**Using Hybrid Macro-Econometric Models to
Design and Evaluate Fiscal Consolidation Strategies**

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One of the most significant developments in macroeconomic research in the past four decades has been the construction and use of structural econometric models that combine some degree of rational expectations or forward-looking behavior with temporary wage-price or other rigidities.[2] Such models have frequently been labeled "new Keynesian" to contrast them with so-called "old Keynesian" econometric models of previous decades. But the newer models have evolved greatly, and they so often have non-Keynesian policy implications—such as a preference for rules over discretion—that a more neutral term like hybrid is more appropriate and accurate.

Such hybrid models are responsible for much of the progress made in the design of rules for monetary policy, and they have helped shape the battlefield in the continuing debate over short-term fiscal stimulus packages.[3] Despite criticism of these models—including that they failed to predict the recent financial crisis—and the reluctance of some private firms to use them in forecasting, they continue to be employed at central banks throughout the world and at international financial institutions as a key tool for policy evaluation research.[4]

In this paper I examine an area of policy research where these models can be especially useful: The design and evaluation of multi-year strategies to reduce a government budget deficit—a particular form of fiscal consolidation. To be concrete, I consider the use of such models during two periods in recent United States history where growing or relatively high levels of federal debt as a percentage of GDP led policy makers to consider multi-year strategies to reduce the deficit and where model-based research had a role in the design or evaluation of such strategies.

I first consider the early 1990s when the federal debt to GDP ratio rose above 40 percent and was approaching 50 percent. I then consider the situation today when the debt to GDP ratio has risen above 70 percent and is expected to continue rising in the future (to 78% of GDP by 2024 or twice the 39% average of the past four decades according to CBO's August 2014

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[2] Over 50 of these structural models can be found in Volker Wieland's Model Data Base www.macromodelbase.com . See also Wieland et al (2012).
[3] See Cogan, Cwik, Taylor and Wieland (2010) and Woodford (2011), for example.
[4] See Coenen et al (2012), for example.

analysis). Figure 1 shows the debt to GDP ratio during these two periods. To be sure, other fiscal consolidations were considered or took place during these periods, including the reduction in defense spending in the late 1990s and the Budget Control Act of 2011.
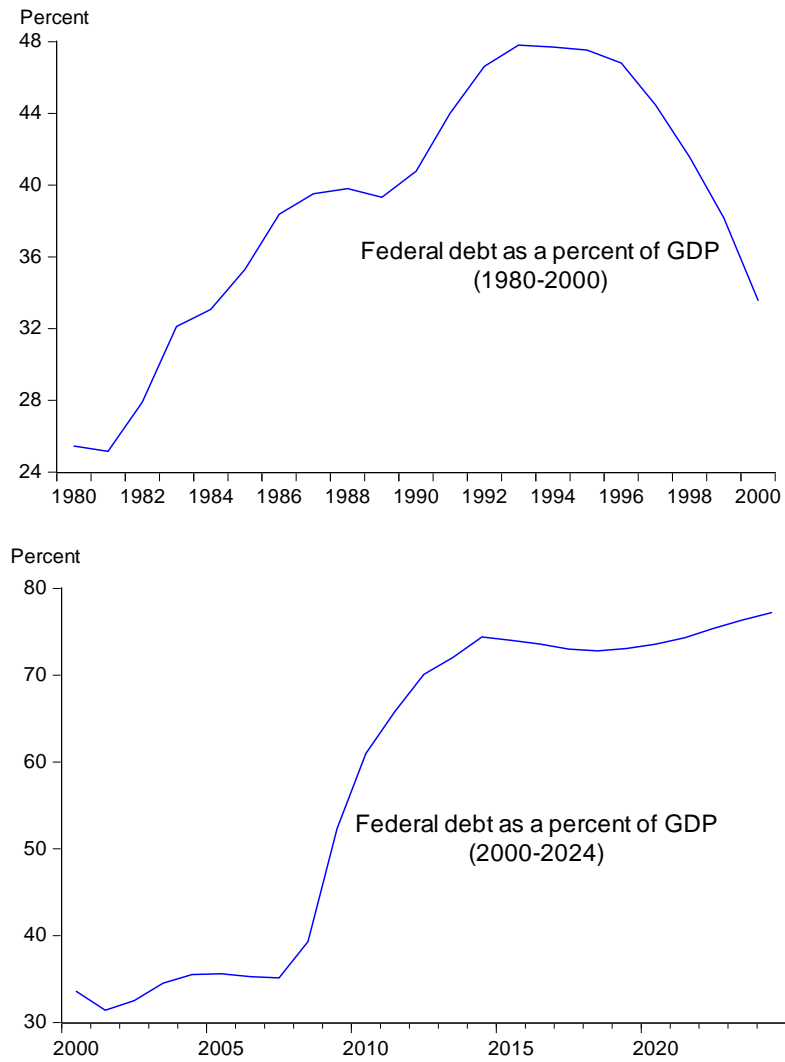
Percent

Federal debt as a percent of GDP
(1980-2000)

Percent

Federal debt as a percent of GDP
(2000-2024)

Figure 1: Debt as a percent of GDP in two periods
Source: "An Update to the Budget and Economic Outlook:
2014 to 2024," Congressional Budget Office, August 2014

I am particularly interested in examining the connection between policy research with these models and the actual policy proposed or adopted, drawing in part on my own experience in research and policy making. Such connections between research and policy are difficult to establish and trace in practice. Nevertheless a comparison of the research and actual policy helps one understand how economic research affects policy choice in this area, and suggests ways in which the models can be improved and better used in the future.

Policy Research and Multi-Year Deficit Reduction in the Early 1990s

In their comprehensive review of fiscal consolidation strategies in different countries over the past 40 years, Devries, Guajardo, Leigh, and Pescatori (2011) identified two multi-year deficit reduction programs in the United States in the 1990s: The Omnibus Budget Reconciliation Act of 1990 (OBRA-90) enacted in November 1990 and the Omnibus Budget Reconciliation Act of 1993 (OBRA-93) enacted in August 1993.

Policy Research

Prior to these Acts, however, research had begun on alternative ways to reduce the deficit using a then new type of structural model. By this time econometric models with a combination of rational expectations and sticky prices were advanced enough that they could be used to simulate alternative fiscal consolidations where expectations of policy changes in future years could affect the economy in the present. I was deeply involved in doing such simulations with my estimated quarterly rational expectations model fit to data from the G7 countries.

In that model wage and price stickiness is described by the staggered wage and price setting approach as in Taylor (1980) rather than as an ad hoc series of lags of prices or wages which had characterized older pre-rational expectations models. The coefficients in the staggered wage equations were empirically estimated using aggregate wage data rather than imposing the geometrically-distributed coefficients proposed by Calvo (1983). The financial sector in the model is based on several "no-arbitrage" conditions for the term structure of interest rates and the exchange rate. Expectations of future interest rates affect consumption and investment, and exchange rates affect net exports. Slow adjustment of consumption and investment is explained by habit formation or accelerator dynamics. A core principle is that in the long run the economy returns to a growth trend (potential GDP) described by a model with flexible prices. Most of the equations of the model were estimated with Lars Hansen's instrumental variables estimation method, with the exception of the staggered wage setting which were estimated with maximum likelihood.

In Taylor (1988), later summarized in Taylor (1993), I considered a particular fiscal consolidation strategy with this model in which government purchases were reduced by considerable amounts, such as 3 % of GDP.[5] After some experimentation with the model it became clear that any negative short-run impact of such a large change in aggregate demand would be mitigated if it were phased in gradually. Thus the research gave empirical content to the advantages of a *multi-year* deficit reduction plan. .

Moreover, the results indicated that the impact of the consolidation strategy would be more favorable if it were announced in advance. Then, assuming rational expectations, the anticipation of lower interest rates and higher incomes in the future (compared to what otherwise would have been) could have positive effects in the short run. Of course, for the rational expectations assumption to make sense it was necessary for the announced multi-year plan to be

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[5] This, of course, was not the only research on fiscal consolidation using the newer econometric rational expectations cum sticky price models. See, for example, McKibbin and Bagnoli (1993).

credible, thus giving rise to often stated importance of *credible* multi-year deficit reduction plans.

An empirical question was how fast the phase-in should be. I eventually focused on a five year plan which would be slow enough to mitigate the short run impact and not so slow to raise credibility issues. In particular, I focused on simulations of a credible multi-year spending reduction plan with equal percentage increments for five years, say from 1991 to 1996.

What was the estimated impact of this strategy? The long run impact (by the end of five years) was that investment was up about 1% of GDP and net exports were up by 2% of GDP with consumption essentially unchanged as a percent of GDP. These effects on investment and net exports were due to declines in real interest rates and real exchange rates. The increase in investment would then raise potential GDP via a standard production function.

The short run estimated impact on GDP was very small, given the large reductions in government purchases as a share of GDP, especially compared with models without expectation effects. Real GDP was essentially unchanged in the first year and the government spending multiplier reached a maximum of only one-third of the phased-in amount each quarter. This small effect was due to a short run crowding in of the other components of spending as the cut in spending was largely anticipated: the expected decline in interest rates and the exchange rate in the future lowered these in the present.

Legislative Outcome

These research results can be compared with the legislation that was later passed and with how it was described by policy makers.[6] According to the 1991 *Economic Report of the President*, OBRA-90 was designed to reduce the federal deficit "over the next 5 years, relative to what it would otherwise be." Moreover, it was "phased so as to minimize adverse short-term effects on the economy." The report then went on to say that "The effects of fiscal policy…depend crucially on expectations for future spending and taxes as well as on their current levels….Economic theory and empirical evidence indicate that expectations of deficit reduction in future years, if the deficit reduction commitment is credible, can lower interest rates…Expectations of lower interest rate in the future will lower long-term interest rates today. Lower long term interest rates will reduce the cost of capital, stimulating investment and economic growth relative to what would be predicted if expectations were ignored."

Due to a host of other factors and compromises that are part of the legislative process, the actual policy was of course different from the earlier model simulations. OBRA-90 included tax increases (or "revenue enhancements" as they were called at the time) as well as reductions in government spending. For example, the top statutory tax rate was raised from 28% to 31%. In addition soon after OBRA-90 was passed, the 1992 election took place and OBRA-93, another 5 year deficit reduction plan, was passed. OBRA-93 extended the five year phase in period of OBRA-90 for an additional three additional years through 1998; it also increased tax rates further, with the top tax bracket rising from 31% to 36% and to 39.6%.

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[6] I was a member of the Council of Economic Advisers during 1989-91, so this close connection between the research and the policy description may not seem surprising. Nonetheless it illustrates the relationship between research and policy.

The ex-ante budgetary impacts of these two overlapping mutli-year plans are shown in Table 1. The total impact on spending was 2.3 percent of GDP though this includes interest and transfer payments, not simply purchases as in the model simulations.

Table 1

Estimated Ex-Ante Budgetary Impacts
(percent of GDP)

OBRA-90

	1990	1991	1992	1993	1994	1995	90-95
Tax	.08	.29	.24	.0	.0	.0	0.69
Spending	.07	.29	.29	.21	.43	.25	1.53
Total	.15	.58	.53	.21	.43	.25	2.22

OBRA-93

|	1993	1994	1995	1996	1997	1998	94-98
Tax	.10	.34	.17	.08	.06	-.02	0.73
Spending	.02	.07	.09	.22	.24	.17	0.80
Total	.12	.41	.26	.30	.30	.15	1.53

Source: Dervries et al (2011) based on historical documents prepared by CBO at the time OBRA-90 and OBRA-93 were passed. Spending includes estimated interest payments.

Ex post estimates of the budgetary impacts are difficult to obtain because of other changes in the budget, such as defense spending, and economic developments that affect spending and revenues, such as the 1990-91 recession which automatically increased spending and lowered revenues. According to historical budget data from the CBO federal spending fell from 20.5 % as a share of GDP in 1989 to 18.5 percent in 1998 and revenues rose from17.8 of GDP in 1980 to 19.2% in 1998. In 1998 the debt to GDP ratio is still above what it was in 1989, but continued to fall through 2001.

We can also look at total government purchases in the National Income and Product Accounts which corresponds most closely to the original model simulations. The upper left hand chart in Figure 2 shows the changes in total government purchases as a share of GDP during the period in question. The size of decline in purchases relative to GDP includes additional cuts in defense spending over and above the reduction in OBRA. Nonetheless this change is close to the size of the multiyear plan in the model simulations

Thus by almost any reasonable measure, government spending declined during the 1990s relative to GDP. Despite these large cuts in spending as well as the tax increases, the Keynesian demand effects appear to be small much as predicted by the structural model. Indeed, from a cyclical perspective the U.S. economy performed very well during this period, which is the central part of the so-called Great Moderation or the Long Boom. As shown in the other panels of Figure 2, investment and consumption rose by more than in the model simulations, a phenomenon that can be accounted for by the large fall in net exports as saving from abroad flowed in to support the additional domestic spending.

Figure 2 Changes in Spending Shares of GDP: 1991- 2000
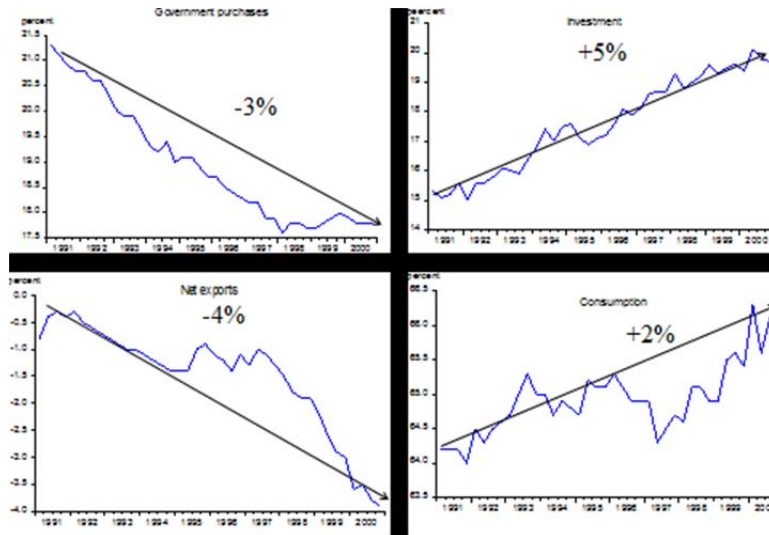
Policy Research and Multi-Year Deficit Reduction Today

Now consider the more recent period. The lower panel of Figure 1 shows the run up in the debt to GDP ratio in the past few years. While the most recent CBO budget outlook projects stabilization of this ratio for a few years, it is at a much higher level than in earlier years and is projected to start increasing again within a decade. For this reason fiscal consolidation strategies are again on the table as is the need for policy research on the best way to proceed.

Policy Research

Fortunately, hybrid macro-econometric models have improved in directions that are very useful for evaluating such strategies. Like earlier hybrid models, they incorporate nominal rigidities that prevent immediate adjustment towards market equilibrium as well as the decision-making of rational, forward-looking households and firms. But in recent years, progress has been made in incorporating distortions in household and firm decisions resulting from taxes that are not collected lump-sum.

To consider alternative deficit reduction strategies in hybrid models with tax distortions, Cogan, Taylor Wieland and Wolters (2013a, 2013b) adapted one such state of the art model. The model was developed and used at the European Central Bank by Coenen, McAdam and Straub (2008). The CMS model not only has nominal rigidities in price-wage setting and forward-looking agents, it also takes into account distortionary taxes on income, capital and consumption. Cogan et al (2013a) calibrated the coefficients of the model using parameter values from Cogan et al (2010) based on US data. The Euro area is also included in the model and the parameters from that part were estimated from Euro data that were first used by Smets and Wouters (2003).

Government spending, tax and debt decisions are of course subject to a budget constraint in the model. Importantly for evaluating current policy, the model also distinguishes between government purchases and transfers. Households pay taxes on consumption, on wage income and on capital income. They also pay social security contributions and receive transfers. They then make their decisions in a forward-looking utility-maximizing manner so that changes in fiscal policy today and anticipated in the future have an immediate effect on their decisions. Thus changes in fiscal policy have a direct effect on consumption, investment, and labor supply. In the CMS model the staggered nominal wage setting assumptions of Calvo (1983) are used to generate wage rigidities. Firms and workers who cannot reset their wage in a specific period adjust their wage by indexing it to last period's change in prices.

Figure 3 summarizes the history and the outlook for federal government spending in the United States as a percent of GDP. Government outlays include both transfers and purchases of goods and services. The red line (labeled baseline) shows spending under current policies as of March 2013. This baseline implies that federal spending as a share of GDP would remain about 3 percentage points above the pre-crisis level. Such a sustained increase in spending would require raising tax rates in the longer run in order to reduce the deficit and prevent the national debt from continuing to grow as a share of GDP. Such higher tax rates, according to the model, would distort private incentives for saving, investment and capital accumulation.

My research with Cogan, Wieland and Wolters examined several alternative fiscal consolidation strategies which tried to slow and stop this rise in spending. In our working paper (2013b) we focused on a particular plan put forth as a House Budget Resolution in March 2013, and that is the strategy shown in Figure 3. In this plan federal spending would decline to 19.1 percent from 22.2 percent of GDP. Thus, the budget plan would imply a significant reduction in spending as a share of GDP. With the CBO projection that revenues would equal 19.1 percent of GDP in 2023, the plan will thereby balance the budget that year
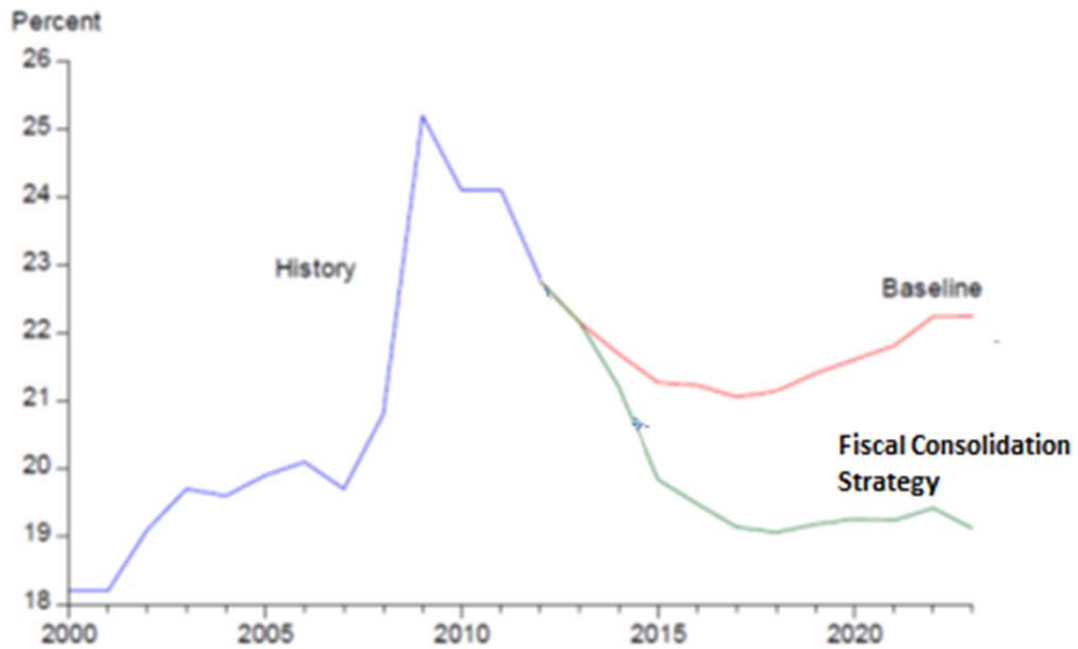
Figure 3 Federal Government Outlays as a Percent of GDP

Source: Figure 1 of Cogan, Taylor, Wieland, Wolters update (2013)

In the current U.S. budget situation, entitlement spending is much more a source of the expansion in future government spending than discretionary spending. Thus a multi-period deficit reduction plan should focus more on the future growth of transfer spending than on purchases of goods and services. Figure 4 shows how the consolidation is distributed between federal government purchases and federal government transfer payments.
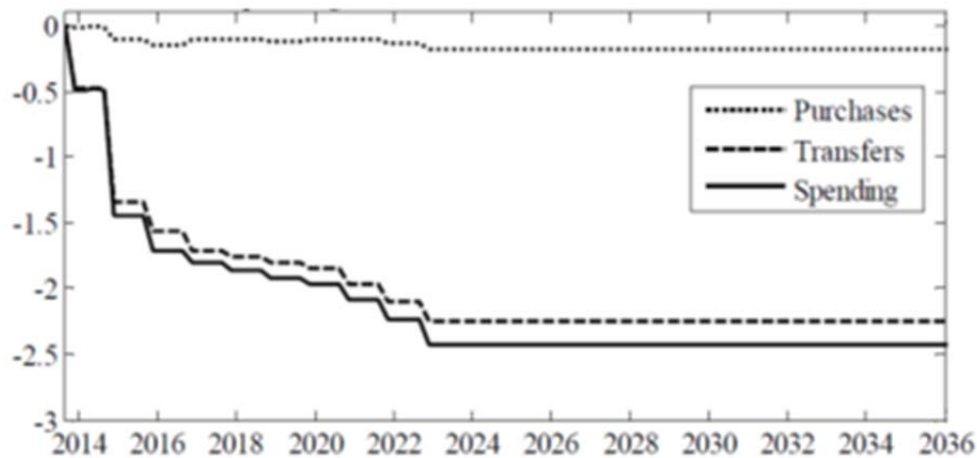
Figure 4 Fiscal consolidation strategy: percentage deviation of purchases, transfers and spending from baseline as a share of GDP

Because the fiscal consolidation plan for spending is lower than the baseline path, it allows for lower tax rates and/or lower levels of government debt. We assumed a mixture in our research. We assumed that the funds released from reduced federal spending are used to reduce labor income and capital income tax rates by about 5 percentage points relative to baseline but with a delay of ten years. The remaining funds are used to reduce the debt to GDP ratio, which turns out to be by about 30 percentage points. To be sure, the reductions in labor and capital income tax rates are relative to a baseline, which, if it corresponds to the actual current spending outlook for the U.S. economy, implicitly includes tax rate increases. Thus, the consolidation strategy would deviate from the baseline outlook by avoiding tax increases rather than requiring actual tax cuts.

The impact of the budget consolidation on GDP, consumption, investment and net exports as a percent of the model's baseline is shown in Figure 5. Note that real GDP increases throughout the simulation. Even in the short-run, the consolidation strategy would boost economic activity in the private sector sufficiently to overcome the reduction in government spending. The extra impact in later years occurs as the delayed tax cuts take hold.
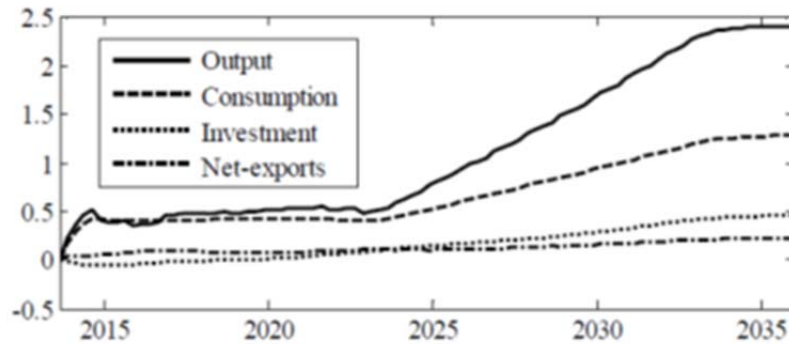
Figure 5. Estimated Impact of Fiscal Consolidation

Legislative Outcome

Unlike the review of fiscal consolidation in the 1990s, the history of fiscal consolidation in the current period is not over. Clearly the legislative proposal described above was not enacted into law nor has any other multi-year fiscal consolidation plan. The debt to GDP ratio thus remains at a high level and eventually will increase under current law as shown in Figure 1.

Figure 6 illustrates what has happened to the spending side of the budget due to other legislative changes and developments in the economy since the policy analysis of Cogan et al (2013b) was completed. The arrows and dots superimposed on the chart from Figure 3 are based on the most recent CBO baseline analysis (August 2014). According to this update, spending as a percent of GDP in 2013 and 2014 was considerably lower than in strategy. However, from 2015 and going forward, spending is much higher than in the strategy and very close to the original baseline, as if no action has been taken. Compared to the consolidation strategies investigated in the policy research, the actual and projected path is too sharp in the short run and not sharp enough in the long run.
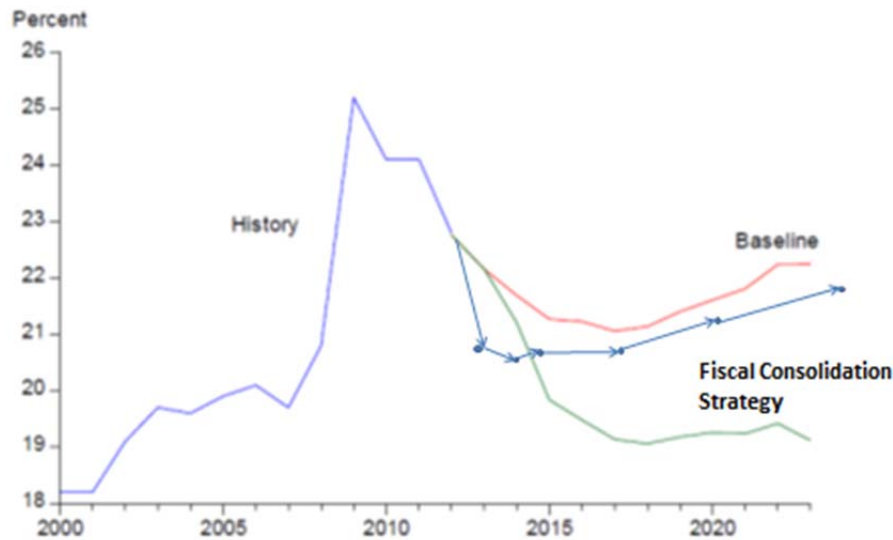
Figure 6 Federal Government Outlays as a Percent of GDP

Source: Figure 1 of Cogan, Taylor, Wieland, Wolters update (2013)

Dots are from CBO Update on the Budget and Economic Outlook, August 2014

Conclusion

In this paper I have endeavored to examine the use of hybrid models to design and evaluate fiscal consolidation strategies. I have traced out considerable progress over the years in the development of these models from the first hybrids featuring rigidities and forward looking behavior to the explicit incorporation of tax distortions and incentives implied by optimizing behavior.

Using specific models and particular episodes I showed how the models have been used in policy research. I also reviewed the sense in which this policy research in turn has had some influence on actual policy making. While deviations of actual policy from the original recommendations makes evaluating the models difficult, their predictions are generally consistent with the outcomes. The importance of fiscal consolidation plans being multi-year, gradual and credible is a common theme.

The use of structural models for policy evaluation complements research work by Giavazzi and Pagano (1990), Alesina and Ardagna (2010) and Alesina, Favero, and Giavazzi (2012) which looks at the patterns and composition of fiscal consolidation and assesses their impact with time series regressions. The findings reviewed here that large multi-year credible deficit reduction plans have little effect on aggregate demand and indeed can have positive effects in the short run is consistent with this research and do not require special announcement triggering effects as in Bertola and Drazen (1993).

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While progress has been substantial, much more research is needed to integrate better the policy analysis and policy making. More realistic treatment of tax policies and the incentive effects of transfer programs will improve relevance. The use of more models will add robustness.

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