NGDP. Kevin Dowd (1994) coined the term "quasi-futures contracts" (QFCs) to denote these sorts of contracts, and Sumner (2006) proposed a measure for how an NGDP target can be implemented with QFCs. In this system, market actors themselves become the agent implementing monetary policy by arbitraging the contract. The monetary authority expands or contracts the monetary base as needed to meet arbitrage demands. Monetary equilibrium is sustained in this institutional setup through private profit-seeking.

Another institutional reform, this one even more radical, is free banking. A significant literature exists arguing that an NGDP target would be the unintended result of a free and unregulated banking system (Selgin 1988, 1994; White 1989, 1995; Selgin and White 1994; see also Salter 2013, 2014).[11] The ordinary profit-maximizing behavior of banks operating within a free banking system (a banking system with no legal restrictions, subject only to the general law of contract, liability, and torts) would stabilize nominal income, albeit unintentionally. Banks have a pecuniary incentive to issue more bank liabilities (notes, checkable deposits, etc.) when demand for these liabilities rises, and to contract bank liabilities when demand for these liabilities falls. Banks' ability to issue more liabilities, in turn, occurs because base money is not ordinarily used in transactions in free banking systems; bank-issued claims to base money are used instead. Monetary policy in a free banking system is merely the ordinary operation of financial intermediaries in a fully privatized system. Because the supply of money is demand-determined in these systems, private profit maximization by banks results in a constant tendency toward monetary equilibrium.

The problems we have highlighted in this paper are ultimately institutional. What matters is credibility, and in particular the public's knowledge of and belief in the monetary authority's goal. But such

[11] But the analogy between NGDP targeting and free banking can be taken too far. See Salter (2013) for a cautionary note.

credibility within discretionary central banking is difficult at best to achieve. Proposed monetary regimes that do not radically alter existing monetary institutions confront the problems we raised. So long as there is a wedge between those who plan and implement monetary policy and those whose behavior is intended to be influenced by monetary policy, this difficulty will persist.[12]

Furthermore, providing the monetary authority with a reduced-form policy specification calibrated to the possibility of various forms of market actors' expectations (e.g., Brock et al. 2003, 2007; Cogley et al. 2011; Levin and Williams 2003) does not provide any guarantee of success going forward. The wedge between policy makers and market actors remains unaddressed. Instead, the focus should be on understanding interactions between the supply side and demand side for the purposes of reform at the institutional level. A comparative institutional approach would identify what sorts of regimes are most robust to problems such as those raised in this paper—themselves discovered through careful theoretical and empirical scholarship—and then seek to discover the barriers to erecting these institutions. Ranking institutions by comparing the economic outcomes that emerge within them is a staple of modern political economy (see, e.g., Buchanan and Tullock 1962), and there is no reason why this framework should not be applied to monetary and macroeconomic issues as well.

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[12] To be fair, we should mention that some proponents of NGDP targeting, most notably Scott Sumner, appreciate the problem we raised. This explains why Sumner, both in his scholarly work and on his blog, *The Money Illusion*, heavily emphasizes the importance of regime credibility in anchoring expectations. As Sumner notes, the most credible regime is one where the implementers of monetary policy—market actors themselves—are also those who will be affected by it.

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