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Dear Readers,

Thank you for responding to our recent *Review* survey. We were gratified to hear that our published research is valuable and appreciated, and we were encouraged by your helpful suggestions.

We continue to print and mail copies of the *Review* to our subscribers. We have also made some changes both in print and online that we feel will make our content even more valuable and flexible for a wide range of readers.

You will immediately notice the one-column format, which allows a cleaner presentation of equations and other elements. It also allows for easier reading on mobile devices. We have strengthened our publication webpages by offering more related content and resources.

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As always, we thank you for your readership.

William T. Gavin
Review Editor-in-Chief

Persistent Macroeconomic Imbalances in the Euro Area: Causes and Consequences

Nils Holinski, Clemens Kool, and Joan Muysken

In this paper, the authors document a growing divergence between current account imbalances in northern and southern euro area countries from 1992 to 2007. The imbalance occurred without a concomitant rise in productivity and growth in the southern (deficit) countries. The authors argue that systematic monitoring of external imbalances and implementation of better coordinated policies to prevent the emergence of unsustainably large imbalances in the euro area is advisable because (i) country heterogeneity and the absence of optimal currency area characteristics may lead to the emergence of large current account imbalances without automatic gains in productivity and economic growth to sustain these imbalances, (ii) the absence of sufficient market-based adjustment mechanisms substantially increases the costs of ultimate adjustment toward more sustainable current account positions, and (iii) large external imbalances—particularly through the major role of the banking system—potentially have strong negative consequences for fiscal policy. (JEL F15, F32, F41)

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January 1, 1999, marked the start of the euro area and the introduction of the euro as the common currency for 11 European Union (EU) members.[1] At the time, this was perceived as the final step in the European economic and monetary integration process. The European Central Bank (ECB) was established with a strict mandate to maintain price stability through the implementation of the common monetary policy. Simultaneously, the Stability and Growth Pact (SGP) set binding constraints on each member country's fiscal policy, limiting its government deficit to a maximum of 3 percent of gross domestic product (GDP) and its government debt to a maximum of 60 percent of GDP. With both monetary and fiscal policy appropriately addressed, the consensus was that the internal EU market with its free mobility of goods, capital, and labor would ensure sustainable growth and economic convergence in the euro area, even though cross-country structural differences still prevailed at its start. This article argues that the euro area actually has shown economic divergence as exemplified by growing external imbalances,

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despite reasonably well-behaved fiscal and monetary policy, and attempts to shed light on the underlying causes of this divergence.

Until the start of the global financial crisis in 2008, ECB monetary policy did succeed in keeping inflation low and stable. On the fiscal side, the picture is more mixed; by 2002-03 it had become apparent that central EU enforcement of the agreed-upon fiscal constraints was difficult. When the two most powerful euro area countries, Germany and France, demonstrated their unwillingness to meet the SGP criteria by interfering with domestic economic conditions, the EU's leverage over other countries' behavior decreased substantially, thereby weakening the SGP constraints. Nevertheless, most euro area countries implemented reasonably conservative fiscal policies even when such policies did not strictly adhere to the SGP criteria. Implicitly, financial markets showed their approval for the fiscal consolidation in individual euro area countries as government bond risk premiums were very low and stable until 2008.

Clearly, all of this changed with the global financial crisis. Not only have all member countries since breached the self-imposed budgetary constraints of the Treaty on European Union (known informally as the Maastricht treaty), but some are even on the verge of a sovereign debt crisis. International capital markets have reacted by demanding extremely high risk premiums for holding public debt issued by Spain, Portugal, Ireland, and, more recently, Italy. Greece faces such unsustainable terms in international capital markets that it effectively can no longer access these markets. The joint euro area countries, together with the ECB and the International Monetary Fund (IMF), had to step in as lenders of last resort in May 2010 and have since been forced to further expand their rescue activities.[2]

Obviously, it is necessary to reassess the sustainability of government finances of the euro area countries in light of the current economic environment. However, in our view, the exclusive focus on fiscal sustainability is unwarranted and insufficient to understand the issues facing the euro area. We argue that growing current account imbalances within the euro area indicate an ongoing process of economic divergence rather than convergence among euro area countries. The divergence process started with the introduction of the common currency in 1999 and cannot be confined only to the public sector. As a result, cumulative current account imbalances have substantially grown between northern and southern euro area countries. So far, euro area governments have treated these imbalances with benign neglect. In our view, this is inappropriate and unsustainable. The ultimately necessary reversal of existing imbalances will require painful adjustment, probably with a clear role for fiscal policy in both the northern and southern euro area countries and the institution of policies aimed at increasing productivity and competitiveness in southern countries. In the analysis, we focus on a group of four typical northern countries—Germany, Austria, Finland, and the Netherlands—with large and persistent current account surpluses on the one hand and a group of four typical southern countries—Greece, Portugal, Spain, and Ireland—with large and persistent current account deficits on the other. However, we stress that the policy implications extend beyond these specific countries and can—and should—be generalized.

The article is organized as follows: In the following section we briefly discuss how macroeconomic external imbalances can contribute to economic convergence across countries. Subsequently, we provide a systematic review of internal and external imbalances in the euro area by differentiating the private and public sectors and their respective savings and investment behavior.

In addition, we disaggregate euro area current accounts into trade balances, net factor income, and net current transfers. We then discuss the available empirical evidence with respect to structural convergence in the euro area and suggest routes for future research, followed by a discussion with some policy suggestions and our conclusion.

CURRENT ACCOUNT IMBALANCES AND STRUCTURAL CONVERGENCE

In the 1950s and 1960s, most developed countries participated in the Bretton Woods system of fixed exchange rates. As a result, except for the United States no country could implement an independent domestic monetary policy. The prevailing doctrine was that each country should maintain internal and external equilibrium using fiscal policy and the level of its exchange rate. The current account of the balance of payments served as a crucial indicator of the sustainability of the fixed exchange rate, while the IMF played an important role in the monitoring of unsustainable balance of payments positions, providing temporary financial support and assisting in orderly exchange rate devaluations.

Since the advent of flexible exchange rates and the development of international financial markets facilitating financial integration in the early 1970s, the concern over external imbalances has decreased and almost disappeared. In a seminal article, Feldstein and Horioka (1980) argue that increased financial integration should lead to a loosening of the relation between domestic savings and investment as countries could use the international capital market to finance savings-investment imbalances. Taken literally, increasing current account imbalances then should be taken as positive news, showing that financial markets are at work to improve the international allocation of capital and economic convergence across countries. Tests of the so-called Feldstein-Horioka hypothesis show that international financial integration was still far from complete in the 1970s and 1980s. However, from the 1990s onward, evidence suggests developed countries are increasingly able to use financial markets to finance domestic investment through foreign funding or invest their excess savings in foreign economies.[3]

Underlying this line of thought is the theory of intertemporal utility maximization. It suggests that diverging current accounts are the natural consequence of a convergence process among countries with different levels of economic development. In particular, in the presence of integrated real and financial markets, we should expect countries with lower per capita income to attract foreign investment because their higher expected productivity growth and corresponding economic growth rate promise above-average rates of return. The productivity of the invested capital ensures that the accumulated foreign liabilities can ultimately be repaid. At the same time, these countries should consume more and consequently save less in anticipation of higher income growth in the future. As a result, these countries run current account deficits for a while, which are nothing to worry about and do not require government intervention.[4]

In a discussion about the potential problem of large and semi-persistent current account imbalances among the G7 countries, Clarida (2007, p. 1) states that "current account imbalances in major economies with open capital markets and flexible exchange rates are a general equilibrium phenomenon." In a similar vein, Blanchard (2007, p. 3) summarizes this view—for the group of rich, developed countries—in the following way:

> Assume that a current account deficit reflects private savings and investment decisions. Assume rational expectations. Is there any reason for the government to intervene, and what is the optimal form of that intervention?
>
> It is clear the answer depends on the existence and specific form of distortions in the economy. Thus, I start from a benchmark in which such distortions are absent, the equilibrium is the first-best outcome, and there is no role for government intervention.

In a world as sketched by Clarida (2007) and Blanchard (2007), any adjustment to a more balanced current account will in the end be automatically brought about by changes in exchange rates and in private investment and savings rates across countries. Then, current account imbalances would require neither special attention nor government intervention. It then comes down to the question of how much confidence one has in the underlying assumptions of rationality, sufficient economic and financial integration, and absence of substantial distortions.[5]

Starting from the above theoretical framework, Blanchard and Giavazzi (2002) empirically investigate the current account deficits of the southern euro area countries and the surpluses of the northern countries. They find that financial integration in the euro area has reached a level that domestic savings and investment decisions indeed can be decoupled. In their view, this allows the southern lower-income countries to borrow extensively in support of economic convergence toward their northern neighbors and provides support for the convergence hypothesis. Although they do not see a reason for concern over persistent current account imbalances in the euro area, Blanchard and Giavazzi (2002) hesitate to define "benign neglect" as the optimal response because of the existence of serious nominal rigidities in the euro area—particularly the impossibility of nominal exchange rate adjustment—and lack of sufficiently strong fiscal policy rules.[6] Ahearne, Schmitz, and von Hagen (2007) point out that capital flows move in the direction predicted by neoclassical theory and strongly support the convergence hypothesis.

On the other hand, Arghyrou and Chortareas (2008) and Jaumotte and Sodsriwiboon (2010) express concern with respect to the sustainability of the observed current account deficits in southern euro area countries. They suggest close monitoring is in order and argue that appropriate policy responses need to be discussed. In addition, Jaumotte and Sodsriwiboon (2010) state that the average current account deficit of southern euro area countries exceeds fundamental current account norms by about 6 percent of GDP. In their view, this was facilitated by their euro area membership. They are unable to determine how much of this deficit bonus can be rationalized using the convergence argument but point out the risk of such deficits for a country's net foreign debt position.

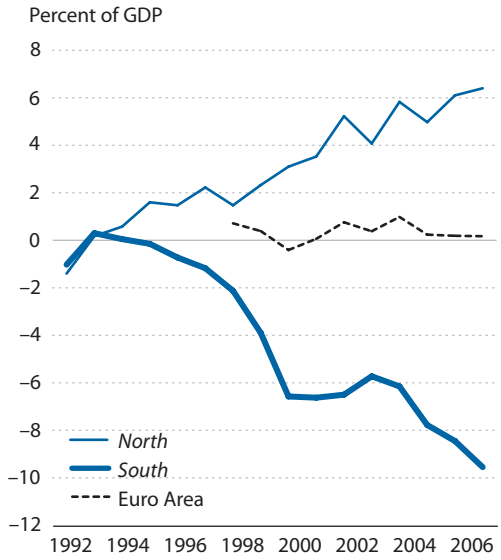
CURRENT ACCOUNT IMBALANCES IN THE EURO AREA

In this section, we provide evidence on the actual current account developments in the euro area over the period 1992-2007.[7] For our empirical analysis, we largely use data from the AMECO database of the European Commission, which allows for a detailed and consistent breakdown of all relevant variables.

First, it is important to note that the current account of the euro area as a whole has been roughly balanced over the period of analysis. That is, no substantial external imbalances with the rest of the world were realized between 1992 and 2007. For this reason, we assume that we

Figure 1

Current Account (1992-2007)



can by approximation treat the euro area as a closed economy and confine our analysis of current account imbalances to the euro area countries. Second, we note that some countries within the euro area have substantial and persistent current account surpluses and others have substantial and persistent current account deficits. We focus on the average behavior of two rather extreme groups in the euro area in this respect. On the one hand, we consider Austria, Finland, Germany, and the Netherlands as one group and call this *North*. All four countries are characterized by substantial and growing current account surpluses, especially from the early 2000s onward. On the other hand, Greece, Ireland, Portugal, and Spain form a group called *South*. These four countries have large and increasing current account deficits over time.[8]

To construct the two groups, we used a clustering method using data for the 11 initial euro area members plus Greece, which entered in 2000. The five countries that entered later have been excluded from the analysis. Clustering was done for both current account data and private savings data and for both levels and first differences. All four cluster analyses put Austria, Finland, Germany, and the Netherlands in one group and Greece, Ireland, Portugal, and Spain in another. Allocation of Belgium, France, Italy, and Luxembourg to one or the other cluster varies, depending on the specification used. In the remainder of this paper, we use the *North* and *South* groups as defined above and exclude the other four countries.[9]

Figure 1 provides evidence of the persistently rising current account imbalances within the euro area. Since the signing of the Maastricht treaty in 1991, the average current account balance of *North* has continuously grown from a small deficit in 1992 to more than 6 percent of GDP in 2007, while at the same time the average current account of *South* has deteriorated from close to zero in the early 1990s to a sizable deficit of almost 10 percent of GDP in 2007. Throughout the paper we use unweighted averages for *North* and *South* to avoid German dominance in *North*

Table 1
Current Account versus Public and Private Savings

	Current account		Net public savings		Net private savings	
Region	1992-1998	1999-2007	1992-1998	1999-2007	1992-1998	1999-2007
South	–0.7	–6.8	–5.7	–2.1	5.0	–4.7
North	0.9	4.6	–3.3	–0.2	4.2	4.8

NOTE: Values expressed as percent of GDP.

and Spanish dominance in *South*.[10] Note that we cannot literally interpret the imbalances in Figure 1 as bilateral imbalances between *North* and *South* because of the trade relations of both areas with other countries. Nevertheless, the figure does provide strongly suggestive evidence of a significant flow of capital from *North* to *South*.

The figure demonstrates that most of the current account divergence can be attributed to the period starting around 1998-99, which corresponds to the introduction of the euro as a common currency. For that reason, we split the overall period into two subperiods. The first, from 1992 through 1998, roughly covers the run-up to the euro area. The second, from 1999 through 2007, captures the actual euro area period. The first column of Table 1 confirms that, in the run-up to the euro area, current account differences were relatively minor, with an average deficit for southern countries of 0.7 percent of GDP compared with an average surplus for northern countries of 0.9 percent of GDP. Since the introduction of the euro, the respective average current accounts imbalances have drifted apart by more than 11 percent of GDP. Distinct groups of creditor and debtor countries have emerged.

Savings and Investment

We proceed along two lines to further explore the origins of current account imbalances in the euro area. First, we investigate the relative contributions of the private and public sectors through their savings and investment decisions to the evolution of current account balances. To this end, we use the following accounting identity:

(1) Current account = Net public savings + Net private savings.

Second, we explore the three major components—the trade balance, net factor income, and transfers—of the current account imbalances using the following equation:

(2) Current account = Trade balance + Net factor income + Net transfers.

Equation (1) clearly demonstrates that a country's current account balance ultimately is the result of savings and investment decisions of the private and public sectors. Figures 2 and 3 show net public and private savings in *North* and *South*, respectively. In addition, columns 2 and 3 of Table 1 present the averages for the two subperiods considered. Several points stand out. In both *North* and *South* net public savings improve—that is, government deficits are reduced consider-

Figure 2

Net Public Savings (1992-2007)

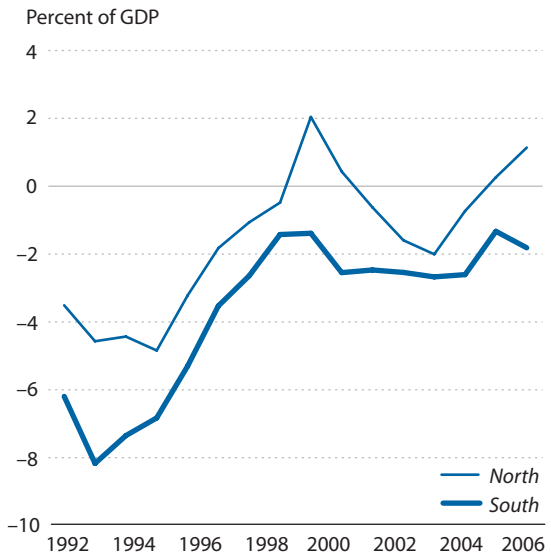
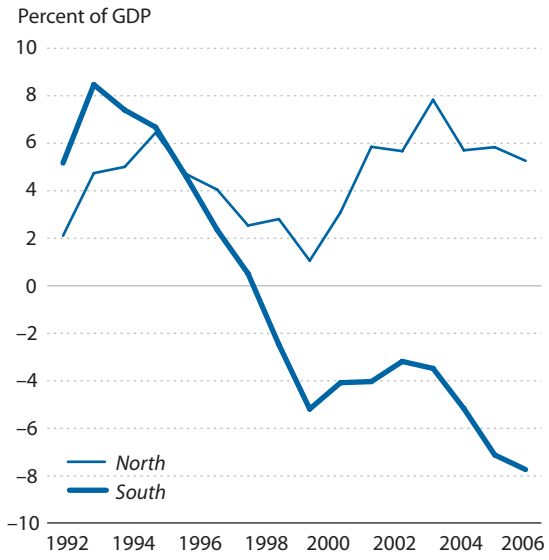


Figure 3

Net Private Savings (1992-2007)



ably—between 1992 and 1998. After 1999, average deficits fluctuate around a mean of almost zero in *North* and about 2 percent in *South*. In summary, the evidence shows that both *North* and *South* implemented fiscal consolidation to comply with the requirements of the Maastricht treaty and the SGP. Note, though, that the average deficit of 2 percent in *South* in the second subperiod was realized in the upward phase of the business cycle. Business cycle adjustment would show that the structural deficit in *South* was too high over this period and insufficient to keep the government deficit below 3 percent should an economic downturn occur.

Both Figures 2 and 3 and Table 1 show that the strong divergence in current account imbalances from 1999 onward is due mostly to private-sector behavior. Net public savings in *South*—even when they structurally fall short of those in *North*—actually improve from the first to the second subperiod by 3.6 percentage points. Simultaneously, the current account of *South* deteriorates from a negligible deficit of 0.7 percent to a large deficit of 6.8 percent as the current account of *North* improves from a surplus of 0.9 percent to 4.6 percent.[11]

Figure 3 and the last two columns of Table 1 show that private-sector behavior in *South* explains most of the current account divergence. In *North* we find relatively steady private net savings that vary within a 3 percent margin around 5 percent of GDP over the entire period of 1992-2007. However, in *South* we see a tremendous deterioration of private net savings exceeding 16 percent of GDP: from a surplus of 8 percent of GDP in the early 1990s to a deficit of the same magnitude in 2007. The table shows that private net savings in *South* reversed from 5 percent of GDP in the first subperiod to –4.7 percent of GDP in the second subperiod.

It is particularly interesting to observe the difference in private-sector behavior in *North* and *South* between the two subperiods. In *North*, the improvement in government finances (as

Table 2
Nominal and Real Interest Rates

	Nominal rates		CPI inflation		Real rates	
Region	1992-1998	1999-2007	1992-1998	1999-2007	1992-1998	1999-2007
South	9.7	4.6	4.0	3.3	5.7	1.3
North	6.8	4.6	2.2	1.8	4.6	2.6

NOTE: Values expressed as percent of GDP. CPI, consumer price index.

indicated by the 3.1-percentage-point increase in net public savings) has no noticeable influence on the level of net private savings, which remain roughly constant across subperiods. In *South* net public and private savings rates move in opposite directions. While the fiscal consolidation imposed by the Maastricht treaty and SGP to some extent disciplined public net savings, the growth of net private spending more than offset the improvement of government finances, resulting in a strongly deteriorating current account. The reduction in net private savings was probably induced in some part by lower real interest rates in *South* upon entry into the euro area and more general financial liberalization and the consequent increased availability of financial assets.[12]

Table 2 summarizes nominal and real interest rate behavior for *North* and *South*. *North* effectively serves as the nominal anchor to the euro area. Its inflation rate remains roughly stable over the whole period. The fall in nominal and real rates in *North*, in our view, reflects the worldwide fall in real rates in this period. Note that both nominal and real rates fall substantially more in *South* than in *North*. This reflects not so much a fall in inflation in *South*—as most inflation convergence had already been achieved before 1992—as a rise in creditworthiness due to the disappearance of previously substantial inflation and exchange risk premiums. One could argue the fall in the real interest rate is the main driver of the increased private spending and the corresponding current account deficit in *South*. The fact that Jaumotte and Sodsriwiboon (2010) fail to find a significant interest rate coefficient in their panel regression framework creates some doubt about the strength of this argument. Moreover, it raises the puzzle of why the combined effect of higher government savings and a lower real rate did not increase spending in *North*. A possible explanation is the presence of heterogeneity in time preference and risk aversion across countries. We return to that observation later.

To further shed light on the dynamics of net private savings, we divide them into gross savings and investment in Figures 4 and 5, respectively, and Table 3. In *North*, gross private savings and investment rates have remained largely unchanged over the past one and a half decades. Private saving rates fluctuate around 23 percent of GDP, while private investment rates are 18.5 percent of GDP on average. This in itself is an interesting result: Neither the preparation for nor the introduction of a common currency (with all its far-reaching consequences) seems to have implications for the savings and investment behavior of households and firms in *North*.

In *South*, developments are fundamentally different. Figure 4 shows that the strong deterioration of private net savings rates can be primarily attributed to the savings behavior of the private sector.[13] The private savings rates dropped from a high of 24 percent of GDP in 1993 to almost

Figure 4

Gross Private Savings (1992-2007)

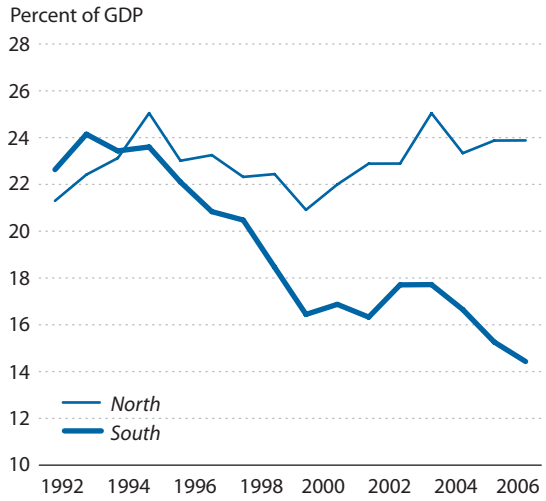


Figure 5

Private Investment (1992-2007)

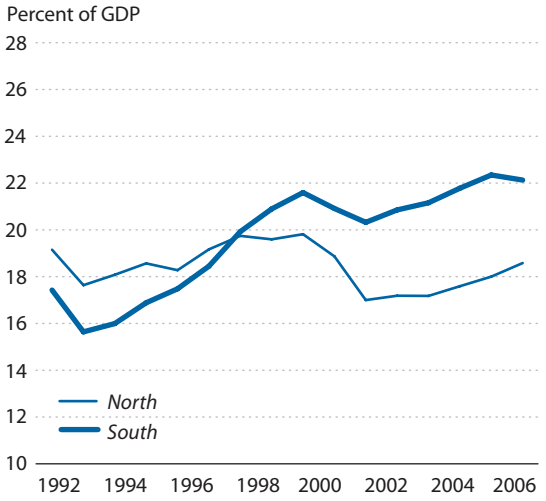


Table 3

Average Savings and Investment as a Percent of GDP

	Net private savings		Gross private savings		Private investment	
Region	1992-1998	1999-2007	1992-1998	1999-2007	1992-1998	1999-2007
South	5.0	–4.7	22.4	16.7	17.4	21.4
North	4.2	4.8	22.9	23.0	18.7	18.2

14 percent in 2007; this is also confirmed by Table 3. In the first subperiod, *North* and *South* displayed almost the same average gross private savings rate of about 22.5 percent of GDP. However, with the introduction of the euro, this declined to an average of 16.7 percent of GDP in *South*, while it remained largely unchanged in *North*. Concomitant with falling private savings rates, we observe private investment growth in southern euro area countries that has contributed to the deterioration of their current accounts. The growth in private investment rates is largely confined to the period of the run-up to the euro's introduction and may have been triggered by the prospect of higher economic growth in the common currency area. Table 3 shows that the average private investment rate for southern euro area countries is 17.4 percent of GDP before the introduction of the euro and 21.4 percent of GDP thereafter.

Current Account Composition

In this section, we use equation (2) to investigate the current account dynamics in *North* and *South* from a different angle, decomposing the current account into its three main elements: the trade balance, net factor income, and net current transfers. In particular, the decomposition sheds light on the often-overlooked intertemporal character of the current account and reveals

Figure 6

Net Foreign Assets (1992-2007)

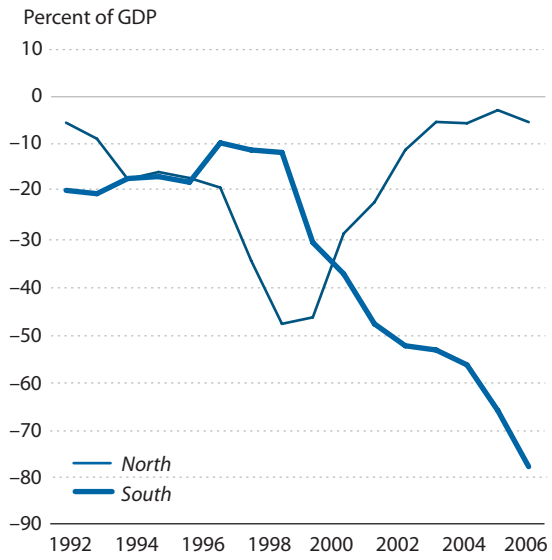
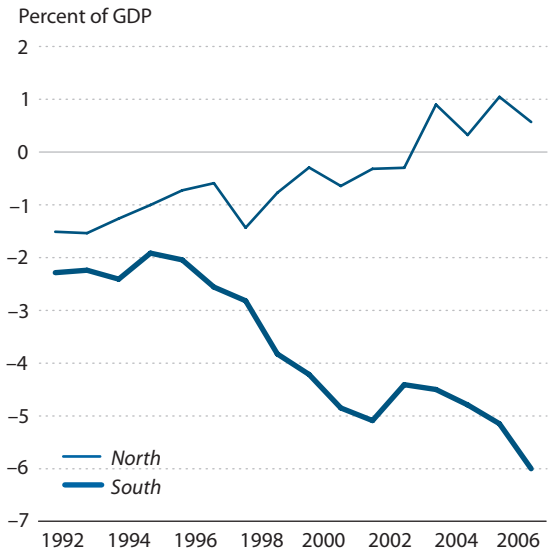


Figure 7

Net Factor Income (1992-2007)



how past external imbalances translate into required future adjustment.[14] The net factor income balance plays a crucial role in this respect.

A simple example suffices to illustrate the point. Assume a country has incurred a series of current account deficits in the past, leading to a net debtor position relative to the rest of the world. This scenario implies that the country needs to pay interest on its foreign debt to other countries. The interest rate payments show up in the net factor income balance and will—if not offset by a positive trade balance or transfer payments from the rest of the world—lead to further increases in foreign debt. A vicious circle will emerge, leading to an unsustainable situation at some point. The only way to break the vicious circle is to implement structural adjustments in the domestic economy that allow the country to obtain a positive trade balance—positive net exports of goods and services—to earn sufficient money to pay the interest on the debt. In addition, higher economic growth will reduce any foreign debt burden in terms of GDP.

Figure 6 shows the evolution of net foreign asset positions as a percentage of GDP over the 1992-2007 period. Until the late 1990s, the net foreign asset positions of *North* and *South* were roughly comparable and fluctuated between –10 and –20 percent of GDP.[15] However, the increasing divergence in current account patterns since 2000 has shown up in the respective net foreign asset positions. *North*'s net foreign asset position improves each year because of current account surpluses, while *South* faces a decline in net foreign assets corresponding to its persistent current account deficits. The 2007 average net foreign liabilities are close to 80 percent of GDP for *South*, with obvious consequences for its future net factor income payments.

Figures 7, 8, and 9 and Table 4 summarize the evidence on the breakup of the current account in its three components. Both Figure 7 and Table 4 directly show the impact of accumulated

Figure 8

Trade Balance (1992-2007)

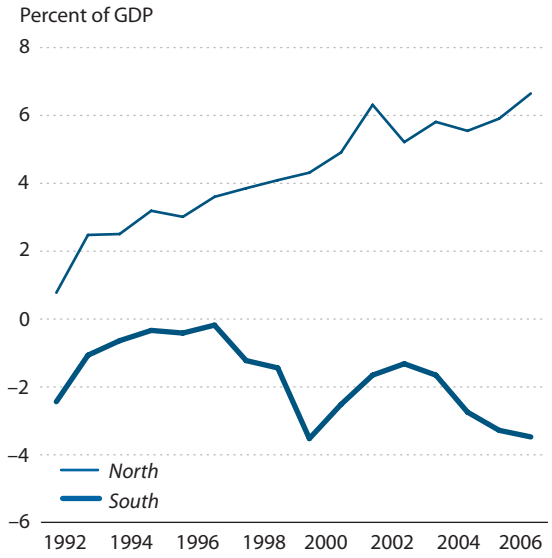


Figure 9

Net Current Transfers (1992-2007)

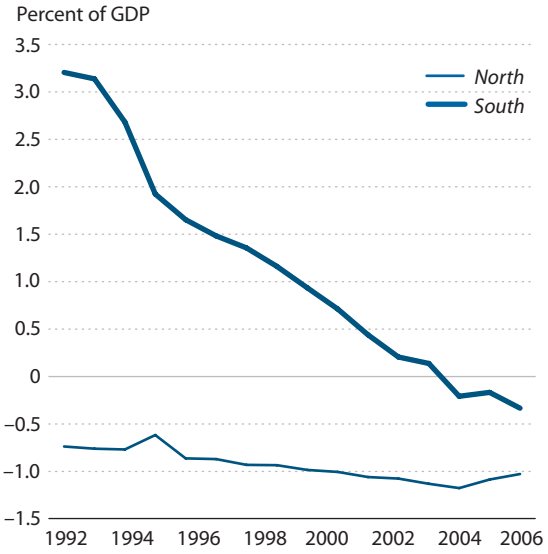


Table 4

Current Account Decomposition as a Percent of GDP

	Current account		Trade balance		Net factor income		Transfers	
Region	1992-1998	1999-2007	1992-1998	1999-2007	1992-1998	1999-2007	1992-1998	1999-2007
South	–0.7	–6.8	–0.9	–2.4	–2.3	–4.8	2.2	0.3
North	0.9	4.6	2.8	5.4	–1.2	0.1	–0.8	–1.1

current account imbalances on net factor income payments, which by themselves reinforce current imbalances. Following the deterioration of its net foreign asset position, *South* must pay an increasing share of GDP to service its debt to foreign creditors, amounting to almost 6 percent of GDP in 2007. *North*, on the other hand, is a net recipient of factor income in the range of 0.5 to 1 percent of GDP in the latest years of our sample. Table 4 shows that about two-thirds of the current account deficit of *South* in the euro area period is due to its net factor income payments. Stated differently, in this period *South* on average borrows almost 5 percent of its GDP from the rest of the world simply to be able to service its debt.

Figure 8 presents trade balance developments for *North* and *South*. *North* consistently improves its trade balance from about 1 percent of GDP in 1992 to more than 6 percent of GDP in 2007.[16] The average trade balance in *South* shows some swings with a trough close to –4 percent in 2000 and a subsequent peak of –1 percent in 2003. Since then, a negative trend has emerged, leading to a new low close to –4 percent in 2007. In comparison, the average trade deficit in the second subperiod is 1.5 percent higher than in the first one. Overall, the size of the trade deficit

has remained limited so far. Nevertheless, before 2007 there is no sign that markets required trade surpluses to compensate for the strongly increasing net factor income payments from *South*. This again shows that the latter are directly passed on to the current account; from there, they feed back on the further accumulation of foreign debt. Clearly, this process is unsustainable and—without structural adjustment—will eventually lead to exploding foreign debt levels.

Figure 9 summarizes the evolution of net current transfers for *North* and *South*. To a large extent these transfers capture EU redistribution policies through, among others, structural cohesion funds. Two observations stand out: First, *North* pays transfers of about 1 percent of GDP over the entire period of analysis. On the other hand, *South* is a structural recipient of transfers only in the first period. Initially, net current transfers for *South* amount to over 3 percent of GDP, but they steadily decrease to about zero in 2007. We hypothesize the decline in net transfers for *South* is caused by the entry of many new low-income members from central and eastern Europe since the mid-1990s. With the EU expanded to include a group of countries with significantly lower income levels than the southern euro area countries, EU redistribution changes direction from south to east. Second, in the 1992-98 period net transfers to *South* went a long way in financing both *South*'s trade deficit and net factor payments. During this period the sum of the latter two equals 3.2 percent of GDP, while the average net current transfers are 2.2 percent of GDP. However, when net transfers fall to about zero in the second subperiod, ongoing trade deficits and net factor payments directly feed into the current account, increasing net foreign liabilities and future net factor payments.

In summary, the increasing current account surpluses in *North* over the period are due to upward trends in the trade surplus and its net factor income receipts. The increasing current account deficits in *South* are driven mainly by the decline in transfers and the increase in net factor payments. The trade balance dynamics play a marginal role in *South*. Put differently, *South* has entered a vicious circle: Lower transfers did not lead to structural adjustment of the trade balance. Instead, *South* has been borrowing to allow it to maintain its positive net imports and finance its debt service. However, the borrowing only further increases the net foreign debt and subsequent interest payments, predictably leading to an unsustainable net foreign debt position in the future.

In the next section, we review the evidence that the observed current account patterns are part of a catching-up process of *South* with its neighbor, *North*.

ALL A MATTER OF ECONOMIC CONVERGENCE?

The neoclassical theory of intertemporal utility maximization as described previously suggests that diverging current accounts can be the natural consequence of a convergence process among countries with different levels of economic development. In particular, in the presence of integrated real and financial markets, countries with a lower per capita income would be expected to attract domestic and foreign investment since higher productivity and economic growth rates promise above-average rates of return. The productivity of the invested capital ensures that the accumulated foreign debt can ultimately be repaid. At the same time, these countries should consume more and consequently save less in anticipation of higher income growth in the future.

Figure 10

Terms of Trade (1992-2007)

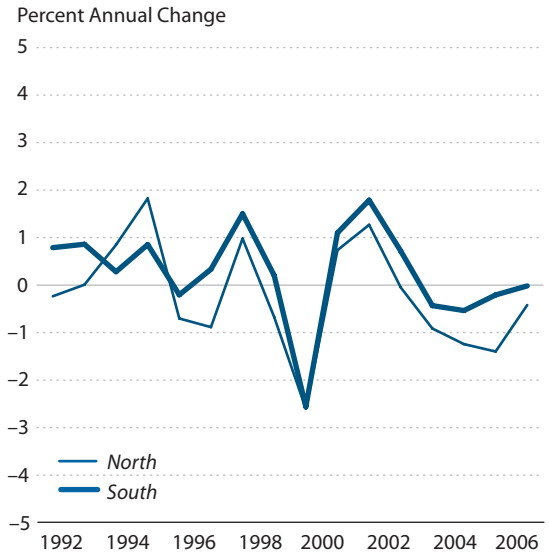
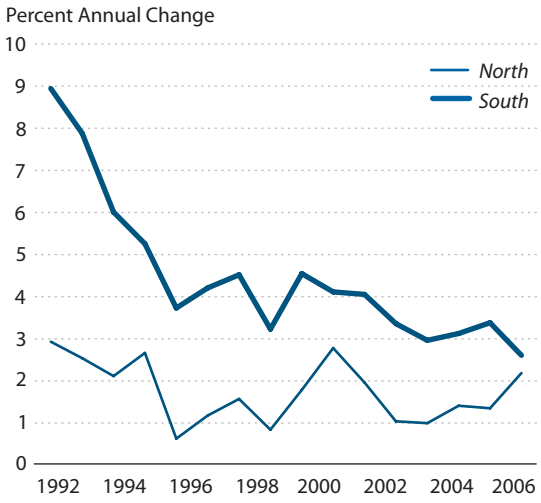


Figure 11

Producer Price Inflation (1992-2007)



Thus, because of higher investment and lower savings, *South* should accumulate net foreign liabilities by running current account deficits, while *North* should act as a net lender—or investor—running current account surpluses. The pattern of capital flows from *North* to *South* observed in the data in principle is consistent with such a convergence process. In the same convergence process, *South* is expected to experience an inflation-induced appreciation of its real exchange rate relative to *North*. The nominal exchange rate between *North* and *South* is fixed because of the common currency. However, relatively high inflation in *South* will lead to an immediate real exchange rate appreciation and thus a less competitive international position and a lower trade balance and current account.[17] As a result, a current account deficit will emerge in *South* that matches the net inflow of funds in its capital account. Most importantly, at some point the increased investment in *South* needs to result in rising productivity and per capita income in *South* relative to *North*.

Figure 10 provides some evidence on the development of trade competitiveness in *North* and *South* using terms of trade data, where the terms of trade variable is defined as the ratio of export over import prices. The figure shows that the relative loss of overall international competitiveness in *South* compared with *North* has been limited to roughly 0.5 percent per year over the analysis period.[18] This is consistent with our earlier finding that it is not the trade balance dynamics that cause the current account deficit in *South* but rather the loss of transfer receipts and the increased net factor payments.

Alternatively, Figure 11 presents producer price inflation rates in *North* and *South*.[19] During the entire 1992-2007 period, producer price inflation in *South* exceeds that in *North* by about 1.5 percent per year.[20] It is inappropriate to use the difference in producer price inflation rates

Figure 12

Relative Real GDP per Capita (1992-2007)

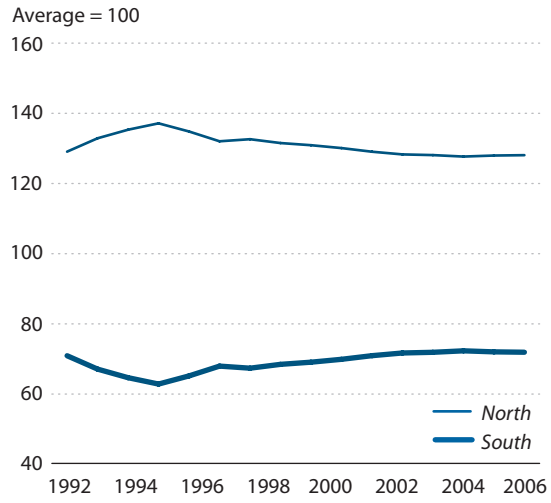
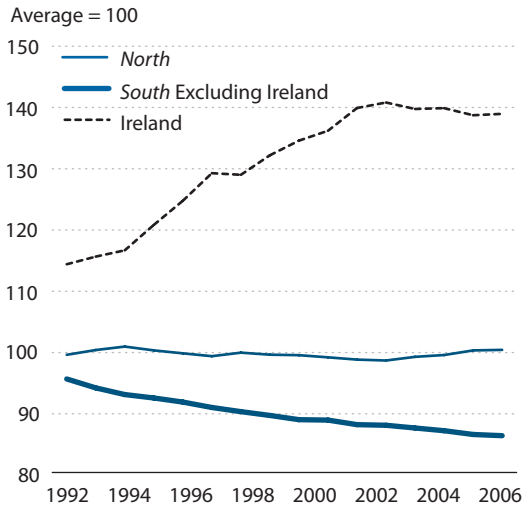


Figure 13

Relative Total Factor Productivity (1992-2007)



as a measure of overall competitiveness, since the trade balance of both *South* and *North* contains imports and exports traded with countries outside the euro area. However, it does show the bilateral real appreciation of *South* relative to *North* over the period.

Overall, the price evidence in a qualitative sense supports the predictions from neoclassical theory. *South* experiences consistently higher inflation than *North*, in principle facilitating a trade deficit to finance capital inflows. The link between the trade balance and the inflation differential appears weak, possibly due to trade links with other euro and non-euro countries.

Finally, we turn to the evidence with respect to per capita income and productivity. Figure 12 shows relative real GDP per capita for *North* and *South*. We find that real per capita income in *North* is about double that in *South*. Most importantly for our analysis, the data reveal little convergence over time despite (i) the European economic and monetary integration process and the introduction of the euro and (ii) the substantial net capital inflow—financed by current account deficits—in *South*. Figure 13 provides suggestive evidence on the reason for the lack of per capita income convergence: Total factor productivity in *South* falls relative to *North* over the years 1992 to 2007, in contradiction to theory. Ireland is an exception—with strongly increasing total factor productivity, in particular during the 1990s—and is therefore presented separately in Figure 13.[21]

In summary, we conclude that the evidence in favor of structural economic convergence is weak as yet. In accordance with theory, capital has flowed from high-income *North* to low-income *South* between 1992 and 2007, even accelerating after the introduction of the euro in 1999. Also, real exchange rates in *South* have appreciated because of higher inflation rates, which is consistent with theory. Unfortunately, the cumulative inflow of capital—roughly equal to 50 percent of *South*'s GDP—over the period 1999-2007 has not yet resulted in measurable gains of productivity and per capita income. Moreover, the evidence also shows that the increase in private invest-

ment in *South* has remained limited despite the massive inflow of capital. Lower savings and higher consumption play an equally large role. In our view, the overall picture casts serious doubt on the hypothesis of automatic convergence in the euro area.

We thus suggest that the economic convergence theory can at best only partially explain the growing external imbalances in the euro area. In addition, Jaumotte and Sodsriwiboon (2010) provide convincing evidence that the increased availability of external funding because of financial liberalization and financial development in *South* also have contributed to *South*'s increased foreign borrowing. Even then, it is likely that a gap remains between the fundamentals-based equilibrium current account imbalances and the actual imbalances in the euro area. Jaumotte and Sodsriwiboon (2010) estimate this gap to be close to 6 percent of GDP for *South*.

In our view, it is important to better understand the determinants behind the emergence of the unsustainable current account imbalances, not only because of the current precarious situation of southern euro area countries, but also to avoid such developments in future low-income entrants into the euro area.

One explanation for excessive borrowing in southern Europe is excessive risk-taking by European banks in both *North* and *South* and the failure of financial markets to recognize that the disappearance of exchange rate risk and inflation risk due to the introduction of the euro did not necessarily eliminate sovereign and country risk. Alternatively, one may argue that financial markets understood that southern euro area governments and countries were riskier than their northern euro area counterparts but expected the EU to bail out southern Europe in case of serious trouble, effectively eliminating the sovereign risk premium to almost zero.

It also needs to be recognized that the common monetary policy has a procyclical effect on the real interest rate in the short run, in addition to the too-low nominal and real interest rates due to underestimated sovereign risk. In the past decade, higher inflation in *South* has caused real rates there to be lower than in *North*, stimulating growth and spending and thereby reinforcing current account imbalances.[22]

Our qualitative and descriptive analysis does not allow a precise estimate of the extent to which fundamentals, including inappropriately low real interest rates, can explain the persistent imbalances between *North* and *South*. However, so far no complete and satisfactory answer has been offered for the combination of large imbalances on the one hand and lack of convergence on the other. For this reason, we believe more attention should be paid to country heterogeneity, such as cross-country differences in time preference, planning horizon, and risk aversion. The evidence in this paper is consistent with agents in southern euro area countries having a stronger preference for current consumption, possibly due to a shorter planning horizon and a higher willingness to take risks with external debts. Recent empirical research by Guiso, Sapienza, and Zingales (2006) supports the relevance of this type of analysis. Controlling for a number of standard economic determinants of macroeconomics savings, they find that countries where more people state it is important to teach thriftiness to children have both statistically and economically significantly higher savings ratios.[23] We regard the descriptive analysis in this paper as a starting point for future empirical and theoretical research that emphasizes behavioral determinants of macroeconomic savings and investment patterns across countries.

WHY CURRENT ACCOUNT IMBALANCES SHOULD NOT BE DISREGARDED IN A COMMON CURRENCY AREA

Given the qualitative nature of our analysis, we are unable to formally reject the convergence hypothesis. Nevertheless, we side with Arghyrou and Chortareas (2008) and Jaumotte and Sodsriwiboon (2010) that the growing current account imbalances in the euro area are cause for serious concern, deserve monitoring, and ultimately require an appropriate policy response.[24] We advance three important reasons for this position.

First, the developments in the euro area in the past decade, in our view, sufficiently demonstrate that private agents' decisions with respect to savings and investment can lead to large external deficits without automatically generating sufficient domestic economic growth and productivity gains. The result can be unsustainable net foreign liability positions that can only be redressed at substantial macroeconomic costs. Most likely it is a reflection of the fact that the euro area was not an optimal currency area from the start. Participating countries differ with respect to economic structure. Additional cross-country heterogeneity may derive from differences in time preference and risk aversion between agents in these countries.

Second, once unsustainable imbalances emerge, adjustment mechanisms are scarce and costly in the euro area. The standard advice to improve productivity and competitiveness in southern euro area countries—as advocated by Jaumotte and Sodsriwiboon (2010), for example—is useful but difficult and unlikely to lead to a quick reversal of the accumulated current account imbalances in the short run. Alternative adjustment paths toward more sustainable current account positions within the euro area are not easy to achieve because of the design of the euro area itself.[25] Because all euro area countries use the same currency, a nominal exchange rate devaluation of *South* relative to *North* to quickly gain competitiveness is impossible. Without productivity gains, the burden of adjustment falls on prices and wages that need to fall and real interest rates that need to rise in southern relative to northern Europe. That is, southern countries can restore international price competitiveness and thus their external balances through a prolonged period of disinflation. Such a process is accompanied by a painful period of economic contraction and will take a number of years to resolve. Lower inflation in deficit countries will also result in higher real interest rates to encourage higher savings and less investment and consumption spending. The re-emergence of country risk premiums in financial markets works in the same way. Note that while higher real interest and lower inflation will be necessary in the long run to ensure a return to a sustainable equilibrium for countries that have let their net foreign debt run up too high, these same higher real interest rates and lower inflation rates will in the short run increase the southern euro area countries' current foreign debt burden and the probability of outright default.[26] The current situation in Greece—and also Italy—provides an alarming example.

Third, a strong, probably bidirectional link exists between current account imbalances and fiscal policy. The IMF (2011) shows that fiscal adjustments have large effects on external balances. On average, current accounts typically improve in countries with contractionary fiscal policies, whereas current accounts deteriorate in countries with more expansionary policies. This implies that interpreting the current account as the result of only private savings and investment decisions

typically is too narrow a view. Past and current fiscal policies influence today's current account both directly and indirectly through the impact of fiscal policy on private savings and investment decisions.

A strong and often-overlooked argument in support of a semi-automatic link from the current account to fiscal policy is that private foreign credit risk can quickly become sovereign risk when banks are involved. Blanchard's (2007) point that no government intervention is required when private savings and investment decisions cause a current account imbalance disregards the fact that many of these private borrowing and lending decisions are made by banks, especially when cross-border credit is concerned. However, the past four years have shown that banking risk can easily be converted to sovereign risk, since a country's government—and its tax base—will ultimately need to provide the banking system's safety net. Even worse, banks that know they will be bailed out by their government may actually take on too much (foreign) debt to increase their expected returns. Obviously, a first-best response would be to adequately regulate financial institutions and markets to prevent such behavior. Experience shows, though, that even good regulation will not permanently prevent financial fragility and default.

In our view, in a common currency area—or an irrevocably fixed exchange rate system, for that matter—fiscal policy in the end will be forced to step in to address unsustainable current account imbalances.[27] This is exactly what experience in the euro area over the past few years shows. To maintain and defend the euro area, northern euro area countries will need to bail out southern countries, willingly or not, and are doing so as witnessed by implicit and explicit guarantees and continuing emergency financial support. And they probably will need to keep doing so for a substantial period ahead.

Looking forward, the current crisis teaches two additional lessons. First, it clarifies that, within a currency area with substantial country heterogeneity, more fiscal policy coordination is required to prevent the buildup of unsustainable external imbalances. Moreover, while public discussion currently has focused almost exclusively on adjustment of the weaker—deficit—countries in *South*, both northern and southern euro area countries should recognize that changes in competitiveness and fiscal stance are a joint responsibility of and will affect both surplus and deficit countries.[28] Recognizing this joint responsibility, in our view, will greatly increase the economic and political stability of the euro area and hasten adjustment. Unfortunately, political recognition and support for such joint responsibility currently is virtually absent in the northern euro area countries.

CONCLUSION

In this paper, we provide a systematic analysis of the divergent pattern of current account imbalances in the euro area that emerged with the introduction of the euro as a common currency. Especially since 1999, we can identify two groups of euro area countries that were running average current account surpluses (*North*) and deficits (*South*) of 4.6 percent and –6.8 percent of GDP, respectively.

Viewed from the domestic side, most of the growth in the current account surplus in *North* arises as the result of substantial fiscal consolidation on the one hand and relatively unchanged private-sector savings and investment on the other. Simultaneously, *North* has been able to trans-

late higher competitiveness into increasing trade surpluses and higher net factor income from abroad. For *South*, the decline in private-sector savings in terms of GDP by about 10 percentage points between 1992 and 2007 is the major driver of the considerable growth of the current account deficit, dominating the effect of higher net public savings. Most of the dynamics in *South*'s current account arise from the trend-like increase in net factor income payments and decrease in net transfer receipts. Stated differently, *South* has been persistently borrowing from abroad to maintain its negative trade balance and pay the interest on its net debt. Particularly worrisome is the observation that *South* has not yet seemed able to convert its large inflow of foreign capital into a more a productive and competitive economy.

In our view, underlying fundamental economic factors cannot fully explain the observed imbalances in the euro area even accounting for financial liberalization and too-low real interest rates in *South* as a result of the start of the euro area. The common argument of economic convergence does not provide a satisfactory explanation of our observations. Potentially, excessive risk-taking by banks and the procyclical effect of the common monetary policy in the euro area may have contributed to the large current account imbalances just before the global financial crisis in 2008. In addition, we believe more research is needed to uncover the potential role of country (agent) heterogeneity in terms of time preference and risk aversion.

In summary, we conclude that systematic monitoring of external imbalances and implementing better coordinated policies to prevent the emergence of unsustainably large imbalances is advisable for the following reasons: First, country heterogeneity and the absence of optimal currency area characteristics may lead to the emergence of large current account imbalances without automatic gains in productivity and economic growth to sustain these imbalances. Second, the absence of sufficient market-based adjustment mechanisms substantially increases the costs of ultimate adjustment toward more sustainable current account positions. And finally, large external imbalances, particularly through the major role of the banking system, potentially have strong negative consequences for fiscal policy.

NOTES

1 Between 1999 and 2011, 6 other EU countries have entered the euro area and introduced the euro as their currency, putting the total at 17 member countries as of November 2011.

2 As the focus of the paper is on macroeconomic external imbalances, we do not further elaborate on the sovereign debt crisis in some euro area countries.

3 See Keijzer and Kool (2009) for a recent overview of this literature.

4 In addition, a transitory current account deficit may arise when a country wants to retain a stable consumption path in the face of a one-time adverse economic shock.

5 Note that an alternative, mostly empirical, literature exists that directly links current account imbalances to financial fragility and crises; see, for instance, IMF (2009).

6 Blanchard (2007) takes a similar position with respect to the euro area countries.

7 We limit ourselves to the period before 2007 to be able to abstract from possible consequences of the global financial crisis for euro area current account imbalances.

8 Obviously, quite a bit of internal heterogeneity exists among the countries in *South* in other economic dimensions—for example, their government debt. The same is true for *North*. In this paper, we abstract from these differences. For a discussion of current economic differences among countries in *South*, see Gros (2010).

[9] Analysis not included here shows that the results remain qualitatively the same when we include Belgium, France, and Luxembourg under *North* and Italy under *South*.

[10] The results are qualitatively similar when we use GDP-weighted figures, which are available from the authors upon request.

[11] So far, the global financial crisis has had little impact on relative current account imbalances within the euro area. In 2010, the average current account surplus in *North* amounted to 4.3 percent, whereas the average deficit in *South* equaled 6.0 percent. These numbers are quite close to the 1999-2007 averages in Table 1, though somewhat smaller than in 2007. Ireland is an exception, as it managed to run a balanced current account in 2010.

[12] Jaumotte and Sodsriwiboon (2010) find a significant negative effect of financial liberalization on the current account in a panel regression framework for southern euro area countries. In addition, they report significant negative effects of entry into the European Monetary Union and the euro area for southern euro area countries on their current account using dummy variables but no significant role for interest rates.

[13] This finding is consistent with Jaumotte and Sodsriwiboon (2010).

[14] In our analysis we abstract from adjustment through valuation effects on foreign assets and liabilities because of the absence of nominal exchange rate adjustment in the euro area. For an empirical and theoretical discussion of valuation effects in the external adjustment process, see, among others, Lane and Milesi-Ferretti (2005) and Holinski, Kool, and Muysken (2009).

[15] In 1997-99 *North* experiences a substantial fall in net foreign assets despite positive current account balances as shown in Figure 1. This is most likely due to valuation effects on *North*'s foreign assets and liabilities in non-euro area countries.

[16] Obviously, this is not just due to net exports to *South*. *North* also runs large trade surpluses with countries outside the euro area such as the United Kingdom and the new central European EU members. This situation again exemplifies that the numbers we present cannot be interpreted as direct bilateral relations between *North* and *South*.

[17] Two complementary theories exist to explain the inflation-induced loss of international competitiveness during the convergence process. For a supply-side approach, see Balassa (1964) and Samuelson (1964); for a demand-side approach, see Baumol and Bowen (1966).

[18] Using a real effective exchange rate approach, Jaumotte and Sodsriwiboon (2010) find an average annual loss of competitiveness of 1.5 percent for Greece, Spain, and Portugal over the period 1999-2008.

[19] A caveat pertains to the use of producer prices here as these also contain nontradable goods prices.

[20] This is consistent with the difference in CPI inflation rates in Table 2 and the evidence in Jaumotte and Sodsriwiboon (2010).

[21] Supporting our conclusion, Gourinchas (2002) concludes that economic convergence in the euro area had already more or less come to a halt in 1996.

[22] Jaumotte and Sodriwiboon (2010) fail to find a significant real interest rate effect on current account balances in their panel regression framework.

[23] Other examples include Alesina, Di Tella, and MacCulloch (2004), who demonstrate that left-wing voters in Europe are more hurt by (income) inequality than left-wing voters in the United States, and Kwok and Tadesse (2006), who use Hofstede's (2001) uncertainty avoidance index to explain cross-country differences in the design of financial systems. See van Hoorn (2011) for a recent overview of research into heterogeneous preferences.

[24] Our subsequent discussion assumes the euro area will be defended and maintained. If not, the consequent changes in institutional design will lead to substantially different adjustment mechanisms. This issue is outside the scope of our paper.

[25] One could interpret this as one of the distortions referred to by Blanchard (2007).

[26] Wealth effects may also act as an important adjustment channel, with higher net foreign debt acting as a drag on spending. Until recently, this channel does not seem to have been a powerful transmission channel in either southern or northern Europe.

[27] We refer to Blanchard (2007) and the IMF (2011) for supporting arguments along this line.

[28] For that matter, the buildup of cumulative current account deficits in *South* could not have happened without the simultaneous buildup of cumulative current account surpluses in *North*.

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Recent Research

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How Good Are the Government's Deficit and Debt Projections and Should We Care?

Kevin L. Kliesen and Daniel L. Thornton

Each year, the Congressional Budget Office (CBO) publishes its *Budget and Economic Outlook*. The CBO's deficit projections for the current fiscal year (FY) and the next 10 FYs are widely followed because they provide an assessment of the medium-term budget outlook based on current law and a presumed path for the economy over the next decade. Admittedly, this task is more difficult because of the required assumption that the laws governing future outlays and revenues do not change. Nevertheless, given its nonpartisan nature and the CBO's well-respected staff of professional economists and budget analysts, its projections are closely followed. In this article, the authors update their 2001 assessment of the accuracy of the CBO's short- and medium-term budget projections by adding an additional 10 years of data. Such analysis is useful in light of the dramatic change in actual and expected fiscal policy, especially over the past few years. In addition, they investigate the extent to which the CBO's projection errors are affected by errors in forecasting key economic variables and the extent to which the errors relate more to inaccurate projections of revenues or expenditures. (JEL H60, H62, H68)

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In 2000, after more than 40 years of nearly consecutive budget deficits, both the White House Office of Management and Budget and the Congressional Budget Office (CBO) projected decade-long budget surpluses. Moreover, both agencies projected that publicly held government debt (then about $3.5 trillion) would be eliminated by 2010. The advent of potentially large budget surpluses, naturally, caused economists and market participants to consider potential changes to market-making activity associated with the all-important Treasury securities market.[1] In addition, some Federal Reserve officials began to speculate about how the Federal Open Market Committee would conduct open market operations without an adequate supply of Treasury securities.[2]

In response to the projections of large budget surpluses, we (Kliesen and Thornton, 2001) analyzed the accuracy of these government agencies in projecting government deficits. Using CBO deficit projections over the period 1976-99, we found that the deficit projections beyond a year were unreliable. Importantly, we found that the projections were biased in the direction of

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underprojecting the size of the deficit or overprojecting the size of the surplus. We concluded that "If the current projections are biased to a similar degree and policymakers choose to alter current tax and spending programs based on these projections, it is possible that the projected surpluses will never materialize" (p. 22).

Our conclusion proved accurate. Rather than being eliminated as projected, publicly held government debt increased to over $9 trillion by 2010. Much of the recent increase was a consequence of the government's attempt to ameliorate the effects of the financial crisis on output and employment; however, the failure of the projected surpluses to materialize was not the consequence of an unforeseen financial crisis. Publicly held government debt had increased to over $5 trillion *before* the crisis. After 2000, revenues began to decline and expenditures began to rise and the projected surpluses morphed into actual deficits. Figure 1 shows this change in the federal surplus/deficit as a percent of gross national product (GNP) or gross domestic product (GDP) since 1800. The blue dashed line shows the CBO's budget projections from 2000. The figure shows there were relatively large deficits before 2009. The vertical line denotes 2011, and the black dashed line shows the CBO's January 2011 budget projections over the next 10 years. The CBO projects that the deficit will stabilize at about 3 percent of GDP by 2021, according to its baseline projections.[3]

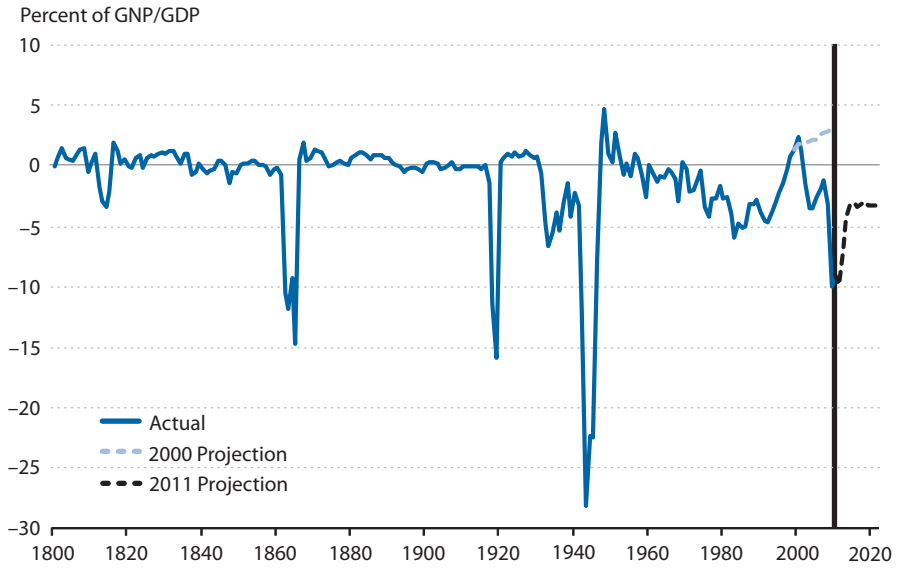
Current budget projections are the polar opposite of a decade ago: Over the past few years, U.S. budget deficits have been at levels previously attained only during the Civil War and the two world wars. Accordingly, in January 2011 the CBO projected that these large, unsustainable deficits would fall to more modest, although still historically large, levels over the medium term. However, since publication of the CBO's January 2011 baseline budget projections, the Budget Control Act of 2011 was signed into law in August 2011.[4] According to the CBO, the act will potentially reduce the cumulative budget deficit by $2.1 trillion over fiscal years (FYs) 2012 to 2021. Accordingly, in the CBO's baseline budget projections published in August 2011, the budget deficit as a share of GDP is projected to decline from about 9 percent in FY 2010 to 1.8 percent in FY 2021. In the January 2011 baseline, the CBO projected that the budget deficit would decline to 3.2 percent by 2021.

How much confidence should the public and policymakers place in these new projections? As noted in our previous analysis, when the CBO constructs its baseline projections it cannot—unlike private-sector forecasters—anticipate future changes in fiscal or monetary policy that affect future economic growth, outlays, and revenues. Instead, the CBO by law uses what is known as a "current services baseline." That is, it must assume that existing laws that govern outlays and receipts will prevail over the projection horizon. However, unexpected actions by policymakers to increase spending or change taxes are important sources of budget projection errors. Of course, this handicap is only one source of projection error. Model misspecification, which may bias the forecast of important economic variables, such as real GDP growth and inflation, and inaccurate demographic projections obtained from other government agencies are other sources of error.[5] In short, the CBO has a difficult task. Nevertheless, policymakers and others rely on its budget projections, which are generally viewed as an unbiased assessment of the medium-term budget outlook by market analysts.

This article provides an updated assessment of the accuracy of these budget projections in light of the dramatic change in actual and expected fiscal policy over the past few years. Specifically, we investigate whether a change has occurred in the accuracy and the bias of the CBO's

Figure 1

The Federal Surplus/Deficit as a Percent of GNP/GDP



short- and medium-term projections relative to our previous analysis. In addition, the current analysis investigates the extent to which the CBO's projection errors are affected by errors in CBO forecasts of key economic variables, something we were unable to do in our previous work because the sample was too short. In addition, we decompose projection errors into revenue and expenditure errors, and further by the source of the revenue and expenditures errors, in an attempt to provide insight about the likely sign and magnitude of the errors associated with the current deficit projections. Our analysis begins with a discussion of U.S. deficits historically, focusing on the experience during the post-WWII period.

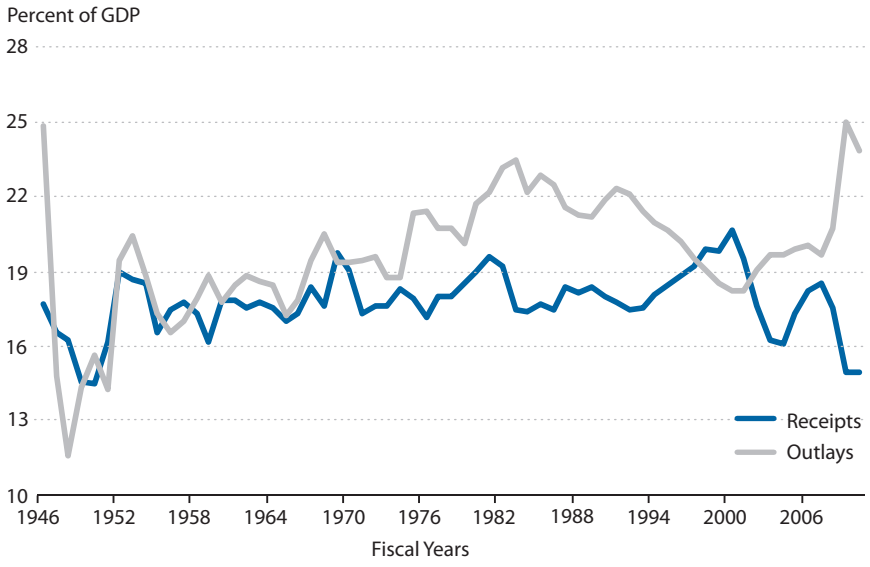
THE HISTORY OF U.S. DEFICITS

Figure 1 shows that large deficits relative to GDP have historically been associated with wars: the War of 1812, the Civil War, and World Wars I and II. By comparison with these wars, the deficits associated with the Korean, Vietnam, and Gulf wars were modest. The United States began running relatively large and persistent deficits in the 1970s. In the 24 years from 1947 through 1970, the average deficit as a percent of GDP was zero. In contrast, in the 37 years from 1971 through 2007, the average deficit as a percent of GDP was 2.5 percent. Moreover, there were only 4 years (10.1 percent of the years) during the latter period when there was a surplus compared with 10 years (41.7 percent of the years) in the earlier period.

An important question is why has the government run large and persistent deficits since 1971? We cannot answer that question per se, but we can ascertain whether large and persistent deficits are associated with increases in expenditures or decreases in revenue or some combination of both. Figure 2 shows government expenditures and revenues as a percent of GDP since

Figure 2

Government Receipts and Outlays as a Percent of GDP



SOURCE: Office of Management and Budget and Haver Analytics.

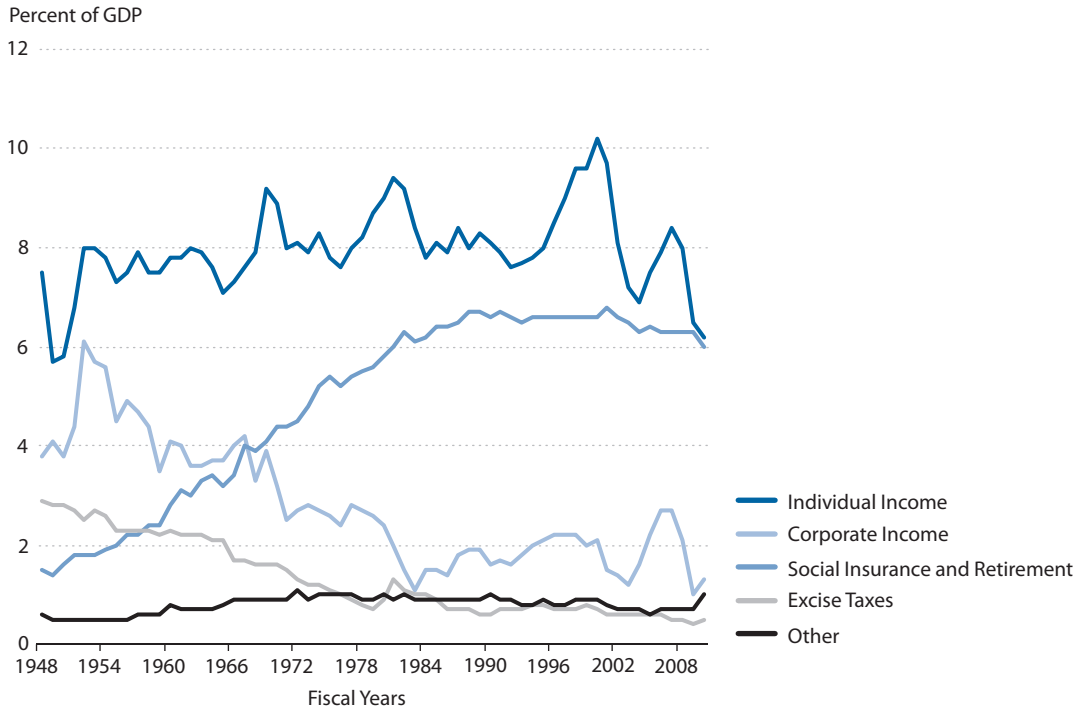
Figure 3

The U.S. Cyclically Adjusted Budget Deficit

SOURCE: Congressional Budget Office.

Figure 4

Federal Government Receipts by Category (1948-2010)



SOURCE: Office of Management and Budget.

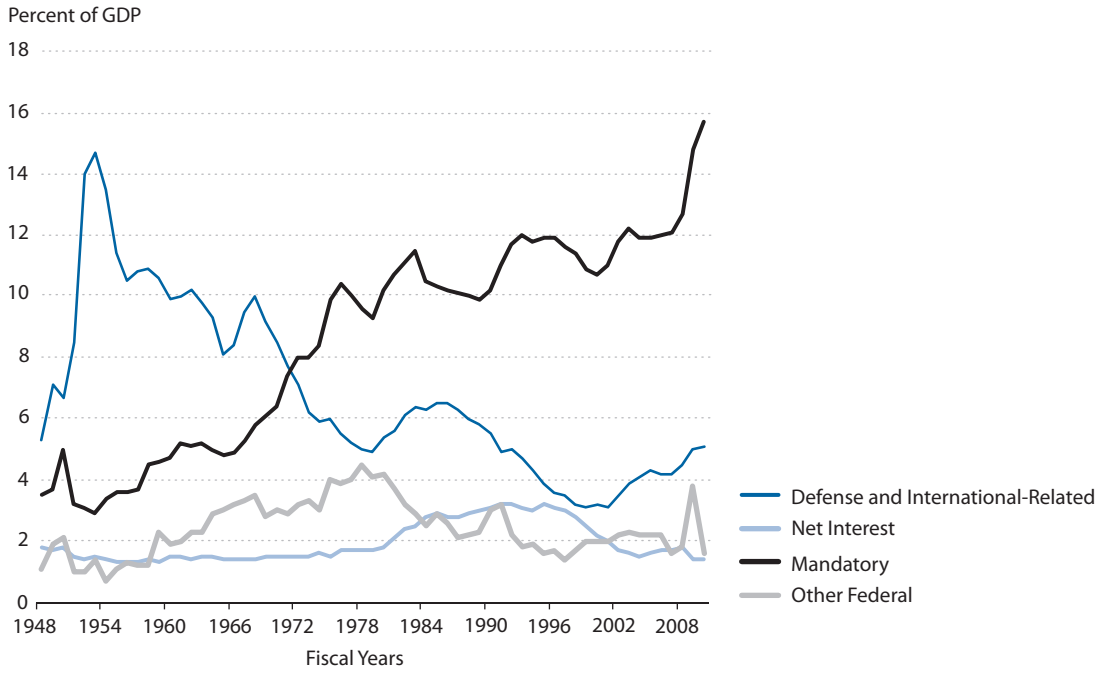
1946. From the early 1950s until the late 1960s, revenues and expenditures were a relatively constant percent of GDP. From 1950 through 1970, revenue averaged 17.6 percent of GDP, while expenditures were only slightly higher, 18.2 percent. In contrast, from 1971 through 2007, revenue averaged 18.2 percent of GDP, while expenditures averaged 20.6 percent. Indeed, the difference between revenues and expenditures, 2.4 percent, is nearly equal to the 2.5 percent average deficit as a percent of GDP over the period. Hence, essentially the entire average deficit over the 1971-2007 period can be attributed to an increase in expenditures relative to revenues.[6]

In response to persistently larger budget deficits, Congress enacted several reforms to the discretionary side of the budget process, such as the Gramm-Rudman-Hollings Balanced Budget and Emergency Deficit Control Act of 1985 and the Budget Enforcement Act of 1990, which instituted "pay-as-you-go" (PAYGO) rules.[7] None of these reforms has permanently reduced the deficit to its pre-1971 levels, though they may have had a temporary effect. Indeed, as seen by the cyclically adjusted (structural) budget deficit (Figure 3), the structural budget deficit increased from a little less than 1 percent of potential GDP in 1962 to a little less than 5 percent of potential GDP in 1986.[8] The structural deficit then declined, reaching a positive 1 percent in 2000, before falling sharply thereafter.

The previous analysis provides little insight into why government spending increased during the period. Considering the source of revenues and expenditures offers some insight into this

Figure 5

Federal Government Expenditures by Category (1948-2010)



SOURCE: Office of Management and Budget.

issue. Figure 4 presents five sources of government revenue as a percent of GDP since 1948. Although total revenue as a percent of GDP has remained relatively constant since 1950 (as noted above), the figure shows the source of revenue has not. The federal government's main sources of revenue are individual income tax receipts, payroll taxes (to fund mandatory programs such as Social Security and Medicare), corporate income taxes, and excise taxes (such as those on gasoline or airfares). Individual income tax receipts and other tax receipts have been relatively constant—about 8 percent and 1 percent of GDP, respectively—but the other sources of revenue have changed considerably. Corporate income and excise taxes declined until the mid-1980s and have since remained relatively constant at about 2 percent and 1 percent of GDP, respectively. As these sources of revenue were declining, social insurance and retirement revenue increased from about 1 percent of GDP in 1948 to nearly 7 percent of GDP in late 1988 and stabilized at about that level.

The composition of government expenditures has also changed substantially. Figure 5 shows the composition of government expenditures by category since 1948. Net interest expenses and other federal spending have fluctuated around 2 percent of GDP over the period. In contrast, after increasing dramatically during the Korean War, defense and international-related spending has trended down and fluctuated in the range of 5 to 6 percent of GDP. Indeed, defense spending as a percent of GDP in 2010 (5.1 percent) is nearly identical to what it was in 1948 (5.3 percent). The large spending increases occurred in mandatory outlays, more than half of which is Social Security benefits and Medicare expenditures financed by payroll taxes paid by employ-

ees and employers.[9] Mandatory spending increased from 3.5 percent of GDP in 1948 to nearly 16 percent of GDP in 2010. Much of the recent increase appears to be associated with the surge in unemployment benefits in the wake of the financial crisis. From December 2007 to October 2009, the unemployment rate rose from 5 percent to 10.1 percent. With a stubbornly high unemployment rate, Congress enacted several extensions of benefits for those unemployed beyond the normal 26 weeks. However, even before the financial crisis, mandatory spending had risen to 12 percent of GDP. Indeed, nearly all of the persistent deficits since 1971 can be attributed to (i) increased spending rather than a decline in revenue and (ii) the fact that the increased spending is in the mandatory component.

THE ACCURACY OF THE CBO'S BUDGET PROJECTIONS

The government's attempt to mitigate the effects of the financial crisis resulted in very large deficits in 2009 and 2010: 9.9 percent and 8.9 percent of GDP, respectively. Despite a weaker-than-expected pace of economic growth in 2011, in its August update the CBO projected that the budget deficit would fall to 8.5 percent of GDP for 2011. As previously mentioned, the CBO's January 2011 baseline projection was that the budget deficit would rise to 9.8 percent of GDP in 2011. This illustrates that reports issued less than a year apart can yield significantly different projections for the deficit.

We provide some insight into the usefulness of these projections by examining the historical accuracy of the CBO's baseline budget projections, which are typically published in January. We do not incorporate into our analysis the mid-term projections, which are typically published in the summer about the same time as the Office of Management and Budget's *Mid-Session Review*. Our analysis focuses on 1-year-ahead projection errors and cumulative 5-year-ahead projection errors. Five years is a reasonable planning horizon for policymakers and a period over which projections might be considered reliable. Figure 6 shows the actual and CBO-projected 5-year cumulative budget surplus/deficit as a percent of GDP. The 45-degree line denotes the points of equality between the actual and projected outcomes. If the projections were accurate, all points would fall on the 45-degree line. Consistent with our 2001 analysis, Figure 6 shows that the 5-year cumulative projections are highly inaccurate: The average absolute projection error is 2.65 percent of GDP. Moreover, most observations lie below the 45-degree line (20 of the 30 observations are below the line), indicating a strong bias in underprojecting the deficit (overprojecting the surplus).

A common benchmark for evaluating forecast accuracy is to compare model-based forecasts with a simple random walk (RW) forecast. The latter assumes that next year's value of the forecasted series is equal to the current year's value—that is, the series cannot be forecasted beyond its current value. We compare the accuracy of the CBO projections relative to the projection errors from a RW projection model. The RW model projects the cumulative 5-year budget balance to be equal to the actual cumulative 5-year budget balance of the previous 5 years. In order to be operational, the CBO would have had to have known the cumulative budget balance over the past 5 years; however, for projections made in year t, the CBO would know only the cumulative 5-year budget in year t. Hence, the RW projections made in year $t-1$ are based on the actual cumulative 5-year budget through year $t-1$. For example, the RW cumulative 5-year deficit projections made in 1976 (i.e., the cumulative 5-year deficit projections for the period 1977 through 1981) are the actual cumulative 5-year deficit over the period 1971 through 1975.

Figure 6

Actual and CBO-Projected 5-Year Cumulative Budget Surplus/Deficit as a Percent of GDP

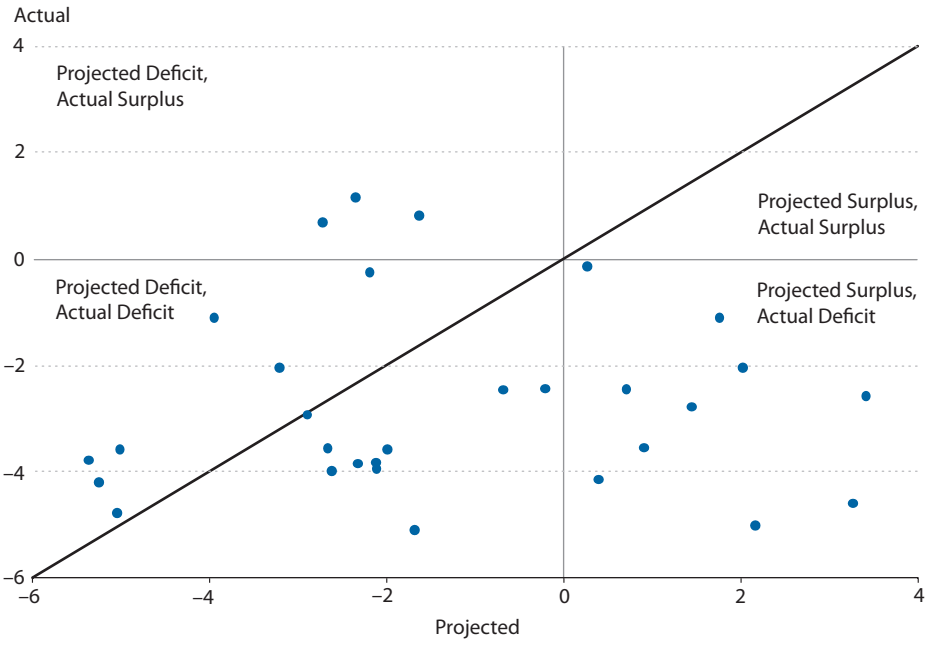


Figure 7

Cumulative 5-Year Random Walk and Actual Deficit as a Percent of GDP

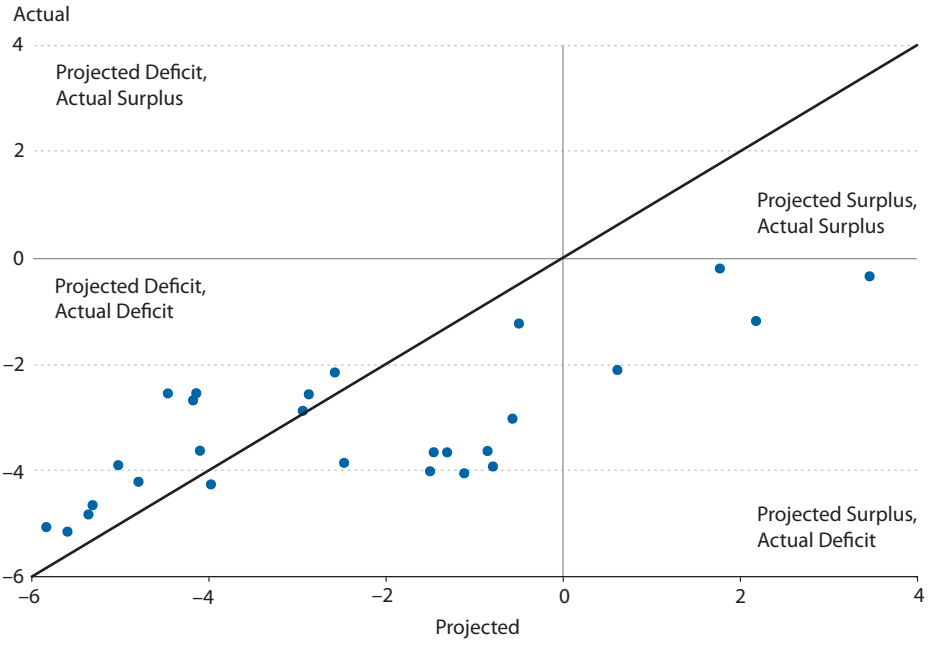


Figure 8

Cumulative 5-Year Projection Errors: CBO and Random Walk Projections

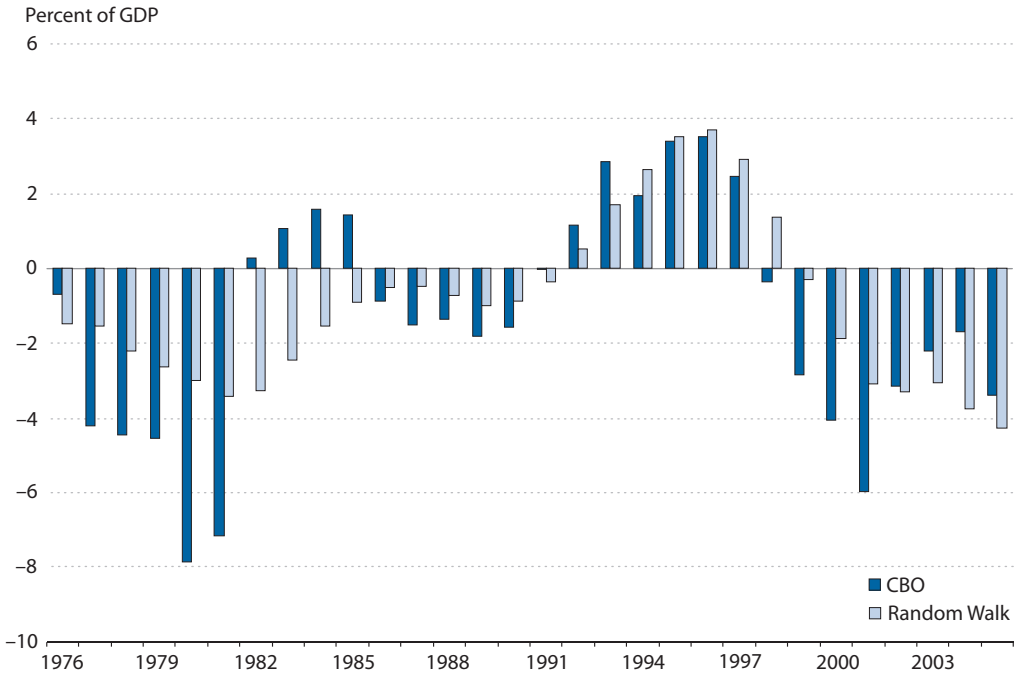
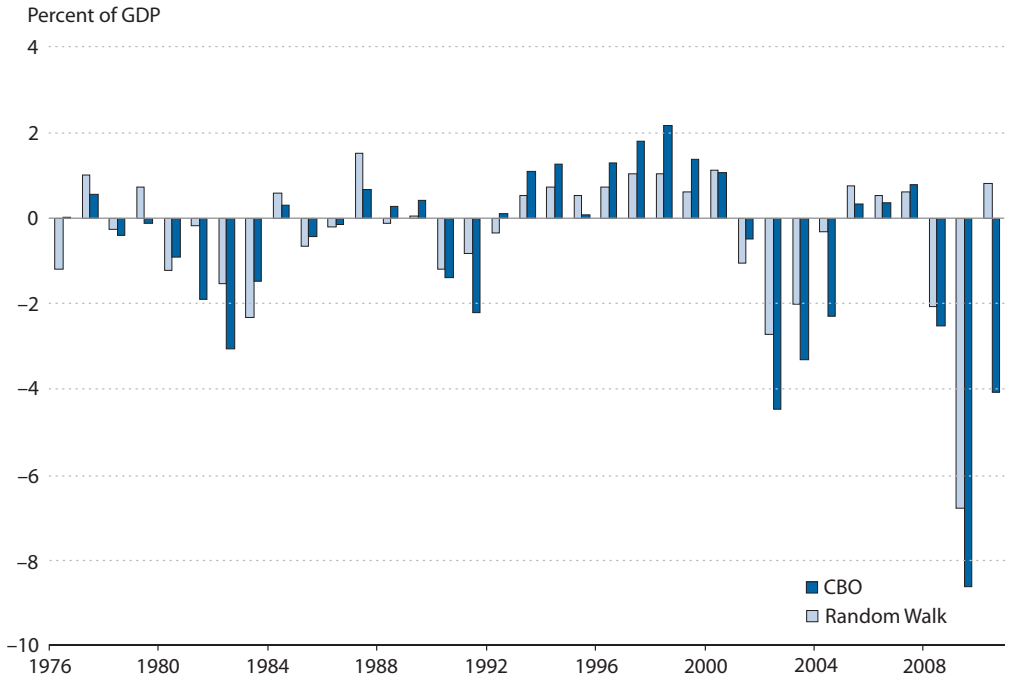


Figure 7 shows the actual and RW cumulative 5-year budget projections over our sample period. The scale is identical to that of Figure 6 to facilitate comparison of the CBO and RW projections. A comparison of Figures 6 and 7 suggest that, on average, the RW projections are somewhat better than the CBO's. For example, there are no observations in the upper left quadrant (projected deficit, actual surplus) and appreciably fewer observations in the bottom right quadrant (projected surplus, actual deficit) of Figure 7 compared with Figure 6. We can test whether this difference is statistically significant by calculating the root mean square projection error (RMSPE) and the mean absolute projection error (MAPE). The RMSPE and MAPE are 10.7 percent and 2.7 percent for the CBO, compared with 5.7 percent and 2.1 percent for the RW projections. Though large, the difference in the two RMSPEs is not statistically significant at the 5 percent significance level. The difference in MAPE is smaller and likewise not statistically significant.[10]

Figure 8 shows the CBO and RW cumulative 5-year projection errors for each year of the sample period. The RW projection errors have been smaller almost every year; nevertheless, the figure suggests that much of the dominance of the RW projections occurred before 1990. Since then the RW projections have been only slightly smaller than the CBO projections. The RMSPE and MAPE are 8.4 percent and 2.5 percent for the CBO compared with 7.1 percent and 2.3 percent for the RW. Again, these differences are not statistically significant.

Figure 9

One-Year Deficit Projection Errors as a Percent of GDP: CBO and Random Walk Projections



Accuracy of CBO Projections One Year Ahead

Not surprisingly, the CBO's 1-year-ahead projections are more accurate than the cumulative 5-year projections. The relevant question, however, is this: Are they better than RW projections? Figure 9 shows the CBO and RW projection errors over the period 1976 though 2010. The figure strongly suggests that even at the 1-year projection horizon the RW model's projection errors are smaller than the CBO's. Indeed, the RMSPE and MAPE are 2.2 percent and 1.5 percent, and 1.6 percent and 1.1 percent for the CBO and RW projections, respectively. These differences are relatively small in absolute terms and are not statistically significant.

Of course, some of these differences are a consequence of the large errors made by the CBO (and other private forecasters) in the wake of the financial crisis. However, the RW projection errors are smaller than the CBO's even over the period 1976 through 2007—the RMSPE and MAPE are 1.6 percent and 1.1 percent, and 1.1 percent and 0.9 percent, for the CBO and RW projections, respectively. These results suggest that the CBO could have done as well by simply assuming that next year's budget surplus/deficit would be the same as last year's.

It is reasonable to believe that the relatively poor performance of the CBO's cumulative 5-year projections can be accounted for (i) by structural changes in the economy that are extremely difficult—if not impossible—to predict or (ii) swings in the government's tax and expenditure policy that are not accounted for in the baseline projections. However, the relatively poor performance of 1-year-ahead projections is more difficult to ascribe to such factors. More recently,

Supplemental Spending Hampers CBO's Budget Projections

Typically, the CBO releases its *Budget and Economic Outlook* for the current FY and the next 10 FYs at the beginning of each calendar year. These budget projections are widely followed because they provide an assessment of the medium-term budget outlook based on current law and a presumed path for the economy over the next decade. The CBO's budget projections thus depend importantly on (i) current budgetary laws that govern federal outlays and tax receipts and (ii) its own economic forecasts.

When the CBO publishes its budget projections for the upcoming FY, it does not know the composition of the FY 2013 budget.* Moreover, it does not know what—if any—additional federal spending in calendar year 2011 will occur that may affect the existing FY 2012 budget projections (made a year earlier). As the accompanying table shows, these additional outlays—termed *supplemental appropriations*—can be significant.† According to the table, supplemental appropriations were rather small from 1990 to 1998, averaging a little less than $14 billion per FY. However, this spending averaged about 41 percent of the average projected budget balance over the period ($–192 billion). From 1999 to 2001 (the period when the budget surplus projections materialized), the average annual supplemental appropriation rose modestly to about $20 billion per year, or about 10 percent of the average surplus projection. From this standpoint, it does not appear that the budget surpluses spurred Congress to undertake spending beyond what was appropriated in that year's budget.

The table shows that the largest amount of supplemental expenditures occurred from 2002 to 2009. Over this period, the average annual supplemental appropriation was slightly less than $125 billion per year, nearly 95 percent of the average annual projected budget deficit ($–261 billion). These supplemental expenditures (associated with the wars in Iraq and Afghanistan and a few severe natural disasters, such as Hurricane Katrina) can help explain the CBO's relatively poor budget projections over this period.

Should Congress continue to use supplemental appropriations in the future to the same degree as it did over this period, economists, budget analysts, and policymakers would be wise to consider this development when trying to ascertain the near-term fiscal outlook provided by the CBO or the White House Office of Management and Budget. In FY 2010, though, supplemental appropriations fell by more than two-thirds from the previous year, perhaps a reflection of the public's increasing concern over the size of the federal budget deficit.

Supplemental Appropriations and Initial Budget Projections

Fiscal year	Supplemental appropriations ($ billions)	Initial budget projection ($ billions)	Supplemental spending as a percent of initial deficit/surplus projection
1990	6.4	–138.0	–4.6
1991	48.6	–298.0	–16.3
1992	19.7	–327.0	–6.0
1993	10.4	–291.0	–3.6
1994	13.5	–171.0	–7.9
1995	6.4	–207.0	–3.1
1996	4.5	–171.0	–2.6
1997	8.9	–120.0	–7.4
1998	6.3	–2.0	–313.9
1999	13.4	131.0	10.2
2000	17.4	177.0	9.8
2001	29.9	313.0	9.6
2002	47.7	–14.0	–340.4
2003	81.1	–145.0	–55.9
2004	117.8	–362.0	–32.6
2005	161.9	–295.0	–54.9
2006	128.5	–270.0	–47.6
2007	120.9	–98.0	–123.4
2008	139.0	–198.0	–70.2
2009	196.8	–703.0	–28.0
2010	56.4	–980.0	–5.8

NOTE: Excludes rescissions. The budget projection is typically published in January of the prior year in the *CBO Budget and Economic Update*.
SOURCE: History of Supplemental Appropriations; www.cbo.gov/publications/collections/collections.cfm?collect=3.

*Fiscal year 2013 begins on October 1, 2012, and ends on September 30, 2013.
†These appropriations exclude rescissions, which were amounts budgeted but not spent.

the CBO's larger 1-year projections may also reflect, as noted in the shaded insert, the significant amount of supplemental expenditures after 2001.

The Sensitivity of CBO Projection Errors to Economic Shocks

This section investigates the sensitivity of CBO projection errors to economic shocks in two ways. First, we evaluate the CBO's projection errors by excluding recession periods. It is reasonable to assume that the CBO's near-term projection errors are heavily influenced by the behavior of the economy. The difficulty in forecasting recessions is widely acknowledged and reflected in the fact that nearly all U.S. recessions have been "called" several months after they actually began.[11] Hence, it is reasonable to assume that projection errors are considerably higher during recessions. To investigate the extent to which CBO projections are affected by recessions, we deleted all years with a recession during any month of the projection year. Specifically, we deleted 1980-82, 1990-91, 2001-02, and 2008-09. The RMSPE and MAPE for the non-recession years are 1.42 percent and 1.01 percent, respectively, smaller than the 1.58 percent and 1.48 percent for the period 1976-2010. Indeed, the differences in the RMSPE and MAPE between recession and non-recession years are highly statistically significant. The projections from the RW model are also larger during recession years but the difference is not statistically significant.

In the process of making its budget projections, the CBO forecasts certain important economic variables. It is possible that the CBO's budget errors are linked to its economic forecast errors. For example, if real GDP growth is weaker than the CBO forecasted, the CBO budget projection could be lower than projected. We investigate this possibility by regressing the CBO's budget projection errors on its forecast errors for four economic variables over the same period: real GDP growth, the unemployment rate, the 3-month T-bill rate, and the 10-year Treasury bond yield. The CBO has published its forecasts for these variables since 1984. For example, in January 1984 the CBO made economic forecasts for these variables for FY 1985. This forecast is then compared with the FY 1985 actual estimate to determine the FY 1985 forecast error. The sample period is too short to analyze the effects of forecast errors on the CBO's 5-year cumulative projections. Consequently, our analysis focuses on the 1-year-ahead projections. The economic data are based on FYs rather than calendar years. Specifically, we estimate

$$CBO_t = \alpha + \delta_1 gdp_t + \delta_2 ur_t + \delta_3 tb3_t + \delta_4 T10_t + \varepsilon_t, \quad (1)$$

where CBO_t denotes the CBO's 1-year-ahead budget projection error for year t, and gdp_t, ur_t, $tb3_t$, and $T10_t$ denote the CBO's 1-year ahead forecast errors for the growth rate of real GDP, the unemployment rate, the 3-month T-bill rate, and the 10-year Treasury bond yield, respectively.

The results are summarized in Table 1, which reports the estimated coefficients, their corresponding significance level (p-value), the estimate of the adjusted R^2 ($\bar{R}^2$), and the standard error of the equation (SE). When all forecast errors are included, none of the coefficients is statistically significant at any reasonable significance level; however, each coefficient is statistically significant at at least the 10 percent significance level when considered alone. The estimate of $\bar{R}^2$ is very small for the $T10$ forecast errors and is largest for the unemployment rate. Indeed, none of the other coefficients is statistically significant when included with the unemployment rate. This point is illustrated in the last two columns of the table, which show the results when both *gdp*

Table 1

Estimates of Equation (1) with CBO Projection Errors

	Coef.	*p*-Value	Coef.	*p*-Value	Coef.	*p*-Value	Coef.	*p*-Value	Coef.	*p*-Value	Coef.	*p*-Value
Constant	–0.269	0.285	–0.095	0.815	–0.372	0.338	0.254	0.502	0.311	0.455	–0.340	0.369
gdp	0.327	0.270	0.498	0.023							0.176	0.294
ur	–0.497	0.415			–1.118	0.000					–0.965	0.000
*tb*3	0.332	0.421					0.420	0.015				
*T*10	–0.441	0.338							0.551	0.058		
$\bar{R}^2$	0.330		0.208		0.375		0.224		0.044		0.364	
SE	1.358		0.170		1.311		1.461		1.622		1.322	

NOTE: Analysis based on annual data, 1985 to 2010. Coef., coefficient.

Table 2

Estimates of Equation (1) with Random Walk Projection Errors

	Coef.	*p*-Value	Coef.	*p*-Value	Coef.	*p*-Value	Coef.	*p*-Value	Coef.	*p*-Value	Coef.	*p*-Value
Constant	–0.031	0.887	0.005	0.985	–0.191	0.375	0.264	0.197	0.357	0.155	–0.182	0.402
gdp	0.105	0.569	0.297	0.054							0.052	0.659
ur	–0.470	0.247			–0.780	0.000					–0.735	0.001
*tb*3	0.154	0.595					0.317	0.011				
*T*10	–0.052	0.881							0.490	0.033		
$\bar{R}^2$	0.412		0.145		0.464		0.339		0.131		0.442	
SE	0.806		0.973		1.770		0.856		0.980		0.786	

NOTE: Analysis based on annual data, 1985 to 2010. Coef., coefficient.

and *ur* are included. Only *ur* is statistically significant, and the estimate of $\bar{R}^2$ is smaller than when *ur* is included alone, suggesting that *gdp* has no marginal explanatory power in the presence of *ur*. A similar result holds for *tb*3 and *T*10. Hence, the CBO's economic forecast errors, as summarized by the unemployment rate, appear to be related to its 1-year-ahead projection errors. Moreover, the sign of the coefficient is consistent with the idea that a higher unemployment rate than the CBO's forecast should yield a smaller surplus (or larger deficit) relative to the CBO's projection.

It is important to emphasize, however, that correlation does not imply causation—that is, it does not necessarily mean that the larger budget projection error was caused by the CBO's economic forecast error. We investigate this by repeating the analysis using the RW budget projection errors. If there is no similar relationship between the CBO's economic forecast errors and the RW budget projection errors, the hypothesis that the CBO's budget projection errors were affected by its economic forecast errors has more credibility. If, on the other hand, the results are materially similar to those using the CBO's budget projection errors, it is unlikely that the correlations reported for the CBO's budget projection errors reflect a cause-and-effect relationship between economic forecast errors and budget projection errors.

The results using the RW projection errors as the dependent variable are summarized in Table 2. All qualitative conclusions described for the CBO's projection errors apply to the RW projection errors as well. Indeed, the most notable difference is that the estimates of $\bar{R}^2$ are somewhat higher for the RW errors. Hence, there is no compelling evidence that the CBO's budget projections could have been materially improved had its forecasting of the unemployment rate or other economic variables been significantly better.

HAS THE CBO DONE BETTER RECENTLY?

In our previous work we evaluated the CBO's budget deficit projections over the period 1976-94. It is possible that, despite its well-known handicaps in the projection process, the CBO may have reduced its projection errors over the most recent period. To investigate this possibility we compare the CBO's 1-year-ahead projections over the periods 1976-94 and 1995-2007; 2008, 2009, and 2010 were omitted so the results would not be affected by the unanticipated financial crisis. The RMSPE and MAPE for the latter period are 2.0 percent and 1.5 percent, respectively, compared with 1.2 percent and 0.9 percent, respectively, for the earlier period.[12] Hence, the accuracy of the CBO's projections appears to have deteriorated in the most recent period. However, despite their relatively large size, these differences are not statistically significant.

The RW projection errors are also larger over the latter period; however, the deterioration in performance is smaller. Moreover, the difference in performance between the RW and CBO projections for the most recent period is statistically significant at the 5 percent significance level for the MAPE and statistically significant at a slightly higher significance level for the RMSPE. Hence, the accuracy of the CBO projection has deteriorated recently both absolutely and relative to the RW benchmark. Consequently, there is no reason to place more faith in the CBO's budget projections now than there was a decade ago. If anything, the evidence suggests that slightly more skepticism of the CBO's projections in recent years may be warranted.

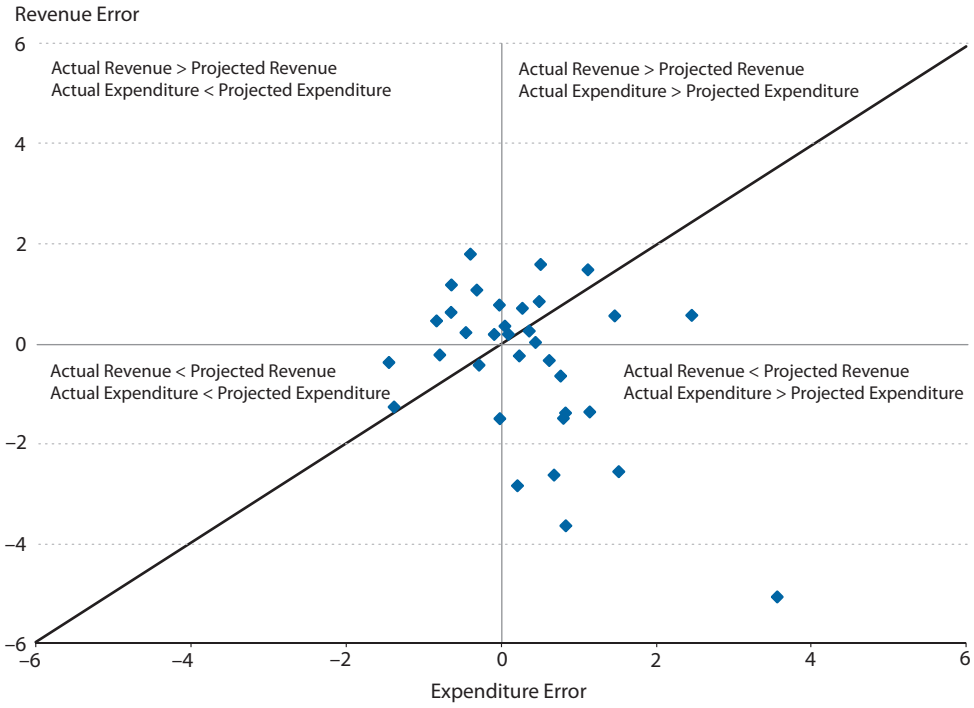
Essentially no change occurred in the bias of the CBO's 5-year-ahead projection errors during the most recent decade. The average underprojection of the deficit in the recent decade is 1.30 percent of GDP compared with 1.35 percent of GDP over the previous period. The 5-year-ahead bias is most likely to be important since this period is a reasonable planning period of reductions in the fiscal deficit. For example, this bias suggests that deficit reduction programs that are projected to reduce the federal deficit by 1 percent of GDP over the next five years relative to the CBO's projections may miss their mark by more than 1 percent of GDP. Stated differently, the CBO is currently projecting the deficit to stabilize at less than 2 percent of GDP (according to the August 2011 baseline projections), but the bias suggests that the actual budget deficit could be considerably higher.

DECOMPOSING THE BUDGET PROJECTION ERRORS

It is interesting to know whether the CBO's budget projection errors are due to the relative inability to accurately project revenues or expenditures and, if so, which category of revenue or expenditures. Because cumulative 5-year projection errors overlap over time, we focus on the 1-year forecast errors; however, the qualitative implications are similar using the cumulative

Figure 10

CBO Revenue and Expenditure Projection Errors as a Percent of GDP



5-year projection errors. Figure 10 shows the CBO's revenue and expenditure projection errors as a percent of GDP. The expenditure errors are plotted on the horizontal axis, while the revenue errors are plotted on the vertical axis. Points on or near the 45-degree line denote years in which the CBO did a good job of projecting both revenues and expenditures. Points near the horizontal zero line denote years when the CBO did a relatively good job of projecting revenues, while points near the vertical zero line denote years when the CBO did a relatively good job of projecting expenditures. Points in the upper left quadrant of the figure indicate years when the CBO underprojected revenue and overprojected expenditures; points in the lower right quadrant indicate the reverse.

While it is not obvious from the figure, on average the CBO did somewhat better in projecting expenditures. The MAPE is 1.14 percent and 0.76 percent for revenue and expenditure, respectively. The RMSPE is 1.58 percent and 1.04 percent, respectively. Hence, even though the relatively large and persistent deficits since the early 1970s are due to an increase in expenditures over revenue, the CBO budget projection errors are somewhat larger for revenue. Indeed, the performance difference is statistically significant at the 5 percent level for the RMSPE, but not for the MAPE. It is important to note, however, that the difference in revenue versus expenditure projection performance over the sample period is the consequence of the unusually large revenue errors associated with the recent recession. When 2008 and 2009 are deleted, the differ-

Table 3

Regression Analysis of the CBO's Cumulative 5-Year Revenue and Expenditure Projection Errors

	Coef.	*p*-Value	Coef.	*p*-Value	Coef.	*p*-Value	Coef.	*p*-Value
Revenue equation								
Constant	–0.015	0.521	–0.068	0.392	–0.077	0.756	–0.312	0.298
IND	1.222	0.000	1.471	0.000				
CORP	0.855	0.000			2.673	0.000		
SI	0.153	0.201					1.493	0.229
$\bar{R}^2$	0.978		0.942		0.550		0.125	
SE	0.231		0.373		1.042		1.452	
Expenditure equation								
Constant	0.788	0.000	0.798	0.000	–0.057	0.801	–0.008	0.969
MAN	0.900	0.000	0.922	0.000				
DISC	0.678	0.003			1.646	0.002		
DEF	–1.023	0.000					2.005	0.054
$\bar{R}^2$	0.942		0.916		0.395		0.202	
SE	0.253		0.306		0.820		0.941	

NOTE: Number of observations is 30.

ences in these performance measures are small and not statistically significant at any reasonable significance level.

The Sources of Revenue and Expenditure Errors

In this section, we investigate the sources of the revenue and expenditure projection errors by examining the CBO's projection errors for the major categories of revenues and expenditures. Specifically, we regressed the CBO's revenue and expenditure projection errors on three main sources of revenue and expenditures. The revenue sources are individual income taxes (IND), corporate income taxes (CORP), and social insurance taxes (SI). The expenditure sources are mandatory spending (MAN), discretionary spending (DISC), and defense spending (DEF). Regression analysis is frequently used to make statistical inferences, so it is important to emphasize that the statistics presented here are merely descriptive.

The results are summarized in Table 3. The results for the revenue error regressions are reported in the upper half of the table. The three sources of revenue errors account for 98 percent of the CBO's total revenue projection errors. However, only the coefficients on the IND and CORP are statistically significant. While each component accounts for a relatively large percentage of the CBO's revenue projection errors, errors in projecting individual tax returns appear to be the most important source of error: This error alone accounts for nearly 97 percent of the total revenue projection errors. In contrast, corporate taxes alone account for only about 33 percent of the variation in revenue errors, and social insurance projection errors account for even less: about 24 percent.

The estimates for the expenditure errors are presented in the bottom half of Table 3. Together the three sources of error account for almost 94 percent of the total expenditure error; however, only the coefficients on discretionary and defense spending are statistically significant, suggesting that they are individually important sources of expenditure errors.[13] This is confirmed by the fact that, individually, each accounts for about 64 percent of the total variation in the CBO's expenditure error. Hence, it appears that none of the three sources of expenditure error was more important in determining the CBO's expenditure projection errors.

Unfortunately, this analysis does not point to a specific area where the CBO could improve its performance as there is no particular source of revenue errors that is more important than another when the effect of the recent recession on the CBO's revenue projections is accounted for. Likewise, there is no dominant source of expenditure error.

CONCLUSION

The CBO's budget projections are widely followed by economic policymakers, investors, and other financial participants. In this paper, we analyze 34 years of CBO budget projections in an attempt to determine the extent to which policymakers and the public should rely on such projections. It is not our intent to malign the CBO. Rather, our purpose is to ascertain whether the process that produces the baseline budget projections yields reasonably accurate results, given the constraints they face. Our results suggest several conclusions. First, and not surprisingly, projections for longer horizons are considerably worse than those for shorter horizons.

Second, despite the better performance at the 1-year horizon, the CBO's 1-year-ahead projection errors are not significantly better than the projection errors made by simply using the previous year's deficit/surplus as the forecast of the next year's deficit/surplus. That is, the CBO could do no worse if it made its 1-year-ahead budget projections using a RW model.

Third, the CBO's cumulative 5-year projections are considerably worse than projections from the RW model; however, none of the differences is statistically significant.

Fourth, no component of the revenue or expenditure forecasts is obviously more important than the others for either the 1-year or 5-year cumulative projections. Hence, there appears to be no area where the CBO could improve its overall performance by simply improving its performance in a particular revenue or expenditure category.

Fifth, the CBO's performance is significantly worse during recession years relative to non-recession years. Hence, recessions appear to account for at least part of the CBO's relatively poor projection performance. However, the CBO's budget projections are not statistically significant from those made by the RW model during non-recession years. In a similar vein, the performance of the CBO relative to the simple RW does not appear to be affected by the CBO's errors in forecasting key economic variables.

Finally, we find no significant change in the CBO's budget projection performance over the past decade relative to our 2001 analysis. The CBO's projection errors are of similar magnitude and are just as biased as for the previous period. If past behavior is a guide to the future, our analysis suggests that projected future deficits will likely be larger than those currently projected.

NOTES

1 See Peach and Steindel (2000). It is important to note that at the time, long-run budget projections continued to show increasingly large deficits owing to future unfunded liabilities of the federal government's two main retirement programs (Social Security and Medicare).

2 See Meyer (2000).

3 The CBO also presents alternative projections, but these are also dependent on scenarios that may not occur. For example, the CBO regularly publishes projections based on the administration's annual budget and long-term budget projections based on alternative scenarios. Regarding the latter, see CBO (2011b).

4 The Budget Control Act of 2011 also included a $2.1 trillion extension of the Treasury debt ceiling. See CBO (2011a).

5 For the past several years, the CBO has regularly published an assessment of its economic forecasts. See, for example, the July 2010 report (www.cbo.gov/ftpdocs/115xx/doc11553/ForecastingAccuracy.pdf).

6 Indeed, the rolling correlation coefficients in a 10-year window between the two series averaged 0.4 from 1956 to 1975 and then –0.4 from 1976 to 2010.

7 PAYGO was initially enacted into law in 1990 as an amendment to the Deficit Control Act. Its purpose was to ensure that new laws changing mandatory expenditures or revenues were deficit neutral. See Heniff and Keith (2004) for a summary of various budget reform measures.

8 The cyclically adjusted budget measure is an attempt to determine how much of the deficit/surplus is due to business cycle effects that raise or lower outlays and revenues. For a discussion of the methodology, see CBO (2008).

9 Most economists believe that the burden of the payroll tax (incidence) falls almost entirely on the employee.

10 The test of the statistical significance of the difference between the CBO and RW projection errors is obtained by regressing the difference between the CBO and RW squared projection error (or absolute projection error) on a constant and testing the hypothesis that the constant term is zero. The regression used heteroskedasticity autocorrelation-consistent estimates of the standard error.

11 Since 1980, the National Bureau of Economic Research Business Cycle Dating Committee has, on average, announced the date of the beginning (peak) or end (trough) of the recession nine months after the determined date of occurrence. This lag length has varied from 6 to 12 months for these 9 episodes.

12 The results not excluding 2007-10 are larger: 3.0 percent and 2.2 percent, respectively.

13 The negative coefficient on defense spending suggests that, conditional on the other two sources of expenditure errors, the error in defense spending reduces the total expenditure error. This result is likely a consequence of the correlation between the errors. The correlations between DEF and MAN and DISC are 57 percent and 77 percent, respectively. In any event, as Table 3 shows, omitting the others results in a positive correlation between errors and defense spending and total expenditure errors.

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Research Focus

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Taylor-Type Rules and Total Factor Productivity

William T. Gavin, Benjamin D. Keen, and Michael R. Pakko

This paper examines the impact of a persistent shock to the growth rate of total factor productivity in a New Keynesian model in which the central bank does not observe the shock. The authors then investigate the performance of alternative policy rules in such an incomplete information environment. While some rules perform better than others, the authors demonstrate that inflation is more stable after a persistent productivity shock when monetary policy targets the output growth rate (not the output gap) or the price-level path (not the inflation rate). Both the output growth and price-level path rules generate less volatility in output and inflation following a persistent productivity shock compared with the Taylor rule. (JEL E30, E42, E58)

Federal Reserve Bank of St. Louis *Review*, January/February 2012, *94*(1), pp. 41-64.

Gross domestic product (GDP) in the United States fell about 8.7 percent below its estimated long-run trend (i.e., potential GDP) during the last quarter of 2008 and the first quarter of 2009. Since that time, actual and potential GDP have grown at about the same rate but with actual GDP considerably lower than potential GDP. Figure 1 shows logged values of actual GDP and two estimates of potential GDP as calculated by the Congressional Budget Office (CBO). The higher level of potential GDP was estimated in 2007 and the lower level in 2011. The reduced 2011 estimate reflects the impact of sluggish GDP growth over the past few years. Uncertainty about how long actual GDP will remain below potential GDP and how much estimates of potential GDP will decline if actual GDP continues to grow slowly are just some of the problems in evaluating the current state of the economy. Obtaining reliable estimates of potential output is particularly important because potential GDP is a key benchmark used by the Federal Reserve to set its federal funds rate target. If the estimates of potential GDP are incorrect, the central bank could make a mistake when setting the federal funds rate target and trigger an unintended shift in inflation.

In recent U.S. history, two episodes occurred in which statistical agencies were initially unaware of a substantial shift in trend GDP growth. Orphanides et al. (2002) argue that rising

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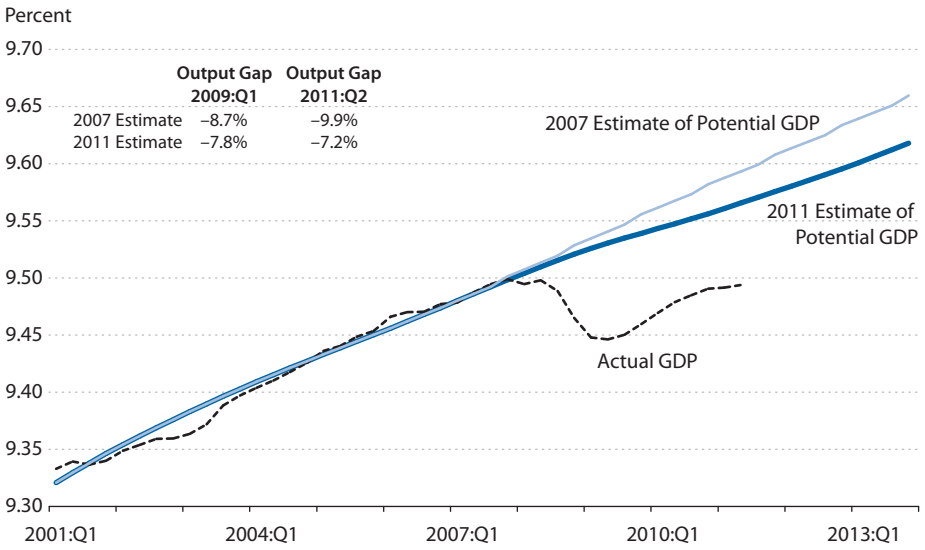
Figure 1

CBO Potential Real GDP and Actual Real GDP



NOTE: Data shown are logged values.

U.S. inflation from 1965 to 1980 was the result of real-time errors in the measurement of trend GDP.[1] They contend that an unexpected productivity slowdown reduced the actual growth rate of potential output below its expected trend, which inadvertently led policymakers to follow an inflationary policy. In the second case, the U.S. inflation rate averaged 3 percent per year during the 1990s, which was well below the 5- to 10-year-ahead forecasts of 5 percent made in 1989. Many economists now believe that the surprisingly low inflation of the 1990s was caused by an unexpected increase in productivity growth.

Taylor (1993) outlines a simple monetary policy rule that performs well in describing how the Federal Reserve conducted monetary policy between 1987 and 1993. The Taylor rule states that the nominal interest rate target responds to deviations of output from its potential and the inflation rate from its target. The fact that the Taylor rule has successfully accounted for monetary policy actions has led economists to examine how well the rule achieves the objectives of the central bank. Research finds that the Taylor rule, while not the optimal monetary policy rule, performs very well in a variety of macroeconomic models.[2] Such analysis, however, generally has omitted consideration of shifts in productivity growth trends.

This article shows how alternative monetary policy rules may prevent unintentional changes in inflation following a persistent productivity growth shock. Our results indicate that a persistent increase in the productivity growth rate causes inflation to fall when the central bank follows the Taylor rule but does not observe the productivity shock. The decline continues until policymakers recognize the shock and adjust to the level of productivity. We demonstrate that when the central bank targets the output growth rate or the price-level path instead of the level of output, inflation initially changes but eventually returns to its target with no further intervention by

the central bank. Furthermore, the model predicts that inflation and the output gap vary much less when the output growth rate or the price-level path is the target of monetary policy.

The paper proceeds in the following manner. The next section provides an overview of the New Keynesian model. We then examine how the economy responds to a persistent productivity growth shock under various monetary policy rules. To assess the approximate welfare implications of alternative policy rules, we investigate the volatility of inflation and output over horizons ranging from 1 quarter to 5 years after a permanent productivity shock.

THE MODEL

Our model is a standard New Keynesian specification with Calvo (1983)-style price setting. A basic overview of the model is presented below. Those familiar with the standard New Keynesian model may wish to go directly to the discussion of calibration and parameter assignments in the next section.

Households

Households are infinitely lived agents who seek to maximize the discounted value of their expected lifetime utility from consumption, c_t, and leisure, l_t,

$$E_0\left[\sum_{t=0}^{\infty}\beta^t u\left(c_t, l_t\right)\right], \tag{1}$$

where E_0 is the expectation operator at time 0 and β is the discount factor. For simplicity, we assume that consumption and leisure are separable in the momentary utility function

$$u(c_t, l_t) = \ln\left(c_t\right) + \chi\frac{l_t^{1-\omega}}{1-\omega}, \tag{2}$$

where χ measures the relative weight of leisure in the household's utility function and ω determines the elasticity of the labor supply with respect to the real wage.

Households' utility maximization problem is subject to constraints on spending, time, and capital accumulation. Households begin each period with their initial real money balances, M_{t-1}/P_t, and income from the sale of bonds purchased in the previous period, $R_{t-1}B_{t-1}/P_t$, where M_t is nominal money balances, B_t is nominal bond holdings, P_t is the price level, and R_t is the gross nominal interest rate earned on bonds from period t to t+1. During the period, households receive resources from labor income, $w_t n_t$, capital rental income, $q_t k_t$, profits from ownership of firms, d_t, and a transfer payment from the monetary authority, T_t/P_t, where w_t is the real wage, n_t is labor, q_t is the capital rental rate, and k_t is the capital stock. The households then use those resources to fund their consumption, investment, i, and their end-of-period real money and bond holdings, M_t/P_t and B_t/P_t, respectively. Thus, households' budget constraint is expressed as

$$c_t + i_t + \frac{M_t}{P_t} + \frac{B_t}{P_t} = w_t n_t + q_t k_t + d_t + \frac{M_{t-1}}{P_t} + \frac{R_{t-1}B_{t-1}}{P_t} + \frac{T_t}{P_t}. \tag{3}$$

Households' time, which is normalized to unity, is divided among labor, leisure, and time spent in transaction-related activities, s_t:

$$l_t + n_t + s_t = 1. \tag{4}$$

The time households spend in transaction-related activities—often called shopping time costs—will rise as the nominal value of consumption purchases rises. It will drop as households set aside more money to facilitate such transactions. This is denoted as follows:

$$s_t = \zeta\left(\frac{P_t c_t}{M_{t-1}}\right)^{\gamma}, \tag{5}$$

where $\zeta > 0$ is set to match the average velocity of money balances, defined as currency plus checkable deposits, and $\gamma > 0$ determines the interest elasticity of money. Our function for s_t depends on beginning-of-the-period money balances and does not include the monetary transfer. That assumption makes our specification more similar to a cash-in-advance model rather than a money-in-the-utility-function specification, which typically uses end-of-the-period money balances.

Each period, households spend resources on investment in order to acquire capital. Some resources are exhausted during the process of converting investment into capital. These lost resources are referred to as "capital adjustment costs," AC_t. The capital accumulation equation then is

$$i_t = k_{t+1} - (1-\delta)k_t + AC_t, \tag{6}$$

where δ is the depreciation rate and $AC_t = i_t - \varphi(i_t/k_t)k_t$. We assume that the average and marginal capital adjustment costs are zero around the steady state (i.e., $\varphi(i_t/k_t) = i/k$ and $\varphi'(i_t/k_t) = 1$). The capital adjustment costs are important in a model with sticky prices to prevent implausibly large movements in investment after most exogenous shocks to the economy.

Firms

Each firm produces a heterogeneous good in a monopolistically competitive market. The presence of monopoly power enables firms to optimally adjust their prices each period unless some friction exists to prevent it. The presence of a friction that prohibits all firms from optimally setting their prices every period is a common characteristic in most New Keynesian models.

Any model with heterogeneous firms requires a couple of assumptions to make it tractable. First, all firms have the same production function. Specifically, firm f produces its output, $y_{f,t}$, according to the following production function:

$$y_{f,t} = k_{f,t}^{\alpha}\left(Z_t n_{f,t}\right)^{(1-\alpha)}, \tag{7}$$

where $n_{f,t}$ is firm f's labor demand, $k_{f,t}$ is firm f's capital demand, Z_t is an economy-wide productivity factor, and $0 < \alpha < 1$. The productivity factor, Z_t, evolves as follows:

$$\ln\left(Z_t / Z_{t-1}\right) = \rho_Z \ln\left(Z_{t-1} / Z_{t-2}\right) + \left(1-\rho_Z\right)\ln\left(\bar{g}\right) + \upsilon_t, \tag{8}$$

where $\bar{g}$ is the steady-state productivity growth rate, $0 \le \rho_Z < 1$, and $\upsilon \sim N(0,\sigma^2)$.

The second assumption is that firms hire labor and rental capital in perfectly competitive factor markets, so that all firms pay the same wage and capital rental rate. The resulting first-order conditions from firm *f*'s problem are

$$q_t = \alpha \psi_t \left(Z_t n_{f,t} / k_{f,t} \right)^{(1-\alpha)}, \tag{9}$$

$$w_t = (1-\alpha) \psi_t Z_t \left(k_{f,t} / Z_t n_{f,t} \right)^{\alpha}, \tag{10}$$

where ψ_t is interpreted as the real marginal cost of producing an additional unit of output. Since all firms have access to the same technology and pay the same price for capital and labor, the capital-to-labor ratio and the real marginal cost are identical for all firms. The capital and labor used by all firms is aggregated as follows:

$$k_t = \left[\int_0^1 k_{f,t} \, df \right], \text{ and } n_t = \left[\int_0^1 n_{f,t} df \right]. \tag{11}$$

Aggregate output, y_t, is a combination of the differentiated products using the Dixit-Stiglitz aggregator:

$$y_t = \left[\int_0^1 y_{f,t}^{(\epsilon-1)/\epsilon} \, df \right]^{\epsilon/(\epsilon-1)}, \tag{12}$$

where $-\epsilon$ is the price elasticity of demand for $y_{f,t}$. Cost minimization by households yields the following product demand equation for firm *f*'s differentiated good:

$$y_{f,t} = \left(\frac{P_{f,t}}{P_t} \right)^{-\epsilon} y_t, \tag{13}$$

where $P_{f,t}$ is the price for $y_{f,t}$ and P_t is a nonlinear aggregate price index such that

$$P_t = \left[\int_0^1 P_{f,t}^{(1-\epsilon)} \, df \right]^{1/(1-\epsilon)}. \tag{14}$$

Price setting follows a Calvo (1983) model of price adjustment. Specifically, the probability that a firm can optimally reset its price in any given period is $(1-\eta)$, while the probability that that firm must charge the last period's price is η. Those firms with a price adjustment opportunity select the price that maximizes the present value of their current and expected future profits subject to the constraint in equation (13) that firms must satisfy all demand at their posted price. When the solution to this problem is linearized around its steady state, the equation for the New Keynesian Phillips curve is obtained[3]:

$$\hat{\pi}_t = \left[(1-\eta)(1-\beta\eta)/\eta \right] \hat{\psi}_t + \beta E_t \hat{\pi}_{t+1}, \tag{15}$$

where "^" represents the percent deviation of a variable from its steady state.

Scattered price adjustment enables individual firms to charge different prices, which leads to some firms producing less than their optimal allocation and others producing more. This dispersion in prices is especially prevalent after an exogenous shock hits the economy. If price stickiness is the only nominal friction in the model, the optimal monetary policy is to stabilize

the price level with long-run inflation expectations equal to zero.[4] As the price level deviates further from its optimal level, output becomes more distorted and welfare is reduced. The welfare losses are directly related to the size of the gap between output in the sticky price model and the level of output that would occur with flexible prices. Thus, the goal of the policymaker is to reduce the size of that gap by aggressively targeting the price level so that output follows the path that it would in an economy with flexible prices.

The Monetary Authority

The monetary authority targets the nominal interest rate, R_t, as follows:

$$\hat{R}_t = \left(1+\theta_\pi\right)\hat{\pi}_t + \theta_y \hat{y}_t + \theta_g \hat{g}_t + \theta_P \hat{P}_t, \tag{16}$$

where $\theta_\pi \geq 0$, $\theta_y \geq 0$, $\theta_g \geq 0$, $\theta_P \geq 0$, and g_t is the growth rate of output. Equation (12) then resembles a Taylor (1993) rule in which θ_g and θ_P are set = 0. In our sticky price model, the optimal monetary policy rule, if it were implementable, prevents the inflation rate from deviating from its target by setting $\theta_\pi = \infty$. We initially analyze the effects of a persistent but temporary shock to the productivity growth rate on key economic variables under the optimal policy rule and then use those results to evaluate alternative monetary policies that are likely to be implementable.

Why is the optimal policy unrealistic? Essentially, under the optimal policy, the central bank promises to raise the interest rate by any amount necessary to prevent the inflation rate from deviating from the target rate. In theory, people expect the central bank to deliver inflation at the target rate; they make decisions, write contracts, and generally forecast inflation assuming inflation will be at the target rate. The central bank does not need to move the interest rate because people react to shocks in a manner that causes inflation to be equal to the target. In equilibrium there is almost no variability in either interest rates or inflation. This equilibrium outcome requires policy to be well defined and credible.

Models that are typically used in central banks to make forecasts and evaluate alternative policies generally assume that inflation expectations are mostly backward looking. That is, people do not have the opportunity to change their decisions in light of announced policy changes. Consequently, central bank simulations of switching to the optimal policy often find that doing so results in extreme variability for interest rates, inflation, and other economic time series. The bottom line is that central bank officials are often reluctant to commit to the optimal policy implied by the forward-looking model.

Fortunately, there are implementable policies that can approximate the optimal equilibrium. By "implementable," we mean that the central bank can make measured responses to incoming data in a way that will inform the public about the policy and help strengthen credibility if it is weak.[5] We demonstrate this result in our model using alternative policies defined by interest rate rules that react to output growth rather than the output gap and a price-level path rather than the period-by-period inflation rate.

CALIBRATING THE MODEL

Parameter values are specified based on a quarterly model. The households' discount factor, β, is set to 0.99, which is consistent with a steady-state annual real interest rate of about 4 percent.

The preference parameter, χ, is calibrated so that the steady-state labor supply, $\bar{n}$, works 30 percent of the available time. The other preference parameter, ω, is set to 7/9, which implies that the elasticity of labor supply with respect to the real wage is approximately equal to 3.[6] Parameters chosen for the shopping time function, s_t, are consistent with long-run studies of money demand. Specifically, the long-run elasticity of money demand with respect to consumption, γ, is set to 1, which implies that the interest rate elasticity of money demand equals –0.5.[7] The scale variable, ζ, is chosen to approximately match the income velocity of currency plus household checkable deposits. Furthermore, the steady-state shopping time cost, $\bar{s}$, is set to 1 percent of the time spent working.

The capital share of output, α, is set to 0.33 and the capital stock depreciates at 2 percent per quarter. The price elasticity of demand, ϵ, is set equal to 6, which is consistent with a 20 percent steady-state markup of price over marginal cost. The probability of price adjustment, $(1-\eta)$, is set to 0.25, which means that firms change prices on average once per year. Capital adjustment costs are calibrated so that the elasticity of the investment-to-capital ratio with respect to Tobin's q, $[(i/k)\varphi''(\cdot)/\varphi'(\cdot)]-1$, is equal to 5.

A persistent shock to the productivity growth rate will lead to a permanent change in the level of both productivity and output. Since the central bank in our model measures potential output as the original steady-state path for output, a productivity shock will cause policymakers to unknowingly respond to a flawed measure of the output gap.[8] This specification has some strong empirical support in the literature. Orphanides and van Norden (2002) and Orphanides (2003a,b) document that historically neither the Federal Reserve nor standard statistical methods have been able to detect large changes in potential output until well after they have occurred.

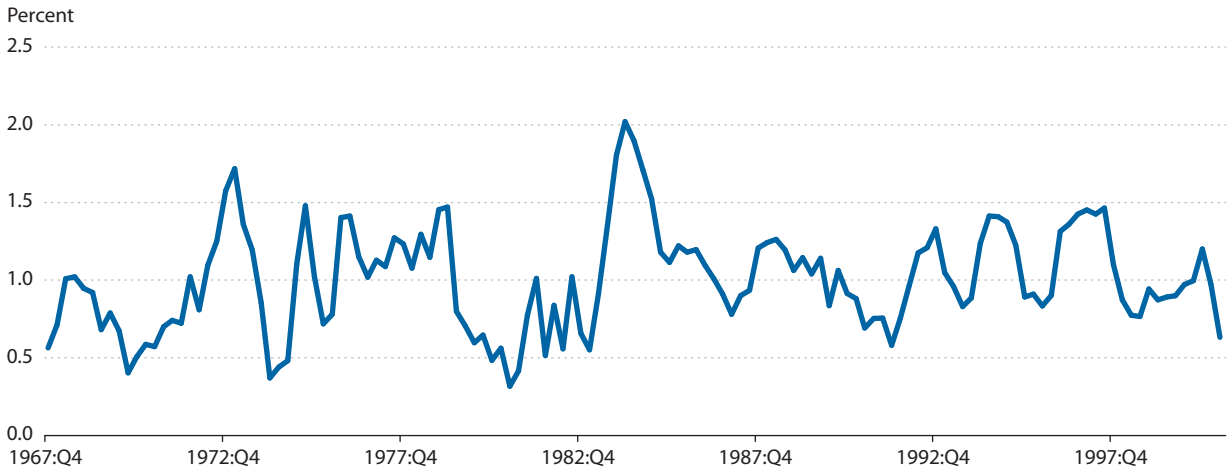
Identifying potential output changes in real time is complicated by frequent revisions to recent GDP data. Figure 2 plots the standard deviation (SD) of 2-year growth rates of real output from different vintages of the data.[9] For example, the growth rate for the 2-year period ending in 1984:Q1 has the largest standard error. It has been revised many times since the data were first computed in 1984:Q2. The SD of the 2-year growth rate ending in 1984:Q1 was 2.0 percent for all vintages of data published since 1984:Q2; that 2-year period had the largest number of revisions of any 2-year period in our sample. Overall, the average SD for the sample shown in Figure 2 is 1.0 percent.

The output gap is measured as the log difference between actual and potential output. Orphanides and van Norden (2002) show that revisions to actual output have a small effect on measured output gaps compared with the effect generated by revisions to potential output. Revisions to potential output for any particular quarter are so large because all statistical methods used to measure it rely on data both before and after the quarter in question. In real time, however, the policymaker has only past data available to measure potential output. As more data become available, the incoming information is used to refine estimates of the trend. For example, Figure 1 compares the 2011 estimate of potential GDP as measured by the CBO with its own 2007 estimate. Slow growth during the current recovery has led the CBO to lower its estimate of potential GDP. As a result, the estimate for 2011:Q2 potential GDP has fallen by about 2.7 percent since the beginning of the mortgage debt crisis.

Orphanides and van Norden (2002) report that the revisions of the Federal Reserve staff's estimates of the output gap for the 1980s and early 1990s have a root mean square error of 2.84

Figure 2

Standard Deviation of 2-Year GNP/GDP Growth Rates (Across Vintages)



SOURCE: Real-Time Data Research Center (www.philadelphiafed.org/research-and-data/real-time-center/).

percent, compared with an SD of 2.44 percent for earlier estimates available at the end of 1994. This means that revisions made in the second half of the 1990s to both the output data and the estimates of potential output have become larger and estimates of the size of the output gap have become smaller. That finding highlights a pattern in recent U.S. economic history: Depending on the particular statistical model used, the real-time estimate of the output gap can be reduced by half or more as new data arrive. If a model with a linear trend is used, Orphanides and van Norden (2002) show that the 11 percent negative output gap estimated for 1974-75 using real-time data nearly disappeared by 2000 as incoming information led to revised estimates. Revisions to the output gap have historically shown a high degree of positive correlation. Therefore, a downward revision to the output gap in the latest data release likely signals further downward revisions for future estimates of that output gap.

We calibrate the technology growth shock process using estimates by Kurmann and Otrok (2010) and Barsky and Sims (2011). The growth rate of technology follows a stochastic first-order autoregressive process around its nonstochastic steady state that is outlined in equation (8). We assume that the annual growth rate of productivity is 1.6 percent which, at a quarterly frequency, means that the steady-state gross growth rate of technology, $\bar{g}$, is 1.004. Following Barsky and Sims (2011), the first-order autocorrelation coefficient for the growth rate of productivity, ρ_Z, is set to 0.837.[10] With this calibration, a –0.1 percent shock lowers the level of technology by 0.6 percent in the long run and has a half-life of about one year.[11]

The equations describing the behavior of the households, firms, and monetary authority combine to form a nonlinear system describing the model's equilibrium. That system of equations is linearized around its deterministic steady state and then the model's rational expectations solution is obtained by standard solution methods (see Appendix). Our objective is to analyze the impact of a persistent but ultimately temporary shock to the growth rate of productivity.

PRODUCTIVITY GROWTH SHOCKS

This section evaluates the economic performance of monetary policy rules when a productivity growth shock shifts potential output but that shift is not immediately observed by the central bank. In all these rules, we assume that the policymaker measures the output gap as the deviation of the observed level of output from its original steady-state path. We examine the impact of a temporary increase in the productivity growth rate from 0.4 percent to 0.5 percent per quarter on capital stock growth, the inflation rate, real and nominal interest rates, real wage growth, real marginal costs, hours worked, and output for several monetary policy rules. Since the potential output shift is not immediately detected by policymakers, the steady-state output path in the policy rule remains unchanged.

Figure 3 presents the impulse responses for those variables when the monetary authority follows the optimal policy rule, the Taylor rule, and an inflation-only rule. In Figure 4, we repeat that experiment with an output growth rule suggested by Orphanides and Williams (2002) and Walsh (2003) and a price-level path rule recommended by many other authors.[12] The economy's response is limited to the first 5 years following the productivity shock because we suspect that after 5 years policymakers will begin to recognize the shift in potential GDP and make appropriate adjustments to its measure of the output gap. Furthermore, our model economy moves sufficiently far from its original steady state after 5 years to make approximation errors problematic.

The Optimal Policy

We report the results for the optimal monetary policy as a benchmark for evaluating the alternative monetary policy rules. King and Wolman (1999), Woodford (2003), and Canzoneri, Cumby, and Diba (2005) show that the optimal monetary policy in a New Keynesian model eliminates the effect of distortions caused by nominal frictions. That rule is only approximately optimal because real distortions exist because of monopolistic competition in the goods sector and shopping time costs. Monetary policy, however, is unable to correct the monopolistic competition distortion, and the distortion due to the shopping time costs is usually small.[13] In our model, the only significant nominal friction is the Calvo price setting by firms, which can be eliminated by stabilizing the price level.

The solid lines in Figure 3 show the impulse responses of key economic variables to a productivity growth shock when the monetary authority follows the optimal policy rule ($\theta_\pi = \infty$, and all other θ_is equal zero). That shock causes a rise in households' permanent income, which in turn leads households to increase their consumption and leisure and decrease their labor supply.[14] Firms raise their demand for labor, which combined with the decline in labor supply, causes the real wage to rise. The decrease in hours worked almost fully offsets the rise in productivity, so output increases only slightly in the first quarter after the productivity shock. A surge in consumption accompanies a sharp decline in investment that initially lowers the capital stock before it starts to rise again. A temporary increase in productivity raises future capital rental rates, so the real interest rate jumps on impact. Under the optimal policy rule, the nominal interest rate mimics the real interest rate because inflation expectations remain unchanged. Finally, the optimal policy keeps the price markup and the real marginal cost constant at their steady-state levels.

Figure 3

Response to a Persistent 0.1 Percent Shock to TFP Growth with Inflation-Targeting Rules

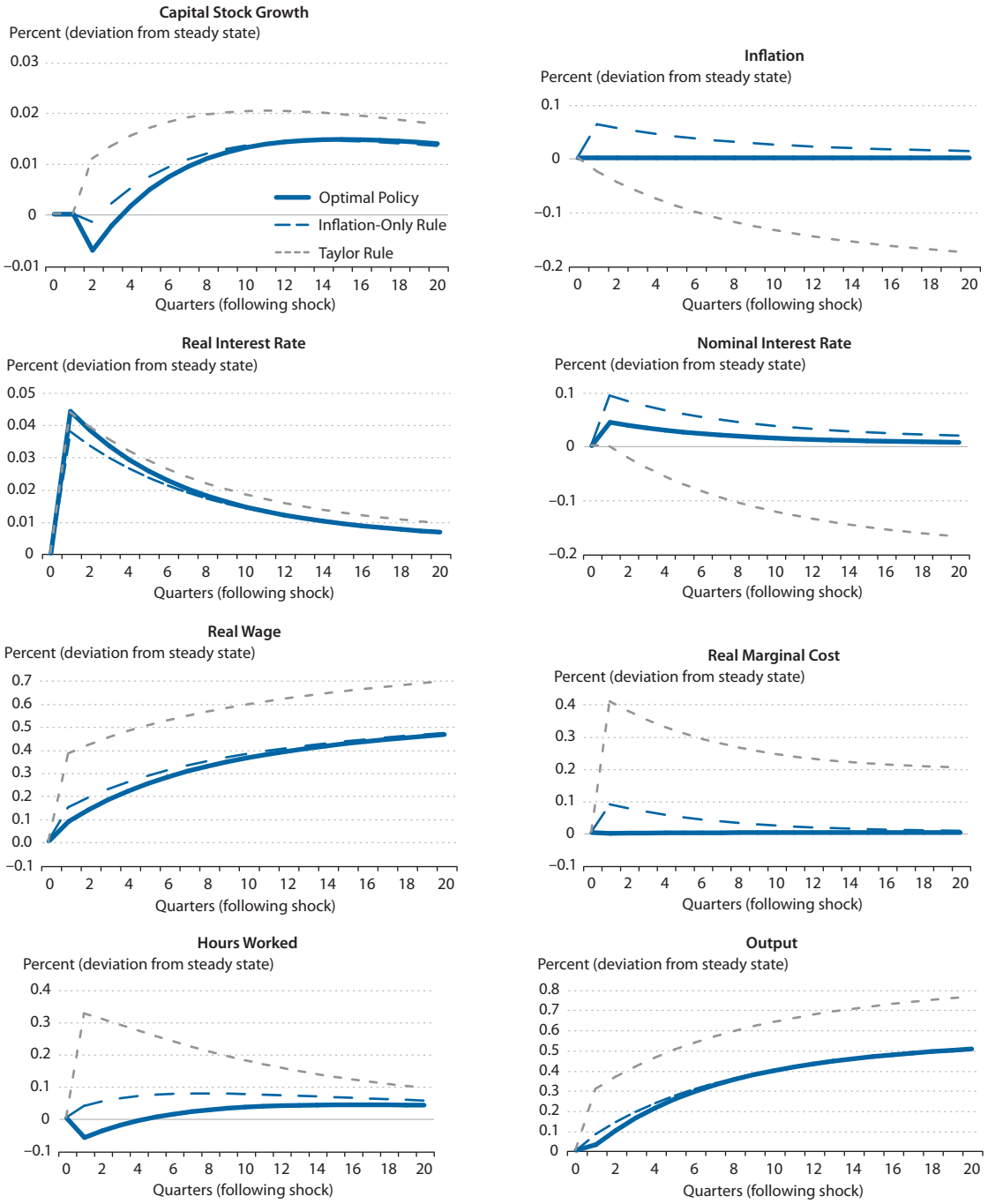
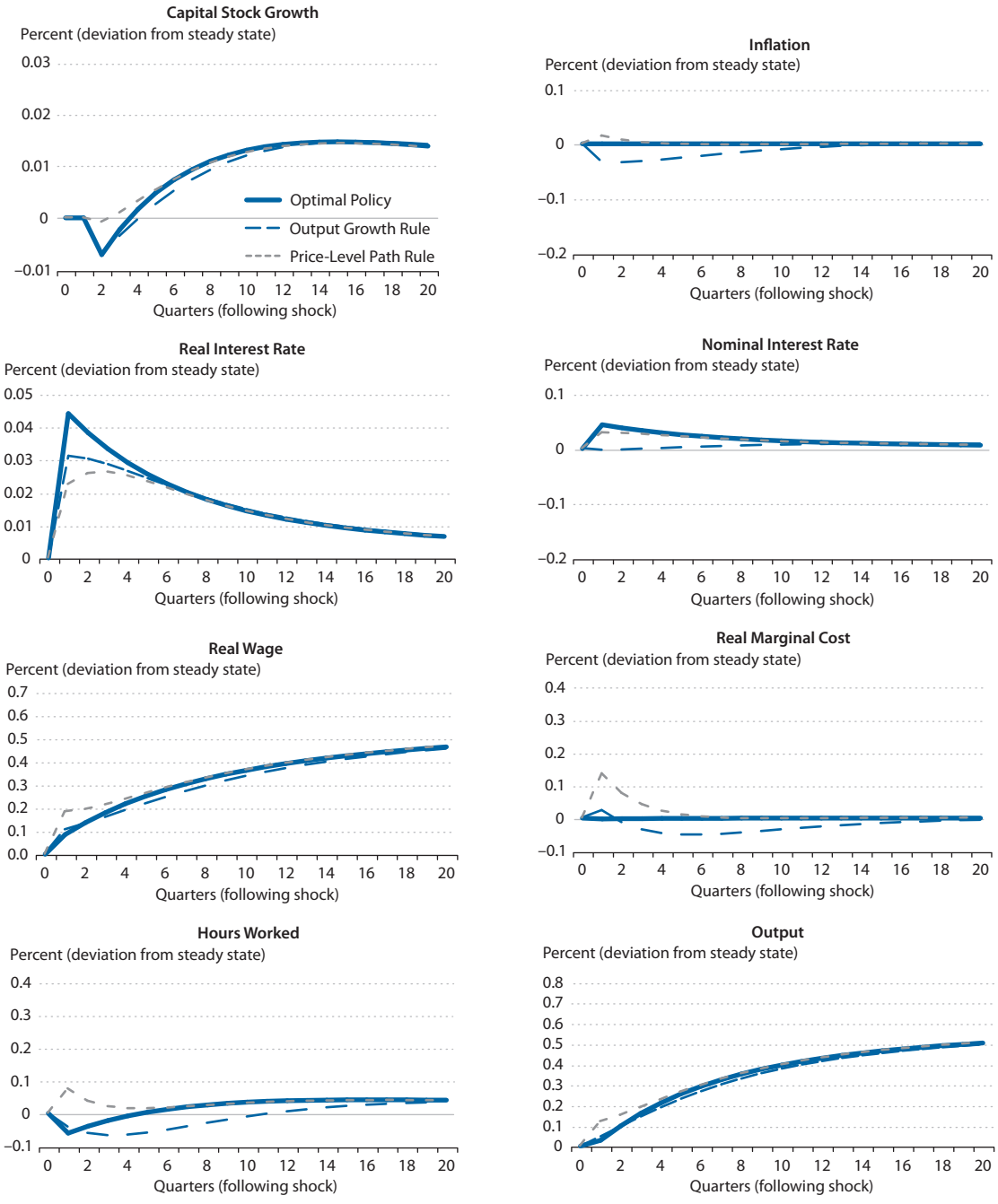


Figure 4

Response to a Persistent 0.1 Percent Shock to TFP Growth with Output Growth and Price-Level Path Rules



In subsequent periods, the economy gradually returns to its steady-state growth path, but with higher levels for productivity, capital stock, output, the real wage, consumption, and investment. The higher levels for productivity further increase the demand for labor, which continues to push up the real wage and eventually encourages households to decrease leisure in favor of more work. The gradual increase in the capital stock over time exerts downward pressure on the capital rental rate until it returns to its original steady state. This response then is mimicked by both the real and nominal interest rates.

The Inflation-Only Rule

The next policy rule that we examine is one in which the monetary authority adjusts the nominal interest rate target in response to changes in the inflation rate but ignores the output gap:

$$\hat{R}_t = \left(1+\theta_\pi\right)\hat{\pi}_t, \tag{17}$$

where $\theta_\pi > 0$ is a necessary condition for the model to have a stable and unique solution.[15] The blue dashed lines in Figure 3 depict the impulse responses to a 0.1 percent positive shock to the productivity growth rate when the monetary authority follows the inflation-only rule ($\theta_\pi = 0.5$). The key difference between the inflation-only rule and the optimal rule ($\theta_\pi = \infty$) is that a persistent productivity growth shock causes the inflation rate to rise under the inflation-only rule. Equation (17) can be rewritten so that inflation is a function of the nominal interest rate:

$$\hat{\pi}_t = \frac{\hat{R}_t}{\left(1+\theta_\pi\right)}. \tag{18}$$

Since the productivity growth shock also raises the real interest rate, the nominal interest rate must increase. Equation (18) then indicates that the size of the inflation response is negatively related to the size of θ_π. Under the optimal policy rule, however, the value for θ_π is so large that inflation does not change after a productivity growth shock.

The inflation caused by the temporary productivity growth shock with the inflation-only rule also affects real variables, albeit only slightly. Firms, which can adjust their prices only infrequently, raise their prices more aggressively when given the opportunity because they expect inflation to increase. When only a fraction of firms can raise prices, the prices charged by different firms vary immediately following a productivity shock. This divergence generates a misallocation of labor and production that causes the economy to move away from potential output. Nevertheless, the real economy does not deviate too far from the optimal path because the productivity growth shock and the resulting inflation are temporary.

The Taylor Rule

The gray dashed lines in Figure 3 show the impulse responses for the Taylor (1993) rule in which the nominal interest rate target responds to both the inflation rate and the level of output:

$$\hat{R}_t = \left(1+\theta_\pi\right)\hat{\pi}_t + \theta_y \hat{y}_t, \tag{19}$$

where $\theta_\pi = \theta_y = 0.5$. The impulse responses in Figure 3 demonstrate that setting $\theta_y > 0$ in the Taylor rule has a dramatic effect on both nominal and real variables. To understand the impact of θ_y, equation (19) is solved for the inflation rate:

$$\hat{\pi}_t = \frac{\hat{R}_t}{\left(1+\theta_\pi\right)} - \frac{\theta_y \hat{y}_t}{\left(1+\theta_\pi\right)}. \tag{20}$$

The increase in the productivity growth rate affects inflation by boosting both the real interest rate and the level of output. The inflation rate in equation (20), however, continues to fall as the deviation of output from the central bank's estimate of its potential continues to grow. If policymakers are slow to recognize a change in potential output, then the Taylor rule implies that a persistent increase in the productivity growth rate will generate an episode of surprisingly low inflation. This result is in contrast to the finding that inflation is unaffected by the optimal and inflation-only policy rules. The reason is simply that the monetary authority reacts to shifts in output under the Taylor rule, but it does not do so under the optimal and inflation-only policy rules.

Firms' pricing decisions are affected by the Taylor rule's endogenous response to the productivity shock. The expectation that inflation will decline leads firms, which adjust their prices infrequently, to select a lower price than if their prices could be adjusted every period. The lower prices lead to higher output demand, a smaller price markup, and a rise in the real marginal cost compared with the optimal and inflation-only policy rules. To raise production, firms further increase their demand for inputs, which not only raises the real wage and the rental rate of capital, but also increases the number of hours worked and investment in the capital stock. Furthermore, the higher capital rental rate puts more upward pressure on the real interest rate. The nominal interest rate initially rises with the real interest rate but then declines in subsequent periods as expected inflation falls.

An Output Growth Rule

Figure 4 examines the impact of a productivity growth shock on the optimal monetary policy rule and two alternative policy rules in which the policymakers respond to the output growth rate and the price-level path, respectively. Under the output growth rule ($\theta_\pi = 0.5$ and $\theta_g = 1$), the output growth rate replaces the output gap in the Taylor rule.[16] This specification is appealing because output growth converges back to the steady-state growth rate, whereas the perceived output gap grows until the monetary authority recognizes the change in potential output. Shifts in long-run productivity growth not only affect output growth but also exert a similar effect on the real interest rate. By including the output growth rate in the policy rule, the monetary authority can endogenously adjust its nominal interest rate target to unobserved changes in the real interest rate.

The output growth rule assumes that the monetary authority's nominal interest rate target responds to both the inflation rate and the output growth rate:

$$\hat{R}_t = \left(1+\theta_\pi\right)\hat{\pi}_t + \theta_g\, \hat{g}_t. \tag{21}$$

The blue dashed lines in Figure 4 display the impulse responses to the productivity shock under the output growth policy rule. In general, the economy's response to that shock under the output growth policy is very close to its response under the optimal policy. The link between the output growth rate and the real interest rate can be seen by substituting the Fisher equation, $\hat{R}_t = \hat{r}_t + \hat{\pi}^e_{t+1}$ into equation (21) and eliminating $\hat{R}_t$,

$$\hat{\pi}^e_{t+1} = \left(1+\theta_\pi\right)\hat{\pi}_t + \theta_g\, \hat{g}_t - \hat{r}_t.$$

The small differences between impulse responses for the two policy rules exist because the increase in the output growth rate exceeds the rise in the real interest rate over the first four years following the productivity shock. As a result, inflation continues to decline over that period. A falling inflation rate in an economy with sticky prices means the firms that cannot adjust their prices are charging higher prices than they would in the optimal policy environment. The sluggish downward adjustment in prices limits the increase in output, which dampens the rise in demand for factor inputs. That response leads to a reduction in hours worked and smaller increases in the real wage and the capital rental rate compared with the optimal policy. Lower capital demand also reduces the upward pressure on the real interest rate, which combined with a fall in inflation expectations, results in a lower nominal interest rate.

A Price-Level Path Rule

Our last monetary policy rule considered is the price-level path rule. This policy is essentially a long-run inflation rate target as opposed to a period-by-period inflation rate target. The key difference between a price-level path target and an inflation target is the policy response when inflation rises above its target. In subsequent periods, a price-level path target automatically signals the monetary authority to set a short-run inflation objective below the average target to "undo" the previous inflation, whereas an inflation target ignores previous deviations and seeks to return the inflation rate to its target. Svensson (1999) shows that an economy with a discretionary price-level path target is equivalent to an economy with a commitment to an inflation target.[17] In other words, a monetary authority that is technically unable to commit to a strong period-by-period inflation target (i.e., $\theta_\pi = \infty$) can do so indirectly by adopting a long-run inflation target or, equivalently, a price-level path target.

Our price-level path rule assumes that the nominal interest rate target moves one for one with the inflation rate and also responds to deviations of the price level from its long-run price path:

$$\hat{R}_t = \hat{\pi}_t + \theta_p\ \hat{p}_t. \tag{22}$$

The gray dashed lines in Figure 4 show the impulse responses of key variables to a persistent productivity growth shock when policymakers implement a price-level path rule ($\theta_p = 1$).[18] As with the output growth rule, the price-level path target closely mimics the optimal policy response to a persistent productivity shock. The key difference is that the rise in the real interest rate initially generates a modest amount of inflation under the price-level path rule.

Targeting the price-level path, however, puts downward pressure on expected inflation. In a sticky price economy, price-adjusting firms limit their increase in prices due to an expected fall

in inflation and instead temporarily increase their production. Higher output lifts the demand for factor inputs, which results in more labor hours and higher wages and capital rental rates. Given that the effects of the price-level path rule relative to the optimal policy are shorter in duration, most additional production is concentrated on investment. The extra investment keeps the capital stock from falling as it does under the optimal policy, which limits any production losses due to the capital adjustment costs. As a result, the real interest rate response is much smaller with the price-level path in the first year after the productivity shock than with the optimal policy.

Both the output growth and price-level path policy rules generate inflation responses that deviate from the steady-state rate. The inflation shift, combined with the sticky price assumption, generates price dispersion among firms, which causes output to deviate from its efficient level under the optimal policy. If the optimal policy is politically infeasible, then policymakers must recognize the trade-off between output and inflation variability when choosing between an output growth rule and a price-level path rule. We can see that result by examining the effect of the two policy rules on volatility of output and inflation induced by the productivity shock.

INFLATION AND OUTPUT VOLATILITY: A MEASURE OF WELFARE

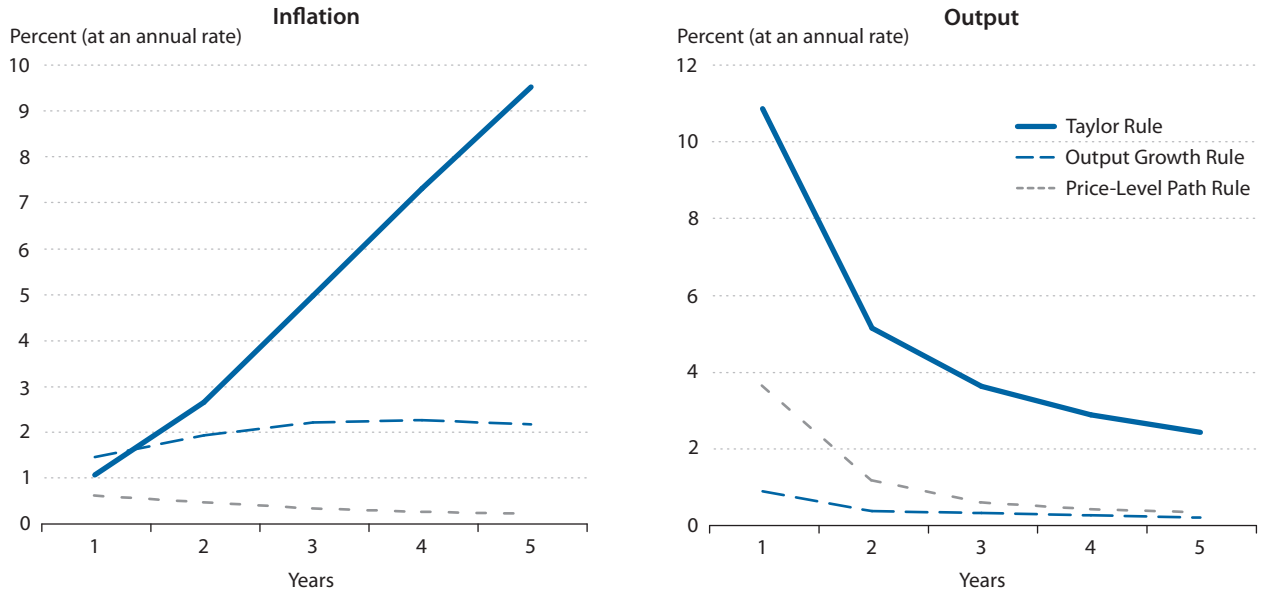
In New Keynesian models, monetary policy minimizes welfare losses by eliminating the output fluctuations caused by nominal frictions. The welfare loss in our model is proportional to the variance of the output gap (i.e., the deviation of output from its path in the absence of nominal rigidities).[19] Although welfare loss is properly measured using current-quarter output volatility, our New Keynesian model—like most other models—does not incorporate characteristics of the real economy that make the longer-term horizons relevant. For example, our model does not include long-term loans or long-term planning problems which, although difficult to model, are essential to the real economy. Given that central banks are concerned about the long-run consequences of their policy decisions, we examine the impact of persistent productivity growth shocks on the volatility of the output gap and inflation over 1- to 5-year horizons. Figure 5 compares the volatility of output and inflation under three rules: the Taylor rule, the output growth rule, and the price-level path rule.[20]

Our analysis focuses on fluctuations in output and inflation over forecast horizons as long as 5 years because that interval is a reasonable time for policymakers to recognize changes in potential output. We assume that the economy begins at its steady state and then simulate 5 years of persistent productivity growth shocks. Each simulation is repeated 1,000 times by drawing the shock from a normal distribution with mean zero and an SD equal to 0.1 percent per quarter. At each forecast horizon, we calculate the average deviation of the annual inflation rate and the output gap from their respective values under the optimal policy.

Figure 5 reports the impact of persistent productivity growth shocks on the SDs of output and inflation from the optimal policy over forecast horizons of 1, 2, 3, 4, and 5 years ahead. The left panel of Figure 5 displays the results for the inflation rate. When comparing the three rules, the Taylor rule generates the most variability in inflation at all forecast horizons except 1 year. Inflation volatility for the Taylor rule is very modest at the 1-year forecast horizon but accelerates as the forecast horizon increases. As for the other two monetary policy rules, inflation variability is considerably lower with the price-level path target than with the output growth target over all forecast horizons. In fact, inflation volatility continues to fall as the forecast horizon increases

Figure 5

Root Mean Square Deviations from the Optimal Path



with the price-level path rule, while it continues to rise mildly for the first three years with the output growth rule and remains elevated thereafter. Our results suggest that, on average, a price-level path rule minimizes inflation fluctuations after a persistent productivity growth shock.

The right panel of Figure 5 depicts the impact of persistent productivity growth shocks on the variability of the output gap over a forecast horizon ranging from 1 year to 5 years. Our findings show that the output growth policy rule produces the least output volatility at all forecast horizons, while the Taylor rule generates the most. Under each policy rule, output variability is highest at the 1-year forecast horizon and lowest at the 5-year horizon. Comparing the price-level path and output growth rules, the price-level path rule generates more output variability at the 1- and 2-year forecast horizons, but the volatility of output is nearly identical for both rules at forecast horizons of 3 years and longer. Overall, Figure 5 reveals that the price-level path rule is the most successful of the three rules at minimizing inflation fluctuations after a productivity shock, while the output growth rule is the best at minimizing the variability of output. Combining an output growth target with a price-level path target is a possible specification for a monetary policy rule that might further minimize the variability of both output and inflation. Determining the optimal coefficients for the output growth rate and the price level in a combined policy rule is beyond the scope of this paper, which considers only shocks to productivity growth.

CONCLUSION

This article analyzes the effect of a persistent productivity growth shock when the central bank does not immediately detect that such a shock has hit the economy. A productivity growth

shock affects the economy by causing the growth path of potential output to change. If the central bank does not recognize this change, a monetary policy rule that targets potential output will produce unintended movements in inflation following the shock. Such a result is important because empirical evidence suggests that changes in the trend growth rate of potential output are usually not identified by the central bank or statistical agencies until well after the shift has occurred.

We show that a productivity growth shock has distorting effects when the central bank uses a Taylor rule but does not observe the shock. Specifically, the positive productivity growth shock raises both real and potential output. Given that the central bank does not notice the shift in potential output, its measure of the output gap in the Taylor rule rises. The perceived increase in a positive output gap causes the central bank to overly tighten monetary policy, which results in falling inflation.

Our results suggest that the Taylor rule can be improved in two ways. First, we find that central banks should target the long-run average inflation rate (a price-level path) as opposed to the period-by-period inflation rate. A commitment to a price-level path target stabilizes inflation over the long term and prevents drifting of the price level from its long-run trend. In practice, the central bank can anchor the price level because monetary policy is the primary determinant of prices in the long run.

Second, our findings indicate that central banks should target the growth rate of output rather than the level of the output gap. The rationale for the modification is that the growth rate of output is known, while the size of the output gap—or more specifically, potential output—is unobservable in real time and subject to substantial shifts over the short to medium term. In practice, potential output at any point in time is measured as a function of the real GDP data observed before and after that particular time. Most of the variation in potential output is attributable to movements in output. An output growth rate rule is a practical alternative to an output gap rule because the output growth rate remains fairly stable after a persistent productivity shock that is not observed immediately by the central bank. Lastly, the output gap is not the best policy instrument to target because potential output is determined by factors beyond the control of the central bank.

We have treated the output gap as the relevant measure of the state of the real economy. Our theoretical results and the empirical evidence about trends in potential output are also applicable to the unemployment rate since there is approximately a one-to-one relationship between the output gap and the unemployment gap (i.e., the unemployment rate minus the natural rate of unemployment). Nevertheless, it is just as difficult to measure the natural rate of unemployment as it is to measure potential output. An analogous policy that is not subject to large measurement errors is targeting the change in the unemployment gap rather than its level.[21]

Finally, our results about a price-level path rule depend critically on the assumption that people are rational and consider central bank behavior when forming expectations about inflation and nominal interest rates. This assumption does not mean that people have perfect knowledge about how the economy works or perfect foresight about what central bankers will do. It simply means that households and firms will gather and use information about how the central bank conducts monetary policy when making their own decisions.

NOTES

1 See also Orphanides (2003a,b). Edge, Laubach, and Williams (2007) investigate a model in which agents learn about shifts in long-run productivity growth.

2 See, for example, the papers collected in Taylor (1999b) and on the Monetary Policy Rule Home Page website (www.stanford.edu/~johntayl/PolRulLink.htm).

3 See the appendix to Gavin, Keen, and Pakko (2005) for a detailed description of the firm's pricing problem.

4 We are ignoring two distortions. The first is due to the monopolistically competitive firms that produce less than they would in a perfectly competitive world. The second is the loss associated with the shopping time constraint. At a zero inflation rate, the return on money is less than the return on bonds and people will hold lower real money balances and spend more time shopping than they would if the nominal interest rate were zero.

5 Note that none of the policies that stabilize inflation may perform well if the public is as irrational and backward looking as is typically assumed in forecasting models.

6 The elasticity of labor supply with respect to the real wage equals $(1 - \bar{n} - \bar{s})/(\bar{n}\omega)$.

7 The interest rate elasticity of money demand is approximately equal to $-1/(1 + \gamma)$.

8 In New Keynesian theory, the concept of the efficient level of output is used to measure the output gap. The efficient level of output is that which would occur in the absence of sticky prices. Neither the Fed nor the statistical agencies attempt to measure the efficient level of output. There is the possibility that the distortion from sticky prices is actually quite small and that actual and efficient levels of output are similar.

9 Figure 2 excludes data after 2000:Q4 because those data are subject to future comprehensive revisions. The revision process is discussed in the National Income and Product Accounts (NIPA) Handbook (www.bea.gov/methodologies/index.htm#national_meth).

10 The value of 0.837 is not explicitly stated in their article but was verified in a private communication with Eric Sims.

11 In our model, this shock is less than one-quarter of the size necessary to account for the decline in potential GDP observed since 2007:Q4.

12 For a recent survey of the literature, see Gaspar, Smets, and Vestin (2010).

13 The optimal policy for the shopping time feature is to saturate the economy with money balances and drive the nominal interest rate to zero. We disregard issues surrounding operating a monetary policy with a zero nominal interest rate because the traditional solution methods used in this article are not easily adaptable to such a model. Wolman (2005), Coibion, Gorodnichenko, and Weiland (2010), and Gavin and Keen (2011) show that economies in which the central bank adopts some version of a price-level path target are not likely to hit the zero lower bound.

14 Basu, Fernald, and Kimball (2006) and Francis and Ramey (2005) provide empirical evidence that hours worked declines after a positive technology shock.

15 This condition, sometimes referred to as the "Taylor principle" (Taylor, 1999a), states that a percentage-point change in the nominal interest rate target must exceed the corresponding change in the inflation rate.

16 Several authors, including Orphanides and Williams (2002) and Walsh (2003), have recommended replacing the output gap with the output growth rate.

17 Gaspar, Smets, and Vestin (2007) survey the literature on price-level path rules, and Gorodnichenko and Shapiro (2007) show that including a price-level path target in the policy rule generally improves the performance of the economy in the presence of temporary shifts in productivity growth.

18 Our calibration of θ_p is based roughly on the relationship between Hodrick-Prescott-filtered data on the price level and the nominal interest rate. Specifically, volatility of the percent deviation of the consumer price index from its long-run trend is similar to that of the federal funds rate over the past two decades.

19 This definition of the output gap is suggested by Neiss and Nelson (2003).

20 The long-term volatility of the output gap and inflation is considered because many papers measure welfare loss as a weighted average of the fluctuations in the output gap and inflation.

21 See Orphanides and Williams (2002) for analysis of unobserved shifts in the unemployment gap.

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APPENDIX

A.1 Nonlinear Equations

(A.1.1) $$\frac{\lambda_t}{P_t} = \beta R_t E_t \left[\frac{\lambda_{t+1}}{P_{t+1}} \right]$$

(A.1.2) $$w_t \lambda_t = \chi \left(l_t \right)^{-\omega}$$

(A.1.3) $$\frac{1}{c_t} = \lambda_t + \gamma \frac{s_t}{c_t} \chi \left(l_t \right)^{-\omega}$$

(A.1.4) $$\gamma w_t s_t = \left(1 - \frac{1}{R_t} \right) m_t$$

(A.1.5) $$\lambda_t = \tau_t \varphi' \left(\frac{i_t}{k_t} \right)$$

(A.1.6) $$\tau_t = \beta E_t \left[\tau_{t+1} \left(\left(1 - \delta \right) + \varphi \left(\frac{i_{t+1}}{k_{t+1}} \right) - \varphi' \left(\frac{i_{t+1}}{k_{t+1}} \right) \left(\frac{i_{t+1}}{k_{t+1}} \right) + \varphi' \left(\frac{i_{t+1}}{k_{t+1}} \right) q_{t+1} \right) \right]$$

(A.1.7) $$l_t + n_t + s_t = 1$$

(A.1.8) $$k_{t+1} - k_t = \varphi \left(\frac{i_t}{k_t} \right) k_t - \delta k_t$$

(A.1.9) $$s_t = \zeta \left(\frac{c_t}{m_t} \right)^{\gamma}$$

(A.1.10) $$c_t + i_t = y_t$$

(A.1.11) $$y_t = \left(k_t \right)^{\alpha} \left(Z_t n_t \right)^{(1-\alpha)}$$

(A.1.12) $$q_t = \alpha \psi_t \left(Z_t n_t \right)^{(1-\alpha)} \left(k_t \right)^{(\alpha-1)}$$

(A.1.13) $$w_t = \left(1 - \alpha \right) \psi_t \left(Z_t \right)^{(1-\alpha)} \left(k_t \right)^{\alpha} \left(nt \right)^{-\alpha}$$

(A.1.14) $$P_t = \left[\eta \left(P_t^* \right)^{(1-\varepsilon)} + \left(1 - \eta \right) \left(P_{t-1} \right)^{(1-\varepsilon)} \right]^{1/(1-\varepsilon)}$$

(A.1.15) $$P_t^* = \left(\frac{\varepsilon}{\varepsilon - 1}\right) E_t \left[\frac{\sum_{i=0}^{\infty} \beta^i \left(1-\eta\right)^i \lambda_{t+1} P_{t+i}^{\varepsilon} \psi_{t+i} y_{t+i}}{\sum_{i=0}^{\infty} \beta^i \left(1-\eta\right) \lambda_{t+i} P_{t+i}^{\varepsilon-1} y_{t+i}}\right]$$

(A.1.16) $$R_t = \pi_t^{\left(1+\theta_\pi\right)} y_t^{\theta_y} g_t^{\theta_g} P_t^{\theta p}$$

(A.1.17) $$g_t = \frac{y_t}{y_{t-1}}$$

(A.1.18) $$\pi_t = \frac{P_t}{P_{t-1}}$$

(A.1.19) $$\frac{Z_t}{Z_{t-1}} = \left(\frac{Z_{t-1}}{Z_{t-2}}\right)^{\rho_z} \left(\bar{g}\right)^{1-\rho_z} e^{\nu_t}$$

A.2 Steady-State Equations

(A.2.1) $$\beta \bar{R} = \bar{g}\bar{\pi}$$

(A.2.2) $$\bar{w}\bar{\lambda} = \chi\left(\bar{l}\right)^{-\omega}$$

(A.2.3) $$\frac{1}{\bar{c}} = \bar{\lambda} + \gamma \frac{\bar{s}}{\bar{c}} \chi\left(\bar{l}\right)^{-\omega}$$

(A.2.4) $$\bar{\lambda} = \bar{\tau}\varphi'\left(\cdot\right)$$

(A.2.5) $$\bar{q} = \frac{\bar{g}}{\bar{\beta}} - 1 + \delta$$

(A.2.6) $$\bar{w}\ \bar{s}\ \gamma = \left(1 - \frac{1}{\bar{R}}\right)\bar{m}$$

(A.2.7) $$\bar{l} + \bar{n} + \bar{s} = 1$$

(A.2.8) $$\bar{i} = \left(\bar{g} - 1 + \delta\right)\bar{k}$$

(A.2.9) $$\bar{s} = \zeta\left(\frac{\bar{c}}{\bar{m}}\right)^{\gamma}$$

(A.2.10) $$\bar{c} + \bar{i} = \bar{y}$$

(A.2.11) $$\bar{y} = \left(\bar{k}\right)^{\alpha}\left(\bar{Z}\bar{n}\right)^{(1-\alpha)}$$

(A.2.12) $$\bar{q} = \alpha\bar{\psi}\left(\bar{Z}\bar{n}\right)^{(1-\alpha)}\left(\bar{k}\right)^{(\alpha-1)}$$

(A.2.13) $$\bar{w} = \left(1-\alpha\right)\bar{\psi}\left(\bar{Z}\right)^{(1-\alpha)}\left(\bar{k}\right)^{\alpha}\left(\bar{n}\right)^{-\alpha}$$

(A.2.14) $$\bar{\psi} = \frac{\left(\varepsilon - 1\right)}{\varepsilon}$$

(A.2.15) $$\bar{P} = \bar{P}^{*} = 1$$

A.3 Linearized Equations

(A.3.1) $$\hat{\lambda}_t - \hat{R}_t = E_t\left[\hat{\lambda}_{t+1} - \hat{\pi}_{t+1}\right]$$

(A.3.2) $$\hat{w}_t + \hat{\lambda}_t = -\omega\hat{l}_t$$

(A.3.3) $$\left[\left(\frac{1}{\bar{c}}\right) - \gamma\left(\frac{\bar{s}}{\bar{c}}\right)\chi\left(\bar{l}\right)^{-\omega}\right]\hat{c}_t + \bar{\lambda}\hat{\lambda}_t + \left[\gamma\left(\frac{\bar{s}}{\bar{c}}\right)\chi\left(\bar{l}\right)^{-\omega}\right]\left(\hat{s}_t - \omega\hat{l}_t\right) = 0$$

(A.3.4) $$\hat{w}_t + \hat{s}_t - \left(\frac{1}{\bar{R}-1}\right)\hat{R}_t = \hat{m}_t$$

(A.3.5) $$\left(\frac{\left(\frac{\bar{i}}{\bar{k}}\right)\varphi''\left(\cdot\right)}{\varphi'\left(\cdot\right)}\right)\left(\hat{i}_t - \hat{k}_t\right) + \hat{\tau}_t = \hat{\lambda}_t$$

(A.3.6) $$\hat{\tau}_t = E_t\left[\left[\left(\frac{\beta}{\bar{g}}\right)\left(\frac{\bar{i}}{\bar{k}}\right)\varphi''\left(\cdot\right)\left(\bar{q} - \left(\frac{\bar{i}}{\bar{k}}\right)\right)\right]\left(\hat{i}_{t+1} - \hat{k}_{t+1}\right) + \left(\frac{\beta\varphi'\left(\cdot\right)\bar{q}}{\bar{g}}\right)\bar{q}_{t+1} + \hat{\tau}_{t+1}\right]$$

(A.3.7) $$\bar{l}\ \hat{l}_t + \bar{n}\ \hat{n}_t + \bar{s}\ \hat{s}_t = 0$$

(A.3.8) $$\left(\frac{\bar{i}}{\bar{k}}\right)\varphi'\left(\cdot\right)\hat{l}_t + \left[1 - \delta + \varphi\left(\cdot\right) - \left(\frac{\bar{i}}{\bar{k}}\right)\varphi'\left(\cdot\right)\right]\bar{k}_t = \bar{g}\bar{k}_{t+1}$$

(A.3.9) $$\hat{c}_t - \hat{m}_t = \left(\frac{1}{\gamma}\right)\hat{s}_t$$

(A.3.10) $$\overline{c}\hat{c}_t + \overline{i}\hat{i}_t = \overline{y}\hat{y}_t$$

(A.3.11) $$\alpha\hat{k}_t + (1-\alpha)\left(\hat{Z}_t + \hat{n}_t\right) = \hat{y}_t$$

(A.3.12) $$\hat{\psi}_t + (1-\alpha)\left(\hat{Z}_t + \hat{n}_t - \hat{k}_t\right) = \hat{q}_t$$

(A.3.13) $$\hat{\psi}_t + (1-\alpha)\hat{Z}_t + \alpha\left(\hat{k}_t - \hat{n}_t\right) = \hat{w}_t$$

(A.3.14) $$\hat{\pi}_t = \left(\frac{(1-\eta)(1-\beta\eta)}{\eta}\right)\hat{\psi}_t + \beta E_t\left[\hat{\pi}_{t+1}\right]$$

(A.3.15) $$\overline{R}_t = (1+\theta_\pi)\hat{\pi}_t + \theta_y\hat{y}_t + \theta_g\hat{g}_t + \theta_p\hat{p}_t$$

(A.3.16) $$\hat{\pi}_t = \hat{p}_t - \hat{p}_{t-1}$$

(A.3.17) $$\hat{g}_t = \hat{y}_t - \hat{y}_{t-1}$$

(A.3.18) $$\hat{Z}_t = (1+\rho_z)\hat{Z}_{t-1} - \rho_z\hat{Z}_{t-2} + \nu_t$$

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How Did We Get to Inflation Targeting and Where Do We Need to Go to Now? A Perspective from the U.S. Experience

Daniel L. Thornton

The Federal Reserve is not formally inflation targeting. Nevertheless, it is commonly believed to be an implicit inflation targeter. The evolution to inflation targeting occurred because central banks, most importantly the Federal Reserve, demonstrated that monetary policy could control inflation. As central banks' credibility for keeping inflation low increased, policy actions became increasingly focused on affecting the growth rate of employment or the unemployment rate. The author argues that this change in emphasis is unlikely to generate positive benefits; more importantly, it endangers the continued effectiveness, and perhaps even the viability, of inflation targeting. (JEL E31, E52, E58)

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INTRODUCTION

This article provides a perspective on the evolution to inflation targeting based on economic theory and the U.S. experience. The Federal Reserve is not formally inflation targeting. Nevertheless, it is commonly believed to be an implicit inflation targeter. While the analysis presented here is based largely on the U.S. experience, I believe that it applies broadly to all central banks.

The economics profession has made considerable progress towards understanding the role of central banks in controlling inflation in the 45 years since I took my first economics course. Until at least the early 1970s the majority of the economics profession believed that central banks could do little to control inflation. Conventional wisdom had it that monetary policy was relatively ineffective for controlling inflation or for economic stabilization. Fiscal policy, not monetary policy, was the principal way that governments could stabilize the economy and keep inflation low, by filling the gap between private demand and potential output. I review the evolution of economic thought from "there is little central banks can do to control inflation" to "inflation targeting."

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My thesis is that policymakers' belief in the efficacy of monetary policy for inflation control changed dramatically in spite of the fact that there was no fundamental refutation of what I call the monetary policy ineffectiveness proposition (MPIP). The evolution to inflation targeting occurred because central banks, most importantly the Federal Reserve, demonstrated that monetary policy could control inflation. It was not a consequence of fundamental advancements in the profession's understanding of how monetary policy affects the economy. Consequently, the profession and policymakers returned, perhaps reluctantly, to the Phillips curve framework for conducting monetary policy. I argue that this framework endangers the continued effectiveness, and perhaps even the viability, of inflation targeting. I then recommend three steps that inflation-targeting central banks should take to preserve and strengthen inflation targeting.

THE MONETARY POLICY INEFFECTIVENESS PROPOSITION

It is difficult to envisage a central banker who would have recommended inflation targeting in the 1950s and 1960s. As Cagan (1978, p. 85) points out, "The quantity of money was not considered important, indeed was hardly worth mentioning, for questions of aggregate demand, unemployment, and even inflation." This view of monetary policy's effectiveness extended well into the early 1970s. Just as today, the conventional view of inflation was that it was caused by an excess of aggregate demand at or near the "full employment" level of output. The MPIP was the belief that monetary policy had relatively little effect on aggregate demand; unable to affect aggregate demand, there was little that monetary policy could do to control inflation.

The MPIP has several components.[1] Important among these is the belief that monetary-policy-induced changes in the money supply have little or no *direct* effect on aggregate demand. The theoretical basis for the direct link between the supply of money and prices is the quantity theory of money, or, more simply, the equation of exchange. As today, the quantity theory was widely viewed as a tautology, rather than an economic theory.[2] It was agreed that, if the central bank simply handed everyone money, prices would increase; this was not how central banks increased the money supply, however. Policy-induced changes in the money supply were a consequence of open market operations, discount window lending, and changes in reserve requirements. These actions would have an immediate effect on bank reserves and, hence, short-term interest rates. Critics argued that a policy-induced increase in the supply of money would cause interest rates to fall, which would in turn increase the quantity of money demanded. The effect of an increase in the money supply would be largely offset by an endogenous decline in money's velocity. Consequently, there would be little or no effect on aggregate demand and, hence, on prices or output.[3]

The effectiveness of monetary policy is determined by the extent to which monetary policy actions affect interest rates—not the supply of money. The so-called interest rate channel of monetary policy was also thought to be relatively weak. Evidence suggested that consumption and investment spending were relatively interest-inelastic. Consequently, the monetary authority would have to produce a relatively large change in interest rates to have a significant impact on aggregate demand. Investment decisions were determined more by expectations of future earnings than by interest rates. Changes in the interest rate not accompanied by changes in expectations about the economy would be of little consequence for aggregate demand. Some thought that the efficacy of monetary policy might be asymmetric: Reducing interest rates during a period

of economic slack would be less effective than raising interest rates during a period of economic expansion.[4] Monetary policy, it was said, cannot *push on a string*.

This tenet of the MPIP was reinforced by the fact that monetary policy actions only directly affect very short-term rates. Spending decisions were thought to be determined by the behavior of long-term rates, however; but central banks' ability to affect long-term rates was problematic.

The last 50 years have done little to change economists' and central bankers' views about the basic tenets of the MPIP. As of 2009 the supply of money is thought to be inconsequential, consumption and investment spending are thought to be interest-inelastic, short-term rates are thought to be relatively unimportant for spending, and the monetary authority's ability to influence long-term rates remains questionable.

Acknowledging that there is little agreement "on exactly how monetary policy exerts its influence" on the real economy, Bernanke and Gertler (1995, p. 27) note that the conventional model, whereby "monetary policymakers use their leverage over short-term interest rates to influence the cost of capital and, consequently, spending on durable goods, such as fixed investment, housing, inventories and consumer durables," is incomplete in several important ways. Important among these is the fact that "empirical studies of supposedly 'interest-sensitive' components of aggregate spending have in fact had great difficulty in identifying a quantitatively important effect of the neoclassical cost-of-capital variable." This evidence motivated Bernanke and Gertler (and others) "to explore whether imperfect information and other 'frictions' in credit markets might help explain the *potency of monetary policy*" (Bernanke and Gertler, 1995, p. 28; emphasis added).[5] One such attempt is called the credit channel of monetary policy, which has two separate channels: the "balance sheet" channel and the "bank lending" channel.[6] The balance sheet channel suggests that restrictive monetary policy increases the wedge between the cost of internal finance and that of external finance. Specifically, monetary-policy-engineered increases in short-term interest rates adversely affect the value of potential borrowers' assets, their cash flow, and, consequently, their creditworthiness. This increases the external finance premium. For small borrowers, the external finance premium increases by more than the rise in short-term rates. While heterogeneity is important for the effect of changes in interest rates on firms and individuals, the empirical importance of the balance sheet channel for the macroeconomy is unclear (see, for example, Hubbard, 1995).[7]

The bank credit channel (see, for example, Bernanke and Blinder, 1988; Bernanke, 1993; and Gertler and Gilchrist, 1993), which asserts that restrictive monetary policy actions have a direct effect on bank lending, is generally recognized (see, for example, Thornton, 1994, and Bernanke, 2007) to be "quantitatively unimportant," because banks have access to external funds that are not constrained by the availability of reserves.[8]

Economists continue to believe that long-term rates, not short-term rates, matter for spending decisions (see, for example, Blinder et al., 2001; Woodford, 2001; Broaddus, 2002; Freedman, 2002; and Eggertsson and Woodford, 2003). Many economists and policymakers believe that central bank actions have a limited effect on long-term rates, however. For example, in his July 20, 1993, congressional testimony, Chairman Greenspan noted: "Currently, short-term rates, most directly affected by the Federal Reserve, are not far from zero; longer-term rates, *set primarily by the market*, are appreciably higher" (Greenspan, 1993; emphasis added).

Conventional wisdom sees central banks influencing longer-term rates in accordance with the expectations hypothesis (EH) of the term structure of interest rates. The EH asserts that the

long-term rate is determined by the market's expectation for the short-term rate over the maturity of the long-term asset plus a constant risk premium. The risk premium compensates investors for the higher degree of market risk associated with holding longer-term assets. The empirical evidence against the EH is overwhelming (see, for example, Campbell and Shiller, 1991; Sarno, Thornton, and Valente; 2007; and Della Corte, Sarno, and Thornton, 2008; and the references cited therein).[9] Nevertheless, because the ability of central banks to affect long-term rates in accordance with the EH depends on the predictability of the short-term rate and the duration for which the market believes the rate will stay at that level, a number of central banks have attempted to provide "forward guidance" about their policy rate.

As was the case with inflation targeting, the Reserve Bank of New Zealand took the lead. It began announcing a path for its policy rate in 1997. Norway followed in 2005, Sweden in 2007. It is thought that announcing the path for its policy rate permits the central bank to "steer" expectations. Irma Rosenberg, the first deputy governor of the Riksbank, Sweden's central bank, suggested in 2007 that, "by affecting expectations of short-term interest rates, we as the central bank can also indirectly affect interest rates with a slightly longer duration, which in turn increases the effect of monetary policy" (Rosenberg, 2007; see also Gjedrem, 2006). Rudebusch (2007), Goodhart and Lim (2008), and Andersson and Hofmann (2010), however, show that forward guidance has not increased the predictability of the path of the policy rate beyond a few months.

The Federal Reserve was a latecomer here. In response to a presentation by Rudebusch on monetary policy inertia (see, for example, Woodford, 1999) at the January 2003 Federal Open Market Committee (FOMC) meeting, the then governor of the Federal Reserve System, Ben Bernanke, asked Rudebusch "if there had been evidence on whether or not the responsiveness of long-term interest rates to movements in the fed funds rate was consistent with the predictability of the type" proposed by Woodford (FOMC transcripts; January 28-29, 2003, p. 31). Rudebusch responded that he did not "think we have the empirical evidence of monetary policy inertia" (for a description of his argument and evidence, see Rudebusch, 2007). Bernanke suggested that this meant only that it had not been tried: "There should be more [inertia in the policy rule] in order to get more effect on long-term rates. I think that's an open question" (FOMC transcripts; January 28-29, 2003, p. 32).

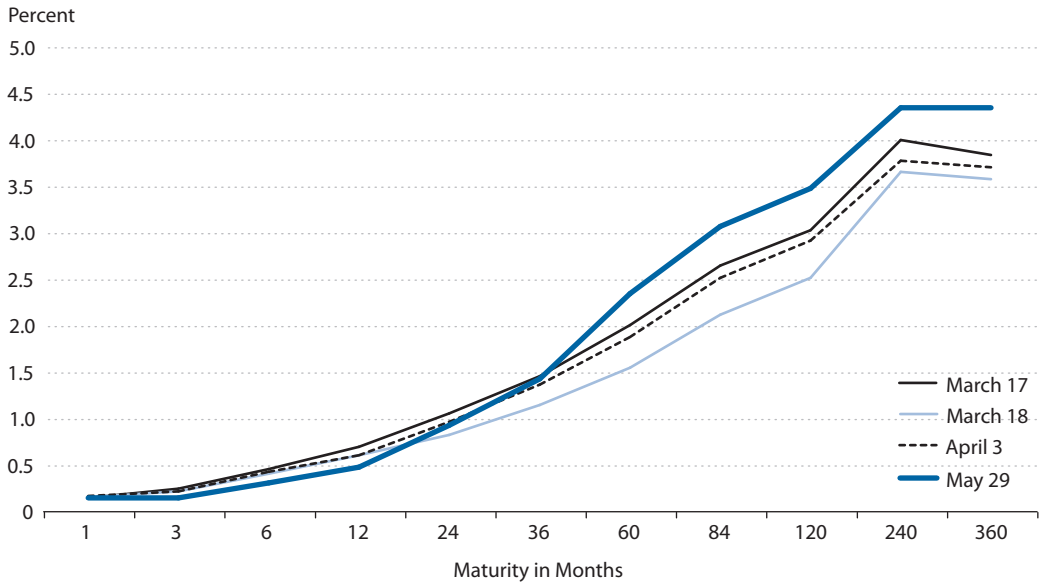
The Fed's first attempt at providing forward guidance came in August 2003. At the June 2003 FOMC meeting, Bernanke responded to several Committee members who voiced reservations about the Fed's ability to influence longer-term interest rates by saying (FOMC transcripts; June 24-25, 2003, pp. 45-46):

> If the policy is one in which we essentially try to lower the whole path of long-term interest rates and we enforce that with a package of complementary actions that includes trying to manage expectations along the term structure and taking a series of other actions such as purchasing long-term bonds and other kinds of instruments, I think that's one of the first things we ought to be doing. I believe that would actually work and would in fact be a good approach.

Consistent with Bernanke's suggestion, the August 2003 FOMC policy statement included the sentence "In these circumstances, the Committee believes that policy accommodation can be maintained for a considerable period."[10] At the September meeting, Alan Greenspan said he thought it a "mistake" to include the sentence (FOMC transcripts, September 16, 2003, p. 80).

Figure 1

The Yield Curve Announcement Effect, 2009



Despite the concern among some members about the usefulness of forward guidance language, the FOMC's May 2004 statement read "The Committee believes that policy accommodation can be removed at a pace that is likely to be measured," suggesting the FOMC might start increasing its target for the federal funds rate at the next meeting (Board of Governors press release, May 6, 2004).[11] The FOMC began increasing the funds rate from the then historically low level of 1.0 percent at its June 2004 meeting and by 25 basis points at each of its next 16 meetings. Forward guidance was dropped at the December 2005 meeting.

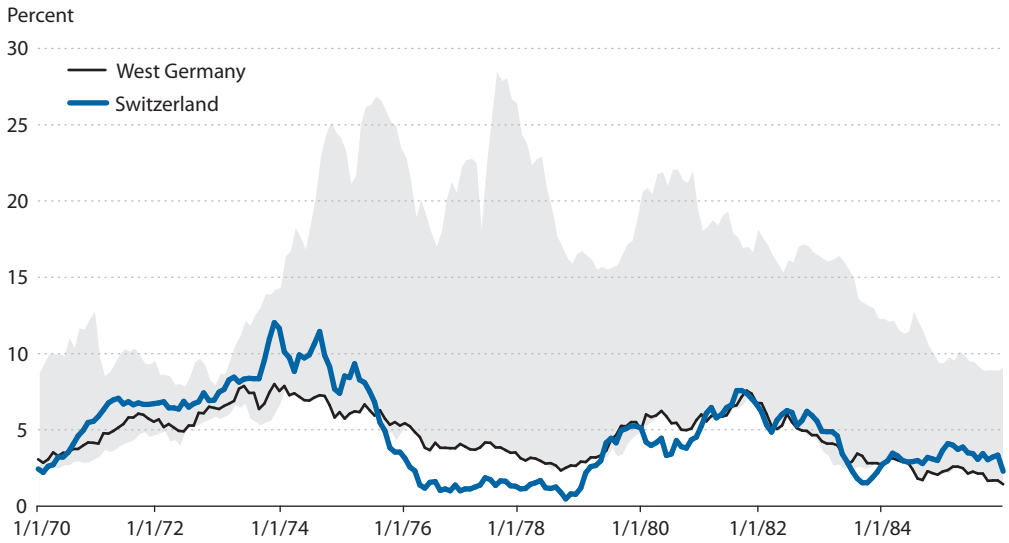
Forward guidance had relatively little effect on long-term rates. Not only did yields on longer-term securities generally increase from August 2003 to June 2004, but the yields across the term structure increased despite the historically low and unchanged target for the funds rate and the FOMC's commitment to keep the funds rate low. Moreover, longer-term rates declined during the first few months following the initial target increases in 2004. Indeed, Greenspan (2005) termed the fact that longer-term rates edged lower despite the 150-basis-point increase in the funds rate target a "conundrum."[12]

The Fed's next attempt with forward guidance occurred at the March 17-18, 2009, meeting, when it implemented the Eggertsson and Woodford (2003) strategy, which Bernanke had outlined at the June 2003 FOMC meeting.[13] Specifically, the FOMC announced that "economic conditions are likely to warrant exceptionally low levels of the federal funds rate for an extended period" and that the Fed would purchase "up to $300 billion of Treasury securities over the next six months" (Board of Governors press release, March 18, 2009).

This attempt was also unsuccessful. While there was an immediate "announcement effect" as yields on 10-year Treasuries and most other long-term securities declined by about 50 basis

Figure 2

European Inflation Rates, 1970-85



NOTE: The shaded area shows the range of low-to-high inflation rates in 12 European countries.

points on March 18, the marked flattening of the yield curve, shown in Figure 1, was short-lived. Figure 1 shows that the announcement effect had essentially vanished by April 6, 2009. By July 27 the yield was considerably steeper than it had been on March 17. This experience is consistent with a high degree of substitutability across assets with differing maturities and suggests that the Fed's ability to influence the behavior of long-term rates is limited at best.

Finally, there is little to indicate that the economics profession has changed its view about the effectiveness of changes in monetary and reserve aggregates. Indeed, Svensson (2007, p. 4) suggests that, over the past 50 years, economists have learned that "monetary aggregates matter little, or even not at all, for monetary policy." The lack of importance of money is reflected in the fact that money is not explicit in the canonical New Keynesian model, which is commonly used to evaluate monetary policy.[14]

The Evolution to Inflation Targeting

Skepticism about the ability of central banks to control inflation vanished despite essentially unchanged views about how monetary policy affects the economy. Consequently, it is natural to ask "What then caused the dramatic shift towards inflation targeting?" It is seldom, if ever, true that such an event is attributable to a single factor. Indeed, I believe a number of factors, in some way or another, contributed to the shift. Nevertheless, three factors or events were critical. The first, and most important, was the demonstration that central banks can control inflation. The cornerstone event was Paul Volcker's decision to reduce inflation by focusing on monetary aggregates. Inflation was in double digits when Volcker became Chairman of the Federal Reserve in

1979 and about 4 percent when he departed in 1987. This remarkable experience demonstrated beyond reasonable doubt that central banks could control inflation.[15]

The West Germans and Swiss also affected perceptions of inflation control. Both central banks were committed to keeping inflation low (Rich and Bèguelin, 1985; Kohli and Rich, 1986; von Hagen, 1999), and both emphasized monetary aggregates in the conduct of monetary policy. Moreover, both countries fared much better than most of their European counterparts. This is illustrated in Figure 2, which compares the year-on-year CPI [consumer price index] inflation rates for West Germany and Switzerland to the envelope (the shaded area) of the lowest and highest monthly inflation rates of 12 European countries in the period 1970 to 1985.[16] West German inflation was low relative to the other countries over the entire period. Swiss inflation was in the middle of the range until the mid-1970s, but at or well below the envelope from the mid-1970s onwards. Had the United States continued on its high-inflation path, it is possible that these experiences would have led to inflation targeting. At a bare minimum, the U.S. experience accelerated the evolution to inflation targeting.

My second event is likely to be controversial. Nevertheless, I believe it to be extremely important, at least in the United States. Beginning around 1970 the United States went from having cyclically balanced budgets, except during wars, to having what was, by the standards of the time, large and persistent deficits. The practice of running large, persistent deficits played an important role in the shift to inflation targeting, because it took countercyclical fiscal policy out of the policy mix. With fiscal policy sidelined, the reduction in inflation and, perhaps more importantly, the subsequent Great Moderation could be attributed only to monetary policy. Had the government continued to conduct activist countercyclical fiscal policy, the relative importance of monetary and fiscal policy for inflation control and economic stabilization would have been less clear. Even those who continued to embrace the tenets of the MPIP conceded that monetary policy was effective, even if they were not exactly sure how it worked (such as Bernanke and Gertler, 1995, p. 28, talking about the desire to "explain the potency of monetary policy").[17]

A third factor that deserves credit for the shift to inflation targeting is the insightful "impossibility theorem" known as the Lucas critique. Lucas's work was motivated by the "mysterious transformation" of an "obvious fallacy [a permanent Phillips curve trade-off] to the cornerstone of the theory of economic policy" (Lucas, 1976, p. 19). Economists were quick to understand that Lucas's insight meant (i) that any effort to reduce inflation permanently had to be credible and (ii) that credible disinflation might be achieved at a lower cost (Sargent, 1983). There is little doubt that credibility played an important role in the Fed's decision to announce its intentions (Lindsey, Orphanides, and Rasche, 2005, and Goodfriend, 2007). Moreover, the need for a credible commitment is a cornerstone of inflation targeting—i.e., the announcement of a specific numerical inflation target.

Given that (i) inflation has been significantly reduced by monetary policy actions and (ii) no change had occurred in their understanding of how monetary policy worked, the economics profession and policymakers fell back on the pre-monetary-policy-appears-to-work inflation paradigm—the Phillips curve. The modern version of the Phillips curve paradigm takes the general form

$$\pi_{t+1} = E_t \pi_{t+1} - \beta y_t, \tag{1}$$

where $E_t\pi_{t+1}$ denotes the expected rate of inflation, y_t denotes some measure of economic slack (e.g., the gap between potential and actual output, or the gap between the actual unemployment rate and the nonaccelerating inflation rate of unemployment [NAIRU]), and the coefficient β is strictly positive (note that equation (6.1) implies that the long-run Phillips curve is vertical). Inflation-targeting central banks anchor inflation by announcing a numerical inflation target to establish $E_t\pi_{t+1}$. Of course, the inflation target must be credible. This requires the central bank to take actions to keep inflation close enough to the target. Because the only thing that determines inflation, given inflation expectations, is the degree of slack in the economy, policymakers have to adjust their policy instrument to changes in the measure of slack even if they have no specific objective for stabilizing the real economy—even if they are what the then deputy governor of the Bank of England, Mervyn King (1997), referred to as "inflation nutters."

The profession and policymakers have adopted this framework despite still believing that changes in short-term rates should have a relatively small impact on aggregate demand. Moreover, they adhere to the Phillips curve framework despite the facts that (i) the Phillips curve framework provides relatively poor forecasts of future inflation and (ii) the marginal contribution of the slack measures to in-sample or out-of-sample inflation forecasts is small (see, for example, Atkeson and Ohanian, 2001; FOMC transcripts, June 25-26, 2002; Fisher, Liu, and Zhou, 2002; and Stock and Watson, 2008).

Implications for Inflation Targeting

I believe that the return to the Phillips curve framework may be a problem for the continued success, and even the viability, of inflation targeting.[18] There are three main threats. The first is the increasing belief in the need for central banks to have a "dual mandate." Meyer (2004) makes a distinction between a dual mandate—in which "monetary policy is directed at promoting both full employment and price stability, *with no priority expressed*"—and a hierarchical mandate—in which "price stability is identified as the principal objective, and central banks are restricted in pursuing other objectives unless price stability has been achieved" (Meyer, 2004, p. 151; emphasis added). It is important to note that (i) monetary policy affects only aggregate demand and (ii) the appropriate monetary policy response to aggregate demand shocks is invariant to inflation or output stabilization; when there are shocks to aggregate demand, inflation stabilization and output stabilization are complements, not substitutes (Svensson, 2007, p. 3). For example, Bernanke (2004) notes that "the ultimate source of this long-run trade-off [between the variance of prices and the variance of output] is the existence of shocks to aggregate supply." As a result, having a dual mandate means that policymakers should *promote both full employment and price stability* when confronted with shocks to aggregate supply. Is this possible? Bernanke (2004) describes the problem:

> According to conventional analysis, an increase in the price of oil raises the overall price level (a temporary burst in inflation) while depressing output and employment. Monetary policymakers are therefore faced with a difficult choice. If they choose to tighten policy (raise the short-term interest rate) in order to offset the effects of the oil price shock on the general price level, they may well succeed—but only at the cost of making the decline in output more severe. Likewise, if monetary policymakers choose to ease in order to mitigate the effects of the oil price shock on output, their action will exacerbate the inflationary impact. Hence, in the

> standard framework, the periodic occurrence of shocks to aggregate supply (such as oil price shocks) forces policymakers to choose between stabilizing output and stabilizing inflation.

Bernanke appears to suggest that the answer is "No." What should policymakers do? If the shock is temporary (a temporary oil price shock), it might be best to do nothing. If the shock is permanent, nothing might still be the best option, since there is no way for monetary policy to affect aggregate supply, and the effect on inflation will be temporary, as the price level adjusts to a permanent new higher or lower level. This policy choice is reinforced by monetary policy neutrality. In any event, just how and under what circumstances policymakers should respond to aggregate supply shocks is unclear.

Moreover, in a thoughtful analysis of the causes of the Great Moderation, Bernanke (2004) describes four ways that improved price stability has reduced the volatility of output (see also Taylor, 2008). If long-run price stability generates greater economic stability for the reasons Bernanke suggests, and perhaps others, it is difficult to understand why policymakers would sacrifice price stability in order to offset temporarily the effect of a permanent adverse supply shock on output and employment.[19]

While most inflation-targeting central banks do not appear to give equal weight to economic stability and price stability, many (perhaps all) follow a hierarchical mandate—the second threat to inflation targeting. Meyer (2004, p. 151) indicates that "inflation-targeting countries today have moved away from the initially austere implementation, more in line with the spirit of a hierarchical mandate, and have become flexible inflation targeters, close cousins of dual mandate central banks." Consistent with Meyer's statement, the former deputy governor of the Reserve Bank of New Zealand [RBNZ], Murray Sherwin, has noted that the RBNZ has moved along the "spectrum between what Svensson refers to as 'strict' and 'flexible' inflation targeting" (Sherwin, 1999). The danger of a hierarchical mandate for inflation targeting comes from three sources. First, while both economic theory and experience suggest that central banks can achieve price stability, there are important reasons to be skeptical of central bankers' ability to stabilize output around potential. This skepticism is embedded in the MPIP and supported by empirical evidence. For example, Rasche and Williams' (2007) review of the empirical literature of the effectiveness of monetary stabilization policy "failed to determine a major role for monetary policy in short-run stabilization" (2007, pp. 469, 474).

Indeed, much of the evidence that monetary policy actions affect the real economy comes from a handful of episodes in which an economic recession appears to be "caused" by a monetary contraction (see Rasche and Williams, 2007, for a discussion of these "case studies"). Such episodes provide no basis for believing that monetary policy can successfully stabilize the economy. Moreover, because they are one-sided, these episodes are not a basis for concluding that expansionary monetary policy can significantly increase output.

Successful economic stabilization policy requires a good, or at least reliable, measure of potential output. It is widely accepted, however, that potential output is difficult if not impossible to measure (see Orphanides, 2003, and the references cited therein, and the July/August 2009 issue of the Federal Reserve Bank of St. Louis *Review* (volume 91, issue 4), entitled "Projecting Potential Growth: Issues and Measurements"). A failure to have good and reliable measures of the output gap or NAIRU can result in destabilizing policy errors. Indeed, Orphanides (2004)

argues that overemphasis on the output gap and its mismeasurement contributed significantly to the Great Inflation.

At a more fundamental level, economic theory suggests that the conventional "steady-state" definition of potential output, which is commonly used by policymakers to construct the output gap and the NAIRU, is ill-suited for economic stabilization policy. The policy-relevant definition is "the rate of output the economy would have if there were no nominal rigidities, but all other (real) frictions and shocks were unchanged" (Basu and Fernald, 2009, p. 3).[20] This policy-relevant definition accounts for the effect of supply shocks on potential output.[21] Consequently, even if the conventional definition of the output gap could be measured precisely, monetary policy actions based on it run a significant risk of being destabilizing.

Successful stabilization policy also depends on the ability of policymakers to forecast what would happen if they did nothing. Economic forecasting has always been difficult, and forecasting economic turning points, which is critical to successful economic stabilization policy, is particularly difficult. This is evidenced by the significant lag in dating both the beginning and end of recessions.[22] There is considerable evidence that both survey and econometric forecasts have considerable difficulty improving upon naïve forecasts. This has been particularly true since the mid-1980s (Atkeson and Ohanian 2001; Tulip 2005; d'Agostino, Giannone, and Surico, 2006; Campbell, 2007; Stock and Watson, 2007, 2008; d'Agostino and Whelan, 2008).[23]

The inability to make accurate forecasts beyond very short horizons means that it will be very difficult, if not impossible, for policymakers to anticipate the longer-run consequences of their actions. For example, the FOMC reduced its funds rate target to the then historically low level of 1.0 percent at the June 2003 meeting and kept the target at 1.0 percent until the June 2004 meeting. The staff had revised up its forecast for the output gap for 2003 and 2004 at the previous meeting, noting that "[a]ny serious delay in the recovery…would imply a larger output gap… and by our analysis would result in an even lower inflation rate" (FOMC transcripts; May 6, 2003, p. 13). The presumption was that the FOMC would reduce the funds rate target at the June meeting unless there was new evidence. Governor Ferguson summarized the evidence, noting that "the output gap still closes relatively slowly…the unemployment rate hangs up above the NAIRU through next year [and]…core PCE [personal consumption expenditure] even before the adjustment stays at what I would consider to be the very low end of an acceptable range" (FOMC transcripts, June 24-25, 2003, p. 130). The funds rate target was reduced to the then historically low level of 1.0 percent, while several members had a desire or a willingness to accept a larger cut. Only President Moskow voiced concern about the action, saying: "Of course the data we talk about are always looking backward, and the key is the forecast going forward. As we've often said in these meetings, sometimes the last cut or the last increase in the funds rate target is the one that's not needed because we didn't have perfect information at the time we made that cut or increase" (FOMC transcripts; June 24-25, 2003, p. 153).

By the December 2003 meeting the data suggested that the economy had grown by 3.3 percent in the second quarter and at an extremely rapid rate of 8.2 percent in the third quarter. Greenspan summarized the situation (FOMC transcripts; December 9, 2003, pp. 88-89) by noting that

> it has almost invariably been the case that the Federal Reserve would tighten under such conditions. Indeed, preemption is something that has filtered its way into the monetary policy lexicon. The issue of preemption implies, of course, that we will adjust our policy ahead of anything

> that we can readily foresee. In current circumstances, therefore, there is and there will continue to be a lot of pressure on us to move rates higher. We have resisted because of a quite considerable and significant difference in the present economy from what we have observed in the past. In recent decades, the turning point toward accelerating economic activity usually occurred when the inflation rate was 3 percent or 4 percent, sometimes even higher, and the necessity for preemption was critically obvious. The problem with preemption, though it is something that is very interesting to observe in retrospect, is that it doesn't necessarily follow that we are preempting future developments that will actually occur the way we expect. So, we have to be careful not to try to preempt something that is not fairly likely to happen. There is a risk and indeed a cost to being wrong.

No one expressed concern about the longer-run consequences of what was recognized as an excessively easy policy.[24] Even though inflation had increased substantially and by December the FOMC had acknowledged that "the probability of an unwelcome fall in inflation has diminished in recent months and now appears almost equal to that of a rise in inflation" (Board of Governors press release, December 9, 2003), the FOMC did not increase the target until June 2004.

The FOMC was effectively pursuing a hierarchical mandate. With inflation in check, presumably because of well-anchored inflation expectations, the FOMC was free to pursue its objective of "maximum sustainable economic growth." Taylor and others have suggested that "this extra-easy policy was responsible for accelerating the housing boom and thereby ultimately leading to the housing bust" (Taylor, 2009b, pp. 343-44).

While there will undoubtedly be much analysis and debate over the Fed's role, the decline in housing prices and the resulting financial market turmoil generated an unprecedented monetary policy response. Initially, the Fed attempted to ease credit conditions by simply reallocating credit (see, for example, Thornton, 2009).[25] When the Fed was no longer able to sterilize the effects of its credit allocation program on the monetary base, the base increased rapidly to an unprecedented level. The massive quantitative easing has generated concerns of future inflation (see, for example, Taylor, 2009a). As President Broaddus noted at the June 2003 FOMC meeting, "Common sense tells us…that a determined expansion of the monetary base has to be effective against deflation at the zero bound. If that were not the case, we could eliminate all taxes, and the government could permanently finance its operations with money creation alone" (FOMC transcripts; June 24-25, 2003, p. 35).[26] What the ultimate verdict will be is uncertain. That the Fed's behavior was motivated by a hierarchical mandate is not.[27]

Policymakers appear to have replaced their belief in a permanent Phillips curve trade-off with the belief that "a little inflation is good for economic growth"—which is the third threat to inflation targeting. Most policymakers believe that the long-run Phillips curve is vertical, which implies that the same long-run real outcome can be achieved with zero inflation as it can with 2 or 3 percent inflation. Nonetheless, most policymakers also profess that the "optimal," "appropriately measured," inflation rate is positive. The theoretical justification for the various hypotheses that motivate the belief that a little inflation is good for economic growth is highly questionable or simply unsound (Marty and Thornton, 1995). Nevertheless, many policymakers believe that "inflation can be too low as well as too high" (Meyer, 2004, p. 160).[28]

The belief that positive inflation is somehow optimal is reflected in the fact that all inflation-targeting central banks have a nonzero inflation target. It is also consistent with the fact that

nearly all inflation-targeting central banks have a recent inflation performance that is in the upper end of their target ranges. It could be that central bankers might simply believe that the inflation measures they target overestimate the true unobservable inflation rate. It seems unlikely, however, that the bias is large enough to explain the observed behavior.

IMPLICATIONS FOR INFLATION-TARGETING CENTRAL BANKS

The analyses in the previous sections have implications for the evolution of inflation targeting. First and foremost, inflation-targeting central banks should be dissuaded from having a dual mandate. If they decide to have a dual mandate, they should inform the public of this policy and the rationale for adopting it.

Second, inflation-targeting central banks should carefully and honestly evaluate the extent to which they can effectively stabilize the real economy around potential output. This analysis should provide a realistic assessment of their ability to measure potential output, the extent to which they believe inflation is related to the output gap, and the other impediments to successful economic stabilization discussed above, as well as some others not discussed here (such as lags in the effect of policy actions on the economy). The end product of this analysis should be a statement indicating the extent to which the inflation-targeting central bank believes that it can pursue a hierarchical mandate.

Third, inflation-targeting central banks should engage in a serious dialog with their constituents about the optimal rate of inflation. In particular, if they believe that the appropriately measured, long-run inflation rate is positive, they should state the reasons for this belief.

NOTES

1 There was also a belief that inflation was caused by "cost-push" factors, not amenable to monetary policy actions (see, for example, Nelson, 2005). For example, Arthur Burns attributed inflation to a variety of "special factors." As these special factors dissipated, but inflation did not, Burns blamed inflation on government deficits (Hetzel, 1998). Hence, cost-push inflation was not an essential element of the MPIP.

2 Cagan (1978, p. 86) notes that "textbooks in basic economics and even in money and banking mentioned the quantity theory of money, if at all, only to hold it up to ridicule."

3 Monetarists made two attempts at incorporating money into the canonical model. One was to suggest that money affects aggregate demand through a "wealth effect." The other was the buffer-stock model of money demand. The profession was not impressed.

4 Another reason is that, if the central bank reduces the money supply, individuals are forced to alter their behavior. On the other hand, if the central bank increases the supply of money, individuals can simply hold the money in idle balances.

5 In essence, Bernanke and Gertler (1995) are saying that we know monetary policy is efficacious, we just don't know why. The credit channel of monetary policy, as it is called, is an attempt to provide a theoretical basis for the belief in the efficacy of monetary policy. See also Bernanke (2007).

6 Skepticism over the interest rate channel also arose out of the Great Inflation and Sargent and Wallace's (1975) demonstration that interest rate targeting can lead to price level indeterminacy. McCallum (1981) changed that by demonstrating that indeterminacy can be eliminated if policymakers have a "nominal anchor"—i.e., if policymakers care about inflation.

7 The lack of empirical support for the interest rate channel of money policy led some analysts (such as Mishkin, 1995; Meltzer, 1995; and Taylor, 1995) to broaden the financial asset price channel of monetary policy to include exchange rates, equity prices, and even land prices. There has been relatively little interest in or empirical support for these alternative asset price channels of monetary policy, however.

[8] Bernanke (2007) also suggests that restrictive monetary policy may affect banks by increasing the external finance premium paid by banks in much the same way that the balance sheet channel is thought to affect individuals and firms. He does not say why restrictive monetary policy will increase banks' external finance premium, however. The spread between the equivalent-term London Interbank Offered Rate (LIBOR) (the rate at which banks lend to each other) and the certificate of deposit (CD) rate (the rate at which banks borrow externally) has been small historically.

[9] One reason for the empirical failure of the expectations hypothesis is that conventional tests of the EH are based on the assumption that the expected future short-term rate deviates from the actual future short-term interest rate by a white noise error. Interest rates are notoriously difficult to predict, however. The empirical failure of the EH is probably a consequence of the incompatibility of the assumption upon which tests of the EH are based and the unpredictability of interest rates (see, for example, Guidolin and Thornton, 2008).

[10] This sentence was not voted on by the Committee. Rather, at the conclusion of a lengthy discussion of the sentence, Greenspan took a vote of all FOMC participants. The vote was 11 to 7 in favor of the sentence. Greenspan concluded, "On the basis of that vote it's right on the margin. But I would say that we have to put in the truncated version of the final sentence" (FOMC transcripts; August 12, 2003, p. 95).

[11] The Committee considered several courses of action, including dropping the sentence. However, the sentence appeared unchanged in both the September and October FOMC statements. On a suggestion from Greenspan, the sentence was modified at the December 2003 meeting. Most thought that Greenspan's rewording made the statement more "conditional." Four participants expressed a preference for removing the statement, however.

[12] Elsewhere (Thornton, 2007) I show that there was a marked break in the relationship between the overnight funds rate and the 10-year Treasury yield that predates the conundrum period. Moreover, it coincides with the FOMC switch from using the funds rate as an operational target to using it as a policy target. I hypothesize that the change in behavior reflects the fact that the FOMC, and not the market, began determining the path for the funds rate in the late 1980s. I also present evidence to support this hypothesis.

[13] Eggertsson and Woodford (2003, p. 200) note that the "effect [on long-term yields] follows not from the purchases themselves, but from how they are interpreted," but that purchases may help overcome "private sector skepticism about whether the history-dependent interest rate policy will actually be followed."

[14] McCallum (2001, p. 146) argues that money is implicit because "the central bank's control over the one-period nominal interest rate ultimately stems from its ability to control the quantity of base money in existence." He suggests, however, that the "error thereby introduced [by omitting money] is extremely small" (2001, p. 150). This conclusion is not surprising, because money has no effect on economic activity, except through its effect on the interest rate. Hence, there is little difference in money being implicit or explicit in such models (see, for example, Leahy, 2001).

[15] Others share my view, such as Goodfriend (2007, p. 8).

[16] The countries are Austria, Belgium, Denmark, Finland, France, Italy, Luxembourg, the Netherlands, Norway, Spain, Sweden, and the United Kingdom.

[17] A contributing factor was the experience of the Great Depression, which made economists and policymakers skeptical of the self-equilibrating nature of market economies. With fiscal policy sidelined and little or no faith in the self-correcting nature of market economies, the experience of the Great Moderation led many economists to conclude that monetary policy was much more effective than previously thought. The monetary and fiscal response to the most recent financial market turmoil suggests that policymakers remain skeptical of the self-equilibrating nature of market economies and the ability of existing institutions to deal with the current "crisis" (see, for example, Miron 2009).

[18] For evidence on the success of inflation targeting, see Rasche and Williams (2007), Rogers (2010), and Schmidt-Hebbel (2010).

[19] This point is directly related to the theoretically correct measure of the output gap, which is discussed later.

[20] For estimates of the theoretically correct output gap, see Nelson and Neiss (2005).

[21] The idea that aggregate supply shocks reduce potential output relative to its steady-state level is not new. For example, see Rasche and Tatom (1977) and the references therein.

[22] For example, the NBER [National Bureau of Economic Research] dating committee announced on December 2, 2008, that the recession began in December 2007.

[23] Reifschneider and Tulip (2007) analyze the forecasting accuracy of the FOMC, the Greenbook (produced before each meeting of the FOMC), the Congressional Budget Office, the administration, the Blue Chip Consensus forecast, and the Survey of Professional Forecasters short-run forecasts of GDP growth, the unemployment rate, and CPI inflation over the period 1986 to 2006. Their estimates suggest that, with the exception of the unemployment rate, the forecasts provide little information beyond that contained in the historical average.

[24] Greenspan noted that "the current federal funds rate is well below any estimate of the equilibrium rate. That is, when we start to raise the rate, we may have the problem of having to return to the equilibrium rate relatively quickly" (FOMC transcripts; December 9, 2003, p. 91).

[25] Taylor (2009a) calls this "industrial policy."

[26] Arthur Burns, Fed chairman from 1970 to 1978, had a similar belief. At the March 18-19, 1974, FOMC meeting, Burns noted that, while he was "not a monetarist, he found a basic and inescapable truth in the monetarist position that inflation could not have persisted over a long period of time without a highly accommodative monetary policy" (FOMC Memorandum of Discussion, March 18-19, 1974, pp. 110-12).

[27] This danger associated with a hierarchical mandate is exacerbated by political pressures. In his Per Jacobsson Lecture, which was delivered just six days prior to Volcker's dramatic change in the FOMC's monetary policy, Burns (1979, p. 15) noted prophetically that "the Federal Reserve System had the power to abort the inflation at its incipient stage fifteen years ago or at any later point, and it has the power to end it today. At any time within that period, it could have restricted the money supply and created sufficient strains in the financial and industrial markets to terminate inflation with little delay" but political pressures limited the "practical scope for restrictive actions."

[28] In addition, at the June 2003 FOMC meeting Governor Bernanke, as he was then, stated: "I think the May 6 statement left the mistaken impression with some that the Fed was concerned about the threat of imminent deflation as opposed to what really concerned us—namely, the possibility of a decline in inflation to a level that, *while below the desirable range*, would still be greater than zero" (FOMC transcripts; June 24-25, 2003, p. 131; emphasis added).

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Research Focus

Dan Thornton analyzes financial markets, interest rates, and monetary policy—most recently, the Fed's policy innovations of quantitative easing and the Term Auction Facility in the wake of the financial crisis.

Recent Research

"The Effectiveness of Unconventional Monetary Policy: The Term Auction Facility," Federal Reserve Bank of St. Louis *Review*, November/December 2011, *93*(6), pp. 439-54.

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