WORKING PAPER NO. 2011-13

GOVERNMENT OUTLAYS, ECONOMIC GROWTH AND UNEMPLOYMENT: A VAR MODEL

By

Siyan Wang and Burton A. Abrams

WORKING PAPER SERIES

UNIVERSITY OF DELAWARE
Alfred Lerner College of Business & Economics
DEPARTMENT OF ECONOMICS

Government Outlays, Economic Growth and Unemployment: A VAR Model

Siyan Wang
Department of Economics
University of Delaware
Newark, DE 19716
wangs@udel.edu

and

Burton A. Abrams
Department of Economics
University of Delaware
Newark, DE 19716

August 4, 2011

Abstract

This paper examines the dynamic effects of government outlays on economic growth and the unemployment rate. Using vector autoregression and data from twenty OECD countries over three recent decades, we found: (1) positive shocks to government outlays slow down economic growth and raise the unemployment rate; (2) different types of government outlays have different effects on growth and unemployment, with transfers and subsidies having a larger effect than government purchases; (3) causality runs one-way from government outlays to economic growth and the unemployment rate; (4) the above results are not sensitive to how government outlays are financed.

JEL Code: C12; C32; H50; J64; O40

Keywords: government outlays; economic growth; unemployment rate; vector autoregression; Granger causality

1. Introduction

How do increases in government outlays affect the unemployment rate and economic growth? How do these effects differ in the short and long run? Do the effects differ if government outlays are purchases or transfers? Does it matter if outlays are financed by debt or taxes? Different theories provide different predictions to these questions. The New Keynesian model, for example, predicts that the various expansionary fiscal policies can raise output and lower unemployment in the short-run. In contrast, open-economy models with flexible exchange rates and perfect capital mobility cast doubt on the short-run efficacy of expansionary fiscal policies to boost output and lower unemployment.

On a less aggregative level, some government purchases and transfers can be growth and employment enhancing (Agell, et al. (1997)). Government spending on education and infrastructure can raise labor productivity and complement private investment. Military spending can generate technological improvements that enhance growth. Clearly, government outlays for public goods such as law enforcement may also facilitate growth and development.

On the other hand, some government outlays and their financing may adversely affect employment and economic growth. Transfer programs such as social security and Medicare create social capital and tend to reduce private capital formation (Feldstein (1996)). Unemployment insurance and taxation on labor income distort work-leisure decisions and raise unemployment rates (Feldstein (1978)). Ill-considered government purchases of goods and services may yield little or no tangible employment and growth benefits, while adversely affecting employment and growth due to taxation distortions and borrowing effects.[1] As with so many issues in economics, the question of the impact of policy must be answered empirically.

This paper seeks to shed some light on the dynamic effects of expansionary fiscal policies on economic growth and the unemployment rate using data from twenty OECD countries over three recent decades. We offer what we believe is a more complete and general vector autoregressive model (VAR) than have been used in earlier studies. Our main conclusions are: (1) positive shocks to government outlays will slow down economic growth and raise the unemployment rate; (2) different types of government outlays have different effects on growth and unemployment, with transfers and subsidies having a larger effect than government purchases; (3) causality runs one-way from government outlays to economic growth and the unemployment rate; (4) the above-mentioned results are not sensitive to how government outlays are financed.

The next section reviews the empirical literature. Section 3 sets up our VAR models and discusses some methodological issues. Section 4 presents the empirical findings. Section 5 offers concluding remarks.

2. Empirical Literature

There is a rich empirical literature on the long-run effects of government outlays on economic growth. Using cross-country regressions, some studies found a statistically significant negative effect of government outlays on economic growth (e.g., Landau (1983), Grier and Tullock (1989), Barro (1991) and Afonso and Furceri (2010)), while others do not (e.g., Kormendi and Meguire (1985), Ram (1986) and Lin (1994)). Agell et al. (1997) provide a good review of the empirical relationship between economic growth

[1] A recent and well publicized proposal for a $250 million "bridge to nowhere" in Alaska is one example.

and government outlays. In contrast, the effects of government outlays on the unemployment rate have not received much attention until recently. Abrams (1999) was the first to find support for the positive link between a nation's steady-state unemployment rate and its total government outlays. Using an error-correction model, Wang and Abrams (2011) also found that the steady-state unemployment rate increases with total government outlays. In addition, when government outlays are disaggregated, transfers and subsidies are found to have a strong negative impact on the steady-state unemployment rate while government purchases of goods and services play no significant role.

Multivariate time series analysis has also been conducted to examine the short-run dynamic relationship between government outlays and economic growth and between government outlays and the unemployment rate.[2] The literature focuses on the causal pattern and impulse response analysis in the context of vector autoregression (VAR). Conte and Darrat (1988) and Rao (1989) examined Granger-causal relationship between government outlays and economic growth using bivariate VAR models. Conte and Darrat (1988) found that total government outlays do not Granger-cause per capita output growth in the majority of OECD countries. Rao (1989) found no causal relationship between output growth and government purchases in most countries and unidirectional

[2] Several studies have examined the short-term and long-term effects of government outlays on output or income levels but their empirical results were misinterpreted as the effects of government outlays on economic growth. Using VAR modeling, Ramey and Shapiro (1997), Fatas and Milhov (2001), Blanchard and Perotti (2002), Perotti (2004), Edelberg, et al. (1999), Burnside, et al. (2003) and Tagkalakis (2006) examined the dynamic responses of output to a one-time shock to government purchases. Overall, government purchases have been found to have an expansive output effect. Ahsan, et al. (1996), Ghali (1998) and Loizides and Vamvoukas (2005) used cointegrating techniques and found positive long-run relationships between output and government outlays. Ghali (1998) also found that government outlays Granger-cause output. Others have studied the effect of government outlays on employment. Edelberg, et al. (1999) and Fatas and Milhov (2001) found that total private employment rises following a positive shock to government purchases. Tagkalakis (2006), on the other hand, found that a positive shock to government purchases lowers the employment in the business sector. None of these studies examined the effects of transfer outlays.

causation from output growth to government purchases in a few others. Hsieh and Lai (1994) estimated a trivariate VAR of government purchases, per capita output growth and private investment for the G-7 countries. Their results are mixed. Specifically, there appear to be substantial cross-country variations both in the dynamic effects of government purchases on growth and in the causal relationship between them. Christopoulos and Tsionas (2002) estimated bivariate VAR models for ten OECD countries and found that the unemployment rate increases following a positive shock to total government expenditures. They also found unidirectional Granger causality running from total government expenditures to the unemployment rate for most countries.[3]

3. VAR Models and Some Methodological Issues

This paper examines the dynamic effects of government outlays on economic growth and the unemployment rate using what we believe is a more complete and general VAR model. In this section, we first set up the VAR models and then discuss some methodological issues concerning estimation and statistical inference.

3.1. VAR Model Specifications

[3] Christopoulos, et al. (2005) conducted panel cointegration tests and concluded that there is a positive long-run relationship between total government expenditures and the unemployment rate and that causality runs one-way from total government expenditures to the unemployment rate. These conclusions should be taken with caution. First, there is no direct link between the presence or lack of cointegration and the direction of causality. Secondly, in residual-based cointegration tests such as the panel cointegration tests employed in Christopoulos, et al. (2005), alternating the dependent variable in cointegration regression often yields conflicting results. In such cases, interpretation of test results can be tricky. In Christopoulos, et al. (2005), the null hypothesis of no cointegration can be rejected when the unemployment rate is used as the dependent variable in the cointegrating regression, but not so when government size is the dependent variable. The inconsistent test results actually imply a lack of cointegration (long-run relationship) between government size and the unemployment rate rather than unidirectional causality.

A question that naturally arises in VAR analysis is what variables should be included in the system. In principle, the system should include any variable that is intimately connected to the variables of interest. Our benchmark specification (Model 1) is a standard VAR of the following five variables: total government outlays as a percentage of GDP (GO), the short-term nominal interest rate (R), the unemployment rate (U), the real per capita GDP growth rate (G_GDP) and the inflation rate (I).[4] Total government outlays, a broad measure of government activity, serve as a portmanteau variable to measure the combined effects of the outlays-cum-taxation of government purchases and transfer programs. The short-term nominal interest rate is included as a control for the stance of monetary policy. The unemployment rate, real per capita GDP growth rate and inflation rate have been at the center of interest of economic policies during our sample period and are therefore expected to be jointly determined. As a matter of fact, since the early 1970s, most OECD countries have witnessed rising unemployment rates and slower economic growth accompanied by periodic bouts of strong inflationary pressures.

The use of an aggregative variable such as GO is consistent with reduced-form models of unemployment. However, economic theory often predicts that government purchases have different effects than transfers since only the former has direct impact on the use of resources. To see if there is any empirical support for this prediction, we experiment by disaggregating GO into transfers and subsidies as a percentage of GDP (TR) and government purchases of goods and services as a percentage of GDP (G). This results in Model 2, a 6-equation VAR consisting of TR, G, R, U, G_GDP and I.

---

[4] Variable definitions and sources are given in the Appendix.

To see if our findings are sensitive to how government outlays are financed, we experiment with some tax variables.[5] Model 3 is a 6-equation VAR obtained by adding total tax revenues as a percentage of GDP (TAX) to Model 1, while Model 4 is a 7-equation VAR obtained by adding net taxes as a percentage of GDP (TAX_NET) to Model 2.

Besides the above-mentioned joint dependent variables, several exogenous factors are also expected to affect growth and unemployment. For example, tight labor market regulations and adverse economic shocks are often argued to be responsible for the high unemployment rates in the OECD countries since the 1970s. Changes in demographics also have the potential to affect the unemployment rate. Globalization may also affect the unemployment rate since higher globalization and higher competition in the goods markets will lead to a more turbulent environment, with more job destruction and job creation (Rodrik (1998)). To accommodate these factors, we include the following exogenous variables in each VAR model specification: minimum wage (MIN_WAGE), trade union density rate (UNION) and the unemployment benefits replacement rate (BENEFITS) for the effects of regulatory and labor-market institutions;[6] oil price shock (OIL) for the effects of adverse economic shocks; population growth rate (G_POP) and share of female in the labor force (FEMALE) for the effects of demographics; and openness (OPEN), measured as the imports plus exports as a percentage of GDP, for the effects of globalization.

---

[5] Kneller et al. (1999) examined the relationship between fiscal policy and economic growth in the OECD countries. They found that omitting taxes causes the coefficient estimate on government expenditures to switch sign.

[6] Other labor-market institutions, such as employment protection legislations, strictness of unemployment benefit conditions, active labor market programs and degree of coordination in collective bargaining, have also been shown to have significant impacts on the unemployment rate. See Elmeskow et al. (1998), Heckman and Pages-Serra (2000), Nickell et al. (2005), Belot and van Ours (2004), Botero et al. (2004). They are not included in this study due to lack of time series data for the sample period.

Compared to the previous VAR studies, our model has the following features: (1) it models economic growth and the unemployment rate jointly while previous studies have focused on one or the other; (2) it examines the potentially different effects of transfers and government purchases while previous studies have examined either total government outlays or government purchases alone; (3) it explicitly controls for the stance of monetary policy and various exogenous factors; (4) it allows us to study the relevance of government financing for growth and unemployment. Our VAR models are therefore more complete and general than those adopted in the earlier studies. This is particularly important for the Granger causality test because inadequately specified systems are subject to the omitted variable bias, resulting in spurious causality (Granger (1969)).

3.2. Some Methodological Issues

In VAR analysis, it is often difficult to interpret the coefficient estimates because the error terms tend to be contemporaneously correlated and the estimated coefficients on successive lags often switch in signs. We therefore follow the standard practice and use the impulse response functions (IRFs) to examine the dynamic effects of a one-time shock to government outlays. We also investigate the causal relationship between government outlays and the unemployment rate and between government outlays and economic growth using pair-wise Granger causality tests.

In section 4, Models 1-4 are estimated by following the lag-augmented VAR (LA-VAR) procedure proposed by Toda and Yamamoto (1995). We choose to use the LA-VAR for the following reasons. First, for Granger causality test Wald statistics based on the LA-VAR estimates has the chi-square limiting distribution regardless of the number and location of unit roots.[7] Secondly, the LA-VAR procedure is not sensitive to the presence of cointegration. Since the focus of this study is on the impulse response functions and Granger causality tests rather than cointegrating relationship, the LA-VAR procedure saves us the trouble of pretesting the rank of cointegration or estimating the cointegration vectors. It is well known that tests for the rank of cointegration tend to suffer size distortion and low power in finite sample. Third, the LA-VAR procedure works even when the joint dependent variables are of different orders of integration. The procedure can be easily implemented as long as the maximum order of integration is known among the joint dependent variables. This feature comes in handy when the unit root test statistic is close to the critical value or different unit root tests give conflicting results.[8] Forth, LA-VAR is fully parametric and therefore tends to be more stable than semiparametric estimators for small and moderate sample. Yamada and Toda (1998) conducted extensive Monte Carlo simulations and found that in terms of the Granger causality test Wald statistics based on LA-VAR estimates has good size and power properties for small and moderate sample sizes.

For the impulse response analysis, previous studies (e.g. Christopoulos (2002)) have reported the orthogonalized impulse response functions (IRFs), which by construction depend on the order in which the variables are arranged in the VAR and are therefore not unique unless the VAR error terms are uncorrelated across equations. The orthogonalized IRFs do not seem appropriate for our study for two reasons. First, for

[7] Toda and Yamamoto (1995) showed that if a VAR model contains unit root processes, the OLS based Wald statistics for Granger causality test in general do not have the chi-square limiting distribution.
[8] The panel unit root tests in Table 1 suggest that variables in our VAR models are of different orders of integration. In particular, some variables are found to be I(1), others stationary, while the tests are not unanimous for the remaining variables.

macroeconomic time series, variables included in a VAR model are expected to be closely related to one another, the error terms are therefore unlikely to be orthogonal. Secondly, in computing the orthogonalized IRFs choosing a particular ordering of the joint dependent variables is equivalent to imposing a recursive structure on the VAR errors. For example, consider a bivariate VAR of government outlays and the unemployment rate. If government outlays are ordered first, then the orthogonalized IRFs are computed assuming that government outlays do not respond to contemporaneous unemployment shock but unemployment rate does respond to contemporaneous outlay shock. These assumptions can be quite restrictive for annual data. In contrast, the generalized IRFs proposed by Koop, Pesaran and Potter (1996) are not sensitive to the ordering of the variables or the VAR error structure. Since there is no prior reason to choose one particular ordering over another in any of our VAR models, section 4 reports the generalized IRFs.

4. Empirical Results

Our empirical analysis is based on a panel of twenty OECD countries from 1970 to 1999.[9] We focus on the OECD countries because their data are of high quality and highly compatible across country. Our sample ends in 1999, which coincides with the introduction of the euro. Combining the pre-euro and post-euro periods will no doubt increase the sample size and make this study appear more up to date. But it will also

[9] Countries include Australia, Austria, Belgium, Canada, Denmark, Finland, France, Germany, Greece, Ireland, Italy, Japan, Netherlands, Norway, Portugal, Spain, Sweden, Switzerland, United Kingdom and United States. Data for Germany includes only West Germany prior to merger with East Germany.

subject our estimation results to the complications of a structural break.[10] Therefore, instead of taking up the ambitious task of investigating the dynamic effects of government size in the midst of a major structural break, we content ourselves with focusing on the pre-euro period.

As a preliminary step, we test each joint dependent variable for the presence of unit root. Table 1 reports the results from four panel unit root tests: Levin, Lin and Chu (2002), Im, Pesaran and Shin (2003), Fisher-ADF test by Maddala and Wu (1999) and Fisher-PP test by Choi (2001).[11] These tests have been shown to give higher power than unit root tests based on individual time series. All the tests suggest that I is a unit root process for all the countries. For GO and G_GDP, the LLC test concludes that they are stationary for all the countries while the other three tests suggest that they are stationary for at least a subgroup of the countries.[12] Test results are, unfortunately, not unanimous for TR, G, TAX, TAX_NET, R and U. It may appear that the results from the panel unit root tests are mixed and uninformative. But they lead to the important observation that the joint dependent variables in our VAR models are likely to be of different orders of integration. Therefore, as discussed in section 3, it is advantageous to use the LA-VAR estimates to construct the Wald statistics for Granger causality test. [13]

---

[10] Including a year dummy to control for the EMU structural break is easy to implement. However, this approach is, in our opinion, naïve and inadequate. The growth and unemployment dynamics are likely to be dramatically different in the euro zone due to its single monetary policy and stringent fiscal policy rules. As a result, it may be necessary to set up a separate model for the EMU members in the post-euro period.

[11] Since all of the joint dependent variables are expressed in relative terms or as percentage changes and none of them displays a deterministic trend, we include a constant but no time trend in the panel unit root tests.

[12] Although the panel unit root tests reported in Table 1 share the same null hypothesis that there is a unit root for all cross-sections, they differ in the alternative hypothesis. Levin, Lin and Chu (2002) specifies that none of the cross-sections has a unit root under the alternative, while the other three tests require only a non-zero fraction of the cross-sections to have no unit root under the alternative.

[13] We also apply the panel unit root tests to the first difference of each joint dependent variable. The unit root null is soundly rejected in all cases. So to apply the LA-VAR procedure, the maximum order of integration is set to 1.

Given the dimensions of our VAR models and the limited number of observations for each country, country-by-country estimation is unlikely to yield accurate estimates. Therefore, we use pooled estimation while including country dummies to control for unobserved country characteristics. The lag order in each model is set to 2 according to the Akaike information criterion. This is consistent with the view that fiscal and monetary policies do not have direct economic impact for more than two years.

4.1. Impulse Response Analysis

Figure 1 plots the generalized IRFs of U and G_GDP to a one-time unit shock to government outlays.[14] The 95% confidence intervals are marked by the dotted lines. The first row gives the responses of U and G_GDP to a GO shock based on the estimates of model 1. The unemployment rate rises upon impact by 0.09 percentage point. The response of U gains strength at first and then weakens gradually with a maximum increase of 0.21 percentage point achieved two years after the shock. It stays positive and significant until six years after the shock. The real per capita GDP growth rate falls upon impact by 0.30 percentage points. The response of G_GDP is less persistent. It stays negative and significant for only two years after the shock.

The second row of Figure 1 gives the responses of U and G_GDP to a TR shock and the third row gives the responses of U and G_GDP to a G shock, all of which are based on the estimates of model 2. These IRFs display the same patterns as those based on model 1. However, compared to a GO shock, the responses of U and G_GDP to a TR shock are much stronger while their responses to a G shock are weaker. Following a one-

[14] A unit shock to GO is a one point increase in GO in the current period, e.g., total government outlays increase from 20 to 21 percent of GDP. A unit shock to TR or G is defined similarly.

time unit shock to TR, the unemployment rate rises upon impact by 0.14 percentage points and reaches a peak two years later with an increase of 0.35 percentage point. Real per capita GDP growth rate falls upon impact by 0.48 percentage points. In contrast, following a one-time unit shock to G, the unemployment rate rises upon impact by only 0.05 percentage points and the peak increase is merely 0.1 percentage points. The real per capita GDP growth rate falls upon impact by only 0.17 percentage points.

4.2. Granger Causality

Table 2 reports the Wald statistics for pair-wise Granger causality tests. In both models 1 and 2, we found evidence of unidirectional causality from the government size variables to growth and the unemployment rate. In model 1, total government outlays are found to Granger-cause both the unemployment rate and real per capita GDP growth. The Wald statistics are significant at 10% and 1% level, respectively. In model 2, transfers are found to Granger-cause both the unemployment rate and real per capita GDP growth at 10% and 5% significance level, respectively, while government purchases Granger-cause only the real per capita GDP growth, significant at 1% level.

The lack of causation from G to U and the weak evidence of causality from GO to U may seem contradictory to the findings of the impulse response analysis. This can be explained by the fact that impulse response analysis makes use of all the coefficient estimates in the VAR system plus the estimated error correlation, while the pair-wise Granger causality tests are based on only a subset of the coefficient estimates in a particular equation. Therefore, impulse response analysis and pair-wise Granger causality tests can and in many cases will yield different results. In such cases, the impulse response analysis tends to be more informative and the results from pair-wise Granger causality tests should be interpreted with caution. For instance, when pair-wise Granger causality tests fail to find causal relationship from G to U, we can only conclude that lagged values of G have no direct impact on the current U. However, we cannot rule out the possibility that G might affect U through a third variable. As a matter of fact, both GO and G are found to Granger-cause G_GDP which in turn is found to Granger-cause U. Therefore, GO and G have indirect impacts on U through G_GDP, which are not detected by the pair-wise Granger causality tests. These observations also point to one of the strength of our VAR model specifications, i.e., modeling economic growth and the unemployment rate jointly allows richer dynamics and offer more insights than modeling one at a time as was done in the previous studies.

4.3. Relevance of Government Financing Procedures

To see if our findings are sensitive to how government outlays are financed, we compare the estimation results of models 3 and 4 to those of models 1 and 2, respectively. In Figure 1, the IRFs based on models 3 and 4 display the same pattern as those based on models 1 and 2 in terms of the signs and magnitudes. The Granger-causality tests based on models 3 and 4 also yield the similar conclusions as those based on models 1 and 2. The only exception is that the unidirectional causality from government outlays and transfers to the unemployment rate is no longer significant at 10% level. In addition, we find that tax variables (TAX in model 3 and TAX_NET in model 4) do not Granger-cause U or G_GDP. Therefore, the effects of government outlays on growth and unemployment do not seem to depend on whether outlays are financed through borrowing or taxation, suggesting Ricardian equivalence (i.e., borrowing and taxation produce equivalent macroeconomic effects).

4.4. Role of Exogenous Variables

Table 3 reports the coefficient estimates on the exogenous variables in the growth and unemployment equations.[15] Most of the exogenous variables are insignificant in both equations except that share of females in the labor force appears to hamper economic growth.[16] Some labor-market institutions are also found to have indirect effects on growth and unemployment through government outlays. For example, unemployment benefits are found to increase total government outlays and transfers. These findings are consistent with the common argument that labor market rigidities are responsible for the high unemployment rates in the OECD countries.

4.5. Sensitivity Analysis

To see if the parameters are stable across countries, we re-estimate the models using two sub-samples. First, Spain and Japan represent potential outliers in our sample. Almost all of Japan's dramatic growth in government outlays over the period was in the form of government purchases, while Spain's was in transfers and subsidies. Meanwhile, Spain's unemployment rate rose dramatically while Japan's increased little. To see if our findings that transfers have a stronger effect than government purchases are driven by these two countries, we drop Spain and Japan from the sample and re-estimate the

[15] To conserve space, coefficient estimates for other equations are not reported here. They are available upon request.

[16] We have no prior expectation for the coefficient on the share of females in the labor force. The variable may be capturing the effects of some demographic or cultural factor that is not included in the model and, as we note in the sensitivity analysis, may be endogenously determined.

models. Secondly, economic growth and unemployment rates in the European and non-European countries may have followed different dynamics. Therefore, we re-estimate the models using data from the 16 OECD-European countries. In both cases, the results are very close to full sample estimates.

We also experimented by dropping the exogenous variables from the models. This is due to the concern that variables such as labor institutions may in fact be endogenously determined. The results hardly change. Our empirical findings therefore seem to be quite robust to changes in samples and the exogenous variables.

5. Conclusions

This paper examines the dynamic effects of government outlays on economic growth and the unemployment rate using data from twenty OECD countries for the period 1970-1999. Our findings are broadly consistent with those in Christopoulos and Tsionas (2002) and Wang and Abrams (2011) but contrary to those in Conte and Darrat (1988) and Rao (1989). However, by modeling growth and unemployment jointly and disaggregating total government outlays into purchases and transfers, our VAR models are more general and offer more insights. We find that increases in government outlays hamper economic growth and raise the unemployment rate. Moreover, different types of government outlays are found to have different effects on growth and unemployment, with transfers and subsidies having a larger effect than government purchases. In addition, Granger causality tests suggest unidirectional causation from government outlays to economic growth and the unemployment rate. Importantly, the estimated effects of government outlays on growth and unemployment do not seem to vary with government financing procedures. Since our empirical analysis is based on the LA-VAR estimates, our findings are robust to the presence of unit roots and cointegration, which are common in macroeconomic time series.

This study is a timely one. The American Recovery and Reinvestment Act of 2009 provided for $787 billion in fiscal stimulus that combined both boosts in spending and transfers and cuts in taxes. Clearly, the designers of the Act expected that expansionary fiscal policy would raise output and lower unemployment, at least in the short run. Our empirical findings, however, suggest the opposite. Of the $787 billions, roughly $500 billions are increases in government outlays, which amount to 3.55% of 2009 GDP. According to our estimates[17], as a result of the ARRA, the U.S. unemployment rate is expected to increase by 0.3 percentage point (0.09*3.35) in 2009 and by 0.7 percentage point (0.21*3.35) in 2011. The negative effect on employment is expected to last until 2014. The U.S. growth rate is expected to fall by roughly 1 percentage point (0.30*3.55) in 2009 but the negative effect should die out by 2011.

Our estimates are diametrical to the estimates of the Congressional Budget Office (CBO). For example, according to CBO (2011), ARRA is estimated to have raised real GDP by 1.1~1.3 percent and have lowered the unemployment rate by 0.7~1.9 percentage point in the fourth quarter of 2010. The discrepancy in these estimates is partly due to fact that our estimates are based on a fiscal shock alone while the CBO's estimates are reflective of joint fiscal and monetary stimulus. Specifically, our VAR model assumes that short-term interest rates are fully responsive to fiscal stimulus. As a result of ARRA, higher interest rates would crowd out private investment spending and spending on

[17] The numbers in this paragraph are based on the estimated impulse response functions of our benchmark specification (model 1). To simplify the calculation, we treat the $500 billion increase in outlays as a one-time shock in year 2009.

durable goods. In contrast, the CBO's estimates are obtained by holding the short-term interest rates very low. As acknowledged in the CBO report, "Under more normal economic conditions, higher interest rates would offset roughly two-third of the cumulative impact of stimulative policies on gross domestic product over two years." [18]

It should also be noted that the ARRA's outlays and tax cuts were financed by public borrowing. The $787 billion in fiscal stimulus amounts to roughly 5.6% of 2009 GDP. Several recent studies suggest that the recent run-up in the U.S. public debt may lower economic growth in the long run. Reinhart and Rogoff (2010) conclude that "normal" levels of debt seem to have little or no effect on economic growth but public debt can reach a tipping point beyond which more debt lowers a country's economic growth. They estimate the tipping point to be a debt/GDP ratio of 90 percent. Kumar and Woo (2010) also find empirical support for an inverse relationship between initial public debt and subsequent economic growth. Caner, et al. (2010) observe that the tipping point might be as low as a debt/GDP ratio of 77 percent. With a debt/GDP ratio of 83.5 percent in 2009 and 89.9 percent in 2010, the U.S. is fast approaching or has already exceeded the tipping point. [19] Therefore, we have reason to believe that the fiscal stimulus provided by ARRA may have negative macroeconomic effects, both in the short run and in the long run.

[18] In estimating the magnitude of the ARRA effects, CBO grouped the spending and tax provisions into several general categories and used evidence from various economic models and historical relationships to determine the estimated multiplier for each category. It is acknowledged that CBO altered the models' usual formation to reduce the extent to which interest rate respond to increases in output and that the estimated multipliers would be reduced by two-third by the end of 2013, when monetary policy is assumed to be fully responsive to fiscal stimulus.

[19] The U.S. debt/GDP ratio refers to gross central government debt as a percentage of GDP. They are available at http://terpconnect.umd.edu/~creinhar/Courses.html. The same measure is used by Reinhart and Rogoff (2010). The debt/GDP ratio in Caner, et al. (2010) is measured as gross general government debt as a percentage of GDP.

Appendix: Variable Definitions and Sources

U: Unemployment as a percentage of total labor force. Source: OECD Historical Statistics, various issues.

G_GDP: Annual percentage change in real per capita GDP measured in U.S. dollar. Source: World Bank, World Development Indicators (2004).

I: CPI-based inflation rate. Source: World Bank, World Development Indicators (2004).

GO: Total outlays of government as a percentage of GDP. Source: OECD Historical Statistics, various issues.

TR: Government subsidies and other current transfers as a percentage of GDP. Source: World Bank, World Development Indicators (2004).

R: Nominal money market interest rate is used for all countries except Greece. For Greece, data on the money market rate is very limited, so 12-month T-bill rate is used instead. Source: International Financial Statistics.

TAX: Total tax revenue as a percentage of GDP. Source: World Bank, World Development Indicators (2004).

TAX_NET: Total tax revenue minus transfers as a percentage of GDP. Source: World Bank, World Development Indicators (2004).

MIN_WAGE: Statutory minimum wage as a percentage of median wage. Source: OECD Labour Market Statistics (2001).

UNION: Trade union members as a percentage of all wage and salary earners. Source: OECD Labour Market Statistics (2001).

BENEFITS: Gross unemployment benefits as a percentage of the previous gross wage earnings. Source: OECD Labour Market Statistics (2001).

OIL: Oil price shock measured as percentage change in world oil price. Source: World Bank, World Development Indicators (2004).

G_POP: Population growth rate. Source: World Bank, World Development Indicators (2004).

FEMALE: Female labor force as a percentage of total labor force. Source: World Bank, World Development Indicators (2004).

OPEN: Imports plus exports as a percentage of GDP. Source: Ghosh, Gulde and Wolf (2002).

References

Abrams, Burton A. (1999), "The Effect of Government Size on the Unemployment Rate," *Public Choice*, 99, 395-401.

Agell, Jonas, Thomas Lindh and Henry Ohlsson (1997), "Growth and the Public Sector: A Critical Review Essay," *European Journal of Political Economy*, 13, 33-52.

Ahsan, Syed M., Andy C. Kwan and Balbir S. Sahni (1996), "Cointegration and Wagner's Hypothesis: Time-Series Evidence from Canada," *Applied Economics*, 28, 1055-1058.

Afonso, Antonio and Davide Furceri (2010), "Government Size, Composition, Volatility and Economic Growth," *European Journal of Political Economy*, 26, 517-532.

Barro, Robert J. (1991), "Economic Growth in a Cross-Section of Countries," *Quarterly Journal of Economics*, 106, 407-443.

Belot, Michele and Jan C. van Ours (2004), "Does the Recent Success of Some OECD Countries in Lowering their Unemployment Rates Lie in the Clever Design of their Labor Market Reforms?" *Oxford Economic Papers*, 56, 621-642.

Blanchard, Oliver and Roberto Perotti (2002), "An Empirical Characterization of the Dynamic Effects of Changes in Government Spending and Taxes on Output," *Quarterly Journal of Economics*, November, 1329-1368.

Botero, Juan C., Simeon Djankov, Rafael La Porta, Florencio Lopez-de-Silanes, and Andrei Shleifer (2004), "The Regulation of Labor," *Quarterly Journal of Economics*, 119, 1339-1382.

Burnside, Craig, Martin Eichenbaum and Jonas D.M. Fisher (2003), "Fiscal Shocks and Their Consequences," NBER working paper, no. 9772.

Canner, Mehmet, Thomas Grennes, and Fritzi Koehler-Geib (2010), "Finding the Tipping Point - When Sovereign Debt Turns Bad," World Bank Policy Research Working Paper Series, WPS5391.

CBO (2011), "Estimated Impact of the American Recovery and Reinvestment Act on Employment and Economic Output from October 2010 through December 2010," Congressional Budget Office, http://www.cbo.gov/doc.cfm?index=12074.

Choi, I. (2001), "Unit Root Tests for Panel Data," *Journal of International Money and Finance*, 20, 249-272.

Christopoulos, Dimitris K. and Efthymios G. Tsionas (2002), "Unemployment and Government Size: Is There Any Credible Causality?" *Applied Economic Letters*, 9, 797-800.

Christopoulos, Dimitris K., John Loizides and Efthymios G. Tsionas (2005), "The Abrams Curve of Government Size and Unemployment: Evidence from Panel Data," *Applied Economics*, 37, 1193-1199.

Conte, Michael A. and Ali F. Darrat (1988), "Economic Growth and the Expanding Public Sector: A Reexamination," *Review of Economics and Statistics*, 70, 322-330.

Edelberg, Wendy, Martin Eichenbaum and Jonas D.M. Fisher (1999), "Understanding the Effects of a Shock to Government Purchases," *Review of Economic Dynamics*, 2, 166-206.

Elmeskov, Jorgen, John P. Martin and Stefano Scarpetta (1998), "Key Lessons for Labour Market Reforms: Evidence from OECD Countries' Experiences," *Swedish Econoimic Policy Review*, 5, 205-252.

Fatas, Antonio and Ilian Milhov (2001), "The Effects of Fiscal Policy on Consumption and Employment: Theory and Evidence," mimeo, INSEAD.

Feldmann, Horst (2006), "Government Size and Unemployment: Evidence from Industrial Countries," *Public* Choice, 127, 443-459.

Feldstein, Martin (1978), "The Effect of Unemployment Insurance on Temporary Layoff Unemployment," *American Economic Review*, 68(5), 834-846.

______________ (1996), "Social Security and Saving: New Time Series Evidence," *National Tax Journal*, 49(2), 151-164.

Ghali, Khalifa H. (1999), "Government Size and Economic Growth: Evidence from a Multivariate Cointegration Analysis," Applied Economics, 31, 975-987.

Ghosh A. R., A.M. Gulde and H. C.Wolf (2002), "Exchange Rate Regime: Choice and Consequences," MIT Press.

Granger, Clive W.J. (1969), "Investgating Causal Relations by Econometric Models and Cross-Spectral Methods," Econometrica, 37, 424-438.

Grier, Kevin B. and Gordon Tullock (1989), "An Empirical analysis of Cross-National Economic Growth, 1951-1980," *Journal of Monetary Economics*, 24(2), 259-276.

Heckman, James and Carmen Pages-Serra (2000), "The Cost of Job Security Regulation: Evidence from Latin American Labor Market," *Economia*, 1, 109-144.

Hsieh, Edward and Kon S. Lai (1994), "Government Spending and Economic Growth: the G-7 experience," Applied Economics, 26, 535-542.

Im, K.S., M.H. Pesaran and Y. Shin (2003), "Testing for Unit Roots in Heterogeneous Panels", *Journal of Econometrics*, 115, 53-74.

Johansen, Soren (1991), "Estimation and Hypothesis Testing of Cointegration Vectors in Gaussian Vector Autoregressive Models," *Econometrica*, 59, 1551-1580.

Kneller, Richard, Michael F. Bleaney and Norman Gemmell (1999), "Fiscal Policy and Growth: Evidence from OECD Countries," *Journal of Public Economics*, 74, 171-190.

Koop, G., M.H. Pesaran and S.M. Potter (1996), "Impulse Response Analysis in Nonlinear Multivariate Models," *Journal of Econometrics*, 74, 119-147.

Kormendi, Roger and Phillip Meguire (1985), "Macroeconomic Determinants of Growth: Cross-Country Evidence," *Journal of Monetary Economics*, 16, 141-163.

Kumar, Manmohan and Jaejoon Woo (2010), "Public Debt and Growth," IMF Working Paper, no. 10/174.

Landau, D. (1983), "Government Expenditure and Economic Growth: a Cross-Country Study," *Southern Economic Journal*, 49, 783-792.

Levin, A., C.F. Lin and C. Chu (2002), "Unit Root Tests in Panel Data: Asymptotic and Finite-Sample Properties," *Journal of Econometrics*, 108, 1-24.

Levine R. and D. Renelt (1992), "A Sensitivity Analysis of Cross-Country Growth Regressions," American Economic Review, 82, 942-963.

Loizides, John and George Vamvoukas (2005), "Government Expenditure and Economic Growth: Evidence from Trivate Causality Testing," *Journal of Applied Economics*, VIII, 125-152.

Maddala, G.S. and S. Wu (1999), "A Comparative Study of Unit Root Tests with Panel Data and A New Simple Test," *Oxford Bulletin of Economics and Statistics*, 61, 631-652.

Nickell, Stephen, Luca Nunziata and Wolfgang Ochel (2005), "Unemployment in the OECD since the 1960s. What Do We Know?" *Economic Journal*, 115, 1-27.

Perotti, Roberto (2004), "Estimating the Effects of Fiscal Policy in OECD Countries," mimeo, IGIER.

Ram, Rati (1986), "Government Size and Economic Growth: A New Framework and Some Evidence from Cross-Section and Time-Series Data," *American Economic Review*, 76 (1), 191-203.

Ramey, Valerie A. and Matthew D. Shapiro (1997), "Costly Capital Reallocation and the Effects of Government Spending," *Carnegie Rochester Conference on Public Policy*.

Rao, V. V. Bhanoji (1989), "Government Size and Economic Growth: A New Framework and Some Evidence from Cross-Section and Time-Series Data: Comment," *American Economic Review*, 79, 272-280.

Reinhart, Carmen and Kenneth Rogoff (2010), "Growth in a Time of Debt," *American Economic Review*, 100, 573-578.

Rodrik, Dani (1998), "Why Do More Open Economies Have Bigger Governments?" *Journal of Political Economy*, 106(5), 997-1032.

Scully, G.W. (1989), "The Size of the State, Economic Growth and the Efficient Utilization of National Resources," *Public Choice*, 63, 149-64.

Tagkalakis, Athanasios (2006), "The Effects of Macroeconomic Policy Shocks on the UK Labour Market," *International Journal of Finance and Economics*, 11, 229-244.

Toda, Hiro Y. and Taku Yamamoto (1995), "Statistical Inference in Vector Autoregressions with Possibly Integrated Processes," *Journal of Econometrics*, 66, 225-250.

Wang, Siyan and Burton A. Abrams (2011), "The Effect of Government Size on the Steady-State Unemployment Rate: A Dynamic Perspective", working paper, University of Delaware.

Yamada, Hiroshi and Hiro Y. Toda (1998), "Inferences in Possibly Integrated Vector Autoregressive Models: Some Finite Sample Evidence," *Journal of Econometrics*, 86, 55-96.

Figure 1: Dynamic responses to a one-time unit shock to government outlays

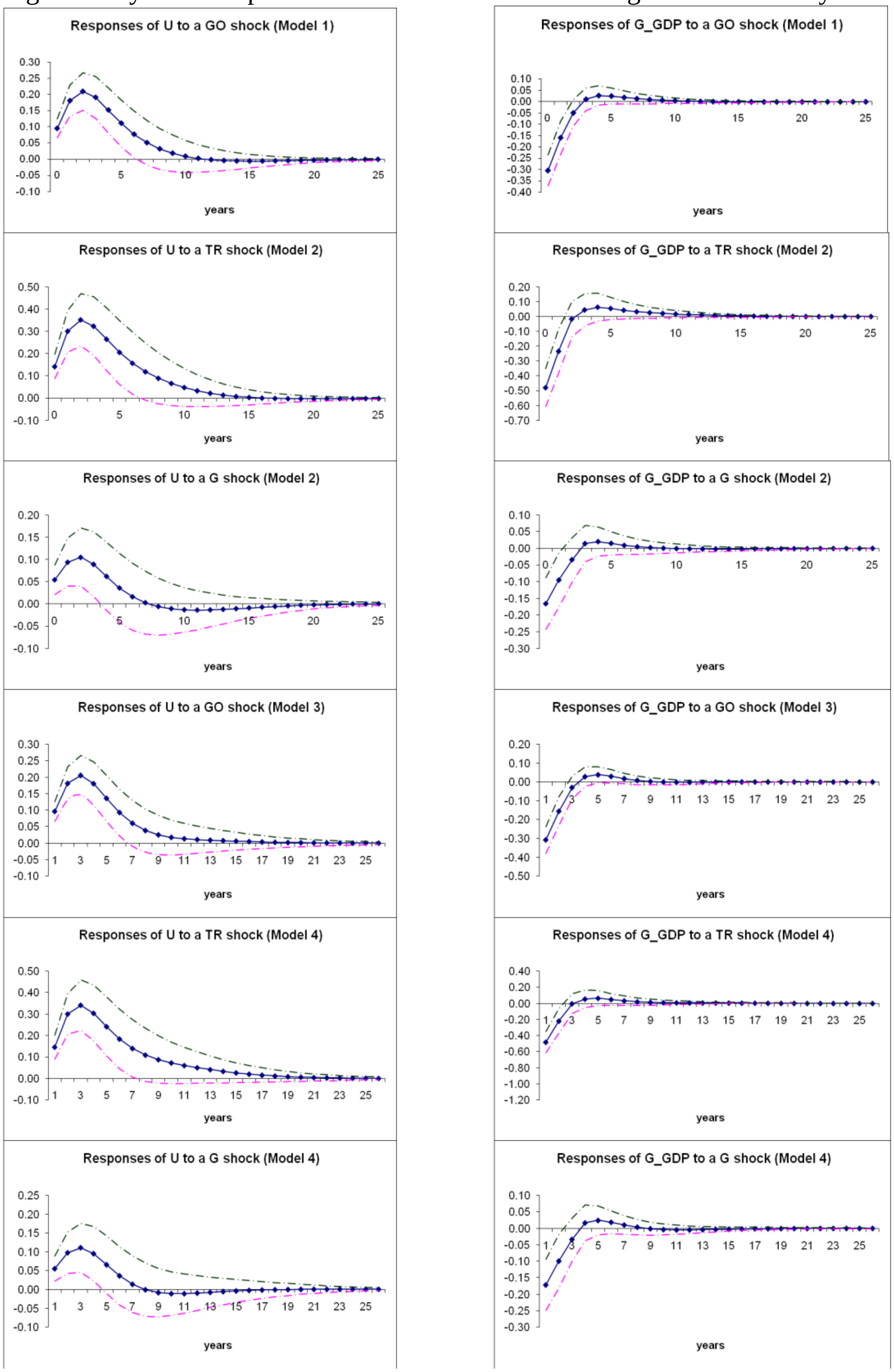

Table 1: Panel Unit Root Tests[a]

	GO	TR	G	TAX	TAX_NET	R	U	G_GDP	I
Levin, Lin & Chu	-3.66 (0.0001)	-4.38 (0.0000)	-2.08 (0.0187)	-3.83 (0.0001)	-1.30 (0.0976)	-0.59 (0.2773)	-2.65 (0.0041)	-9.53 (0.0000)	0.58 (0.7174)
Im, Pesaran & Shin	-3.01 (0.0013)	-3.45 (0.0003)	-1.15 (0.1248)	-1.53 (0.0634)	-2.81 (0.0025)	-2.05 (0.0201)	-0.92 (0.1787)	-11.17 (0.0000)	0.39 (0.6513)
Fisher - ADF	66.12 (0.0058)	69.41 (0.0027)	59.45 (0.0245)	47.53 (0.1928)	69.05 (0.0029)	59.48 (0.0243)	43.51 (0.3244)	200.75 (0.0000)	30.28 (0.8674)
Fisher - PP	64.07 (0.0092)	54.86 (0.0589)	51.79 (0.1002)	53.22 (0.0787)	50.82 (0.1173)	44.17 (0.2999)	28.89 (0.9037)	220.84 (0.0000)	28.00 (0.9234)

Notes: Numbers in parentheses are p-values.
[a] Lag orders used in tests are selected according to the Akaike Information criterion (AIC).

Table 2: Pair-wise Granger causality tests

Model 1	Dependent Variable				
	GO	R	U	G_GDP	I
GO	---	1.24	5.26*	16.32***	14.07***
R	20.82***	---	69.90***	77.39***	9.47***
U	.57	1.36	---	2.06	3.92
G_GDP	1.52	12.00***	39.07***	---	14.41***
I	.16	16.09***	4.64*	7.73**	---

Model 2	Dependent Variable					
	TR	G	R	U	G_GDP	I
TR	---	3.41	.42	5.43*	7.46**	6.38**
G	.87	---	1.85	2.24	13.17***	10.57***
R	11.83***	3.60	---	56.89***	68.92***	10.36***
U	.001	.19	1.72	---	1.94	3.97
G_GDP	2.12	.52	10.16***	33.97***	---	15.54***
I	.94	.78	14.97***	4.08	7.37**	---

Model 3	Dependent Variable					
	GO	TAX	R	U	G_GDP	I
GO	---	4.84*	1.22	4.19	16.12***	10.64***
TAX	1.32	---	2.65	.83	2.05	8.44**
R	14.20***	2.81	---	56.56***	60.87***	8.89**
U	.47	.25	1.61	---	2.19	4.63*
G_GDP	1.99	7.04**	12.85***	37.32***	---	11.83***
I	1.37	.50	23.42***	3.69	8.24**	---

Model 4	Dependent Variable						
	TR	G	TAX_NET	R	U	G_GDP	I
TR	---	1.63	3.78	1.80	3.16	6.87**	7.20**
G	1.74	---	5.41*	1.49	2.24	14.87***	8.51**
TAX_NET	5.64*	1.54	---	1.65	.15	1.73	11.55***
R	9.85***	3.99	12.25***	---	54.34***	61.56***	8.89**
U	.15	.29	.30	1.94	---	1.32	5.27*
G_GDP	1.66	.47	10.81***	10.61***	33.30***	---	13.77***
I	2.20	.40	1.69	18.84***	3.70	9.46***	---

Notes: The pair-wise Granger causality test has a limiting chi-squared distribution with 2 degrees of freedom. ***, **, * denotes statistical significance at the 1%, 5%, 10% level, respectively.

Table 3: Coefficient estimates on the exogenous variables

	Model 1		Model 2		Model 3		Model 4	
	U	G_GDP	U	G_GDP	U	G_GDP	U	G_GDP
MIN_WAGE	-.0004 (-0.11)	.002 (0.23)	.0002 (0.04)	.002 (0.24)	-.0006 (-0.15)	.005 (0.50)	.0001 (0.02)	.006 (0.57)
UNION	.014 (1.51)	-.001 (-0.06)	.013 (1.31)	-.007 (-0.31)	.016* (1.69)	-.002 (-0.09)	.013 (1.32)	-.012 (-0.53)
BENEFITS	.0003 (0.04)	.021 (1.01)	.002 (0.20)	.018 (0.82)	.001 (0.11)	.018 (0.83)	.002 (0.20)	.014 (0.63)
G_POP	-.002 (-0.40)	.009 (0.64)	-.001 (-0.19)	.009 (0.61)	-.002 (-0.38)	.007 (0.52)	-.001 (-0.22)	.010 (0.69)
OIL	-.130 (-1.03)	-.182 (-0.61)	-.109 (-0.79)	-.237 (-0.74)	-.095 (-0.71)	-.330 (-1.06)	-.104 (-0.74)	-.344 (-1.07)
FEMALE	-.009 (-0.34)	-.208*** (-3.10)	-.022 (-0.70)	-.206*** (-2.80)	-.018 (-0.60)	-.165** (-2.32)	-.023 (-0.72)	-.185** (-2.52)
OPEN	.515 (0.87)	2.409* (1.72)	.794 (1.28)	1.644 (1.14)	.524 (0.87)	2.321* (1.66)	.770 (1.24)	2.025 (1.41)

Notes: t-statistics are in parentheses. ***, **, * denotes statistical significance at the 1%, 5%, 10% level, respectively.