Taxes and the Labor Market*

Tommaso Monacelli[†] Roberto Perotti[‡] Antonella Trigari[§]

First version: October 6, 2010

Abstract

We estimate the effect of exogenous changes in taxes on the US unemployment rate and on several other labor market variables. Our estimates are based on a revised version of the Romer and Romer (2010) narrative record of exogenous tax innovations, with the additional benefit of distinguishing between capital income and labor income taxes. We first show that accounting for the difference between automatic and discretionary tax changes is crucial in order to obtain an unbiased measure of the tax multipliers. An increase in tax receipts of one percent of GDP has a sizeable positive impact on the unemployment rate, and a negative impact on hours worked, labor market tightness and job finding probability. The effect on GDP is also sizeable, but somewhat in the mid range of other values found in the literature, due to the fact that we account for the difference between discretionary and automatic changes in tax revenues. The effect on the unemployment rate of variations in business taxes is larger than that of personal income taxes. We suggest that the latter result poses interesting challenges for future research.

Keywords: Tax shocks, Tax multiplier, Taxation, Fiscal Policy.

JEL Classification Numbers: E62, H20, H60.

*This paper was produced as part of the project Growth and Sustainability Policies for Europe (GRASP), a Collaborative Project funded by the European Commission's Seventh Research Framework Programme, contract number 244725.

[†]IGIER, Università Bocconi and CEPR. Email: tommaso.monacelli@unibocconi.it. URL: http://www.igier.uni-bocconi.it/monacelli.

[‡]IGIER, Università Bocconi, CEPR and NBER. Email: roberto.perotti@unibocconi.it. URL: http://www.igier.uni-bocconi.it/perotti.

[§]IGIER, Università Bocconi. Email: antonella.trigari@unibocconi.it. URL: http://www.igier.uni-bocconi.it/trigari

1 Introduction

One of the defining features of the aftermath of the financial crisis of 2008-09 has been its persistent impact on the US labor market, with the unemployment rate roughly doubling from early 2008 through mid 2010 (see Figure 1). This has ignited an intense debate on the appropriate stimulus response of fiscal policy. This debate has revolved around two main issues: (i) the relative merits of higher government spending vs. tax cuts; (ii) the suitability of labor income vs. capital income tax cuts. In Monacelli, Perotti and Trigari (2010) we address part of the debate related to point (i). In that paper, however, we are mostly concerned with estimating the size of the unemployment multiplier of government spending. In this paper, we focus on the effects on the labor market of variations in taxes.

The idea that tax cuts are likely to be a more effective stimulus device than higher government spending is widespread in both the business and the academic community. This idea, however, often remains vague, for it typically does not distinguish between expansionary effects of tax cuts on GDP and its alleged, more specific, implications for the unemployment rate and the labor market as a whole. For instance, in a *Wall Street Journal* editorial on 29 January, 2009, Alberto Alesina and Luigi Zingales argue that "tax-cuts have a much better effect on job-creation than highway rehabilitation", but propositions of this sort remain so far virtually untested in the literature.

Advocates of measures geared towards a cut in capital income taxes have mainly proposed two types of interventions. First, a reduction in capital gains taxes. The idea underlying this proposal is that this recession is unique because it originates from credit markets, where investors are still reluctant to lend to risky firms. Hence a reduction in capital gains taxes would boost the willingness of investors to take risks.[1] Skeptics of this proposal, however, mostly doubt the effectiveness of variations in capital gains taxes specifically on job cre-

[1]This argument has been made, for instance, by Alesina and Zingales in the same *WSJ* editorial cited above.

ation. A second type of intervention that has been advocated is a reduction in depreciation allowances: firms that purchase new machines and other capital goods would be able to write them off immediately, instead of over many years.[2]

Some argue, however, that in a period of exceptionally low interest rates the latter measure is likely to have a limited impact, and insist on options mostly geared towards cuts in payroll taxes.[3] The argument is that a cut in payroll taxes would boost output and employment both by increasing demand for goods and services and by providing incentives for additional hiring; also, others have noted that firms are hoarding a large share of profits but still perceive the cost of labor being too high.[4]

Most of the recent debate on the alleged merits of tax cuts has revolved around whether or not extending the tax cuts enacted under President George W. Bush. Supporters of this measure observe that a failure to extend the cuts would imply an actual increase in taxes for the whole population by the end of 2010.[5]

According to the Congressional Budget Office, however, extending all of the Bush tax cuts would have a small "bang for the buck", the equivalent of a 10- to 40-cent increase in GDP for every dollar spent. The argument (a classic one) goes that the Bush tax cuts mostly go to higher-income households, who have a relatively low marginal propensity to consume.[6] Interestingly, of eleven potential stimulus policies the CBO recently examined, an extension

[2] See for instance the *Wall Street Journal* editorial by Glenn Hubbard, September 10, 2010.

[3] Congressional Budget Office (2010).

[4] See for instance Roubini (2010).

[5] For instance, Rep. McConnell reportedly said that "only in Washington could someone propose a tax hike as an antidote to a recession". Some Senate Democrats such as Kent Conrad of North Dakota, Evan Bayh of Indiana and Ben Nelson of Nebraska are also arguing "against raising taxes on anyone during a fragile economic recovery" (Gale and Harris (2010)).

As another example, Bill Rys, tax counsel for the National Federation of Independent Business, a small-business group, has argued that "[t]he best thing to do is to get rid of uncertainty, and that includes the cliff we're falling off with all these [tax] provisions that are expiring," (Weisman and McKinnon 2010).

[6] In work in progress, Monacelli and Perotti (2010) explore (both empirically and theoretically) precisely the issue of whether "pro-poor" tax cuts (i.e., tax cuts favoring households in the lower brackets of the income distribution) are more expansionary than tax cuts that redistribute in favor of the "rich".

of all of the Bush tax cuts seems to imply the lowest stimulus per dollar spent.[7] Therefore, some argue that the government could more effectively stimulate the economy by letting the high-income tax cuts expire and use those savings for a combination of a job-creation tax credit and continued state fiscal assistance that would allegedly generate "three times as much additional economic activity as using them to extend the high-income tax cuts" (Gale 2010, Marr 2010). Taking the CBO estimates literally, each of these measures is "estimated" to have roughly about three times the impact on GDP as continuing the Bush tax cuts.[8]

Different views about the possibility of extending the tax cuts also depend on the perceived tradeoff between stimulus today and sustainability tomorrow. As reported by Gale and Harris (2010), former Obama administration budget director Peter Orszag recently endorsed extending the Bush tax cuts for both middle-income taxpayers and the wealthy, but only for two years: temporary extension of the tax cuts "would keep the economy humming during the recovery", but a more permanent extension of the tax cuts—even if limited to middle-income households—"is simply unaffordable because of the impact on the deficit". Alan Greenspan, former chairman of the Federal Reserve, called an extension of the Bush tax cuts without corresponding spending reductions "disastrous".[9]

These quotations do only partial justice to the complex ramifications of the current debate on the appropriate size and composition of the response of fiscal policy to the Great Recession. That debate, however, almost invariably relies on rather unstructured empirical evidence on the effects of tax changes on the macroeconomy, let alone on the labor market. As an illustration, CBO (2010) reports that "low and high estimates of multipliers for a given policy were chosen, on a *judgmental* basis, to encompass most economists' views about the effects of that type of policy".

[7]See CBO (2010), Table 1.
[8]See CBO (2010), Table 1.
[9]See Gale and Harris (2010).

In this paper we study the effect of exogenous variations in taxes on the US unemployment rate and on several other labor market variables. Our estimates are based on a revised version of the Romer and Romer (2010) narrative record of exogenous tax innovations. There are two main differences in our data set relative to that of Romer and Romer: first, while they use data on tax *liabilities*, we track the quarterly exogenous changes in *receipts* generated by each tax bill; second, we distinguish between different types of taxes: personal, corporate, indirect, social security, and several subcomponents of each of these.[10] Using this disaggregation, in this paper we begin to address some of the policy issues quoted above, although not yet at the level of detail that one might like: for instance, there is not enough variation in the post-war time series to address issues like the relative merits of capital gains taxation vs. employment tax credits.

Our results are based also on a different empirical methodology from that used by Romer and Romer: in fact, we show that accounting for the difference between automatic and discretionary tax changes is crucial to obtain an unbiased measure of the effects of tax changes. By doing so, we find estimates of the effects of tax shocks that are typically in between the extremely large effects estimated by Romer and Romer, and the much smaller (and often statistically insignificant) effects estimated by Favero and Giavazzi (2010).

We obtain the following main results. First, an increase in tax liabilities of one percent of GDP has a sizeable negative impact on GDP, the unemployment rate, hours worked, employment, labor market tightness and the job finding probability. For instance, under our preferred empirical specification, the unemployment rate falls -after six quarters- by .53 percentage points and GDP falls .92 percent. Second, we find that the data set matters. When we employ exactly the original Romer and Romer (2010) specification but with our data set, the size of virtually all estimated multipliers decline substantially in absolute value.

[10] See Perotti (2010a) for more details.

Third, we find that the multiplier on private investment is particularly large and persistent, with investment contracting by almost 4 percent after six quarters and 3.88 percent after 12 quarters. Fourth, the effect on GDP and labor market variables of shocks to taxes on *business* is typically larger than the effect of shocks to *labor income* taxes. We also show that a shock to taxes on business has a larger negative effect on private employment. In the conclusions we discuss some of the possible theoretical implications of this result.

The outline of the paper is as follows. In the next section we present our estimation methodology. Section 3 briefly discusses the data. Section 4 presents the main results. In section 5, we show the effects of the main types of taxes. Section 6 studies the robustness of our results in different subsamples. Section 7 concludes.

2 Estimates of discretionary taxation

In this section we introduce our methodology to estimate the effects of discretionary taxation.[11]

2.1 Romer and Romer (2010) and Favero and Giavazzi (2010)

Romer and Romer (2010) (R-R henceforth), estimate an equation of the type:

$$y_t = a(L)\tau_t + \varepsilon_t \tag{1}$$

where τ_t is a measure of tax shocks constructed by R-R based on the original documentation accompanying tax bills, and $a(L)$ is a lag polynomial of order J (in R-R, $J = 13$, i.e., $a(L)$ includes powers 0 to 12 of the lag operator L). For future reference, we call this the "R-R one

[11]See again Perotti (2010a) for more details on the methodology. Chahrour, Schmitt-Grohe and Uribe (2010) use a DGSE model to compare a SVAR-based identification strategy of tax shocks to one based on narrative records. They conclude that the different tax multipliers obtained from the SVAR and narrative approaches do not depend on differences in the transmission mechanism, but rather on either a failure to identify the same tax shock or to small sample uncertainty.

equation specification". R-R typically find that, in response to a tax shock of 1 percentage point of GDP, output declines by up to three percent within three years. These effects have appeared to many as implausibly large.

In fact, Favero and Giavazzi (2010) (F-G henceforth) argue that these results are due to an erroneous specification of the regression to be estimated. They argue that equation (1) cannot be derived from the correct truncated MA representation of any underlying VAR. Let the vector $\widetilde{X}_t$ include n endogenous variables of interest, say output y_t, government spending g_t, the interest rate i_t, government revenues s_t, and a labor market variable such as the unemployment rate; one should then treat the R-R tax shocks as exogenous variables in a reduced form VAR in $\widetilde{X}_t$. Formally this corresponds to the following model:

$$\widetilde{X}_t = B(L)\widetilde{X}_{t-1} + \Gamma\tau_t + \widetilde{u}_t, \tag{2}$$

where $B(L)$ is a lag polynomial of order 4, Γ is a $(n \times 1)$ vector and $\widetilde{u}_t$ is a vector of reduced form residuals. F-G estimate (2) by OLS, and argue that the correct impulse responses are obtained by simply tracing the dynamic effects of a shock to τ_t of one percentage point of GDP. For future reference, we call the one in equation (2) the "OLS F-G specification".

Notice that if one is interested only in the effects of the R-R tax shocks, there is no need to go beyond this reduced form specification, provided the two identifying assumptions of R-R are satisfied: (i) τ_t is orthogonal to $\widetilde{u}_t$, and (ii) τ_t is unpredictable using lagged variables in the information set of the econometrician. F-G find that a one percentage point of GDP realization of τ_t causes a decline in output by less than one percent, and often insignificant.

The correct truncated MA representation of (2) is:

$$\widetilde{X}_t = C(L)\tau_t + D(L)\widetilde{X}_{t-J} + \widetilde{\eta}_t \tag{3}$$

where $C(L)$ is a lag polynomial of order J, $D(L)$ is of the same order as $B(L)$, and $\widetilde{\eta}_t$ is a moving average of $\widetilde{u}_t$. A comparison of (1) with the first row of (3) shows that R-R's equation (1) does not correspond to the first equation of the truncated MA representation of the original VAR, because R-R omit the lagged values of the endogenous variables.[12]

2.2 Discretionary and automatic tax changes

Perotti (2010a) argues that the specification adopted by F-G is also incorrect if one wants to capture the dynamic effects of the R-R tax shocks. The reason is that changes in tax revenues are the combination of *discretionary* changes to taxation, which reflect intentional actions of the policymakers like changes in tax rates, depreciation allowances, deductions, etc., and *automatic* changes to revenues, which reflect the effects of output, inflation etc. on tax revenues, for given tax rates.

Let therefore tax revenues be given by the following expression:

$$s_t = \underbrace{\tau_t}_{\text{discretionary}} + \underbrace{\Phi X_t + \mu_t}_{\text{automatic}} \tag{4}$$

where τ_t (the R-R tax shocks) captures the changes in discretionary taxation, X_t is a vector of endogenous variables that includes the same variables as $\widetilde{X}_t$, except s_t, and Φ is a $(1 \times (n-1))$ vector of coefficients. For simplicity, we will refer to the term $\Phi X_t + \mu_t$ as the "automatic" component of tax changes.

Perotti (2010a) argues that the discretionary and the automatic components of changes in tax revenues are likely to have different effects on output. One can think of at least two reasons for this. First, discretionary changes are more distortionary, because they consist of changes in both tax rates and tax rules. Second, discretionary tax changes are likely to be more persistent. In order to see this, suppose discretionary taxation is defined with reference to trend or potential output, so that deviations of output from the reference level sum to zero

[12] R-R also estimate a version of (1) that includes lags 1 to 4 of y_t, but this does not address the criticism raised by F-G.

over the cycle. In this case, if agents are not liquidity constrained, the automatic component of taxation should have no effect on the agents' behavior, because neither tax rates nor the present value of tax payments change.[13]

In light of this distinction, the correct specification of the model is not (2), but (4) combined with the VAR:

$$X_t = B(L)X_{t-1} + C(L)\tau_t + D(L)(s_t - \tau_t) + u_t \tag{5}$$

where $D(L)$ is a lag polynomial of order 5. Combining (4) and (5) one obtains:

$$(I - D_0\Phi)X_t = \ [B(L) + \Phi D'(L)]\, X_{t-1} + C(L)\tau_t + D(L)\mu_t + u_t \tag{6}$$

where D_0 is the vector of coefficients of $D(L)$ when $L = 0$ and $D'(L)$ is a lag polynomial of order 4 defined as $D(L) - D_0$.

Rearranging, (6) yields:

$$X_t = F(L)X_{t-1} + G(L)\tau_t + H(L)\mu_t + v_t \tag{7}$$

where $F(L) \equiv (I - D_0\Phi)^{-1} [B(L) + \Phi D'(L)]$, $G(L) \equiv (I - D_0\Phi)^{-1}C(L)$, $H(L) = (I - D_0\Phi)^{-1}D(L)$, and $v_t \equiv (I - D_0\Phi)^{-1}u_t$.

Mertens and Ravn (2010) (M-R henceforth) perform an OLS regression of X_t on its lags and on τ_t and its lags, therefore treating the term $H(L)\mu_t + v_t$ in (7) as the error term. We will refer to the one in (7) as the *OLS M-R specification*.

However, the OLS M-R approach gives biased estimates because μ_{t-i} is likely to be correlated with X_{t-i}. The solution is to take μ_t and its lags out of the error term and include them explicitly as regressors in (7). This can be done by an instrumental variable estimation

[13] One could argue that a purely cyclical source of changes in revenues could matter if individuals are moved into different tax brackets, so that the average marginal income tax rate changes. This effect is however likely to be second order.

of (4), which allows one to recover an estimate of μ_t.[14] The natural instruments for the variables in X_t in (4) are lags of X_t and lags of τ_t. We call this the *IV M-R specification*.

As we will see, IV and OLS M-R estimates are similar, and both display much stronger effects on all endogenous variables than the OLS F-G specification. We now show that both these observations are relatively easy to explain in our context.

To see why the F-G specification is likely to lead to attenuated estimates of the effects of a tax shock, use (7) to replace the vector X_t in (4). This gives:

$$s_t = \Phi F(L)X_{t-1} + (1 + \Phi G(L))\tau_t + (1 + \Phi H(L))\mu_t + \Phi v_t \tag{8}$$

Staking (7) and (8), and collapsing the polynomials in μ_t and the terms in v_t in the error terms of each equation of the resulting system, it is easy to see that one can "almost" reproduce the F-G reduced form specification (2), except that the lags of s_t in the latter are replaced in (8) by lags of τ_t.

Consider therefore an OLS estimation of the F-G specification (2), when the true model is given by the (7) and (8). There are two sources of bias in the OLS F-G approach. The first is the same as in the OLS M-R approach: the lags of μ_t are likely to be correlated with the lags of X_t. The second source of bias stems from the inclusion of lags of s_t instead of lags of τ_t. The difference between s_{t-i} and τ_{t-i} has two components. The first is ΦX_{t-i}, which gets incorporated in the polynomial $\Phi F(L)X_{t-1}$ on the right hand side of (8) and does not cause any harm; the second component, μ_{t-i}, introduces a classic error in variable problem. As it is well known, error in variables typically biases estimated coefficients towards zero. The solution to both problems consists once again in taking μ_t and its lags out of the error term, generating the IV F-G estimates. In fact, it can be shown that, if one used exactly the same instruments to estimate (4), the IV F-G and IV M-R estimates are numerically

[14] To do so, one needs a third identifying assumption, in addition to the RR assumptions: v_t should be uncorrelated with current and past values of μ_t.

identical.

To see why the OLS M-R and IV M-R estimates are very close to each other, note that when $D(L) = 0$ in (5), so that automatic tax changes have no effects, OLS M-R responses are consistent because lagged values of μ_t do not appear in the error term. Thus, the fact that OLS M-R and IV M-R responses are close is an indication that the effects of automatic tax changes are negligible.

Note that OLS F-G responses continue to be inconsistent, because it remains true that this specification has lags of s_t instead of τ_t. If instead $D(L) = C(L)$, so that the two components of tax changes have the same effects, OLS F-G responses are consistent, because s_t is the right variable to have in the system. The intuition is clear: in this case, there is no need to decompose lags of s_t into the discretionary and the automatic components.

2.3 Back to Romer and Romer

We have seen that the original R-R approach, as exemplified by equation (1), has problems in small samples because it omits some terms of the truncated MA representation. F-G's version of the truncated MA representation, equation (3), includes these terms but has the problem that it does not allow for different effects of the discretionary and automatic components of tax changes. The correct truncated MA representation can be derived from (7) and takes the form:

$$X_t = V(L)\tau_t + W(L)X_{t-J} + \eta_t \tag{9}$$

where $V(L)$ is a lag polynomial of order J, $W(L)$ is of the same order as $B(L)$, and η_t is a moving average of μ_t and v_t. Henceforth we call this the *OLS augmented R-R specification.* Note the difference with (3), which includes s_t among the endogenous variables, while (9) does not.

Once again, an OLS estimate of (9) generates biased impulse responses because of the correlation between lags of μ_t in the error term and lags of X_t. The solution, as usual, is to take lags of μ_t out of the error term; we denote the resulting specification the *IV augmented R-R specification.*

3 The data

Perotti (2010a) presents a new set of data that extends the R-R data in several dimensions. That paper provides full details on the construction of the data; here we summarize the main points. First, the aggregate tax shocks are divided into *four* main categories: (i) personal, (ii) corporate, (iii) social security, and (iv) indirect taxes, as well as several subcategories. We exploit this disaggregation in section 5.

Second, unlike R-R, who collect data on liabilities, Perotti (2010a) collects data on both receipts and liabilities, whenever the distinction is made in the sources. In this paper, we use receipts.

Third, R-R typically report the effect of a tax legislation as the first full year effect of liabilities after enactment, and attribute that number to the quarter of enactment. But there are cases where a tax legislation manifests its effects gradually over several quarters. For instance, accelerated depreciation typically causes a large change in the time profile of receipts, but a small change in their present discounted value: receipts decline initially but increase later. Using the first full-year effect would therefore provide a distorted picture of the effects of the tax measure. Whenever possible, Perotti (2010a) follows the effects of tax legislation over time.

Fourth, while R-R attribute all the effects of retroactive changes to the first quarter of enactment, Perotti (2010a) keeps track of the effects of retroactive measures over time. This can make a considerable difference, particularly in the case of corporations.

4 Estimates

In this section we present the results of our empirical analysis, based on a battery of alternative specifications and decompositions of the data set.

4.1 Specifications

To summarize the discussion of the previous section, we estimate the following specifications:

Romer -Romer (R-R) one equation specification:

$$z_t = a(L)\tau_t + \varepsilon_t \tag{10}$$

where $a(L)$ is of order 13 and z_t is the variable of interest.

Augmented Romer-Romer (R-R) specification

$$X_t = A(L)\tau_t + B(L)X_{t-13} + \varepsilon_t \tag{11}$$

where $A(L)$ is of order 13 and $B(L)$ of order 4. The vector X_t includes the log change of real per capita output y_t, the log change of real primary government spending per capita, g_t, the first difference of the interest rate Δi_t, and the first difference of a labor market variable, each considered in turn (see more below). As suggested above, this is a multidimensional extension of the original R-R one-equation regression, with the addition of lags 13 to 16 of the endogenous variables, as it should be if the MA representation is truncated correctly.

Favero-Giavazzi (F-G) specification

$$\widetilde{X}_t = \alpha\tau_t + B(L)\widetilde{X}_{t-1} + \varepsilon_t \tag{12}$$

with $B(L)$ of order 4.

Mertens-Ravn (M-R) specification

$$X_t = A(L)\tau_t + B(L)X_{t-1} + \varepsilon_t \tag{13}$$

where $A(L)$ and $B(L)$ are of order 5 and 4, respectively.

All specifications described above also include a constant. To maximize comparability with Romer and Romer (2010), in the baseline case we estimate all these specifications in first differences. All these specifications, except the R-R one equation specification, are estimated by both OLS and IV, as discussed above. In the latter case, the set of regressors includes also the moving average (lags 0 to 4) of the series μ_t obtained by IV estimation of (4), using as instruments lags 1 to 4 of the variables included in the vector X_t, and lags 0 to 4 of τ_t.[15]

In all cases the initial shock is a realization of the R-R tax shock of 1 percentage point of GDP. We report both 68 percent confidence bands, that have been used extensively in the recent empirical fiscal policy literature, and the more traditional 95 percent confidence bands.[16] Standard errors are obtained by bootstrapping with 1000 replications. We display both the point estimates of the impulse responses and the median response of the replications. In most cases, the two impulse responses are indistinguishable in the figures.

Sample The sample of Perotti (2010a)'s data on τ_t is 1945:1 - 2009:4 (the sample of R-R data is 1947:1 - 2006:2). The other constraints on the sample are the series on the log change in GDP, government spending, and revenues per capita, that start in 1948:2 and end in 2009:4.[17] With four lags of the endogenous variables as instruments, the estimated series

[15] In the case of the F-G specification, the set of instruments includes also lags 1 to 4 of s_t and only lag 0 of τ_t.

[16] In their original work, R-R mostly display 68 percent confidence bands.

[17] The NIA income account data on the levels of these variables start in 1947:1, but in the FRED dataset the data on population starts in 1948:1. The series on the interest rate starts in 1947:1 and ends in 2007:1. This series is defined as the average cost servicing the debt, and it is constructed by Favero and Giavazzi (2010) by dividing net interest payments at time t by the federal government debt held by the public at time $t-1$.

μ_t starts in 1949:2; and since at least four lags of the endogenous variables appear in each specification, the earliest starting date of an IV estimate is 1950:2.

Labor market variables We consider the following labor market variables: the *unemployment rate*, the log of *unemployment*, and the log of the *labor force* (the latter two variables divided by population)[18]; the *job finding probability*, labor market *tightness* (the ratio of vacancies to unemployment), the log of *vacancies* (as a share of the population), and the *separation rate*; the log of *employment* and *hours* in the private sector and in manufacturing, all as shares of the population;[19] the log of the *real product wage* in manufacturing and in the business sector;[20] and the *markup* in manufacturing and in the non financial business sector.

4.2 Results

Below we illustrate our empirical results for the alternative methodologies described above.

Favero-Giavazzi OLS specification Figure 2 displays responses from an OLS F-G specification. GDP, private consumption and private investment all decline, but by much less than estimated by R-R: for instance, GDP declines by a mere .3 percent. In addition, the standard errors are large: only the consumption response is significant, whereas the responses of GDP and investment are insignificant even at the 68 percent level. All labor market variables also move very little, and never significantly at the 95 percent level of confidence. Unemployment and the unemployment rate increase by very small amounts, .20 percentage points and .25 percent at the peak, respectively, and barely significant at the 68 percent level. Tightness and vacancies decline, by about 8 and 4 percent at peak,

[18] Here and in what follows, "population" stands for "population age 16 and above".

[19] Total employment and civilian employment behave almost exactly like private employment, and the same for hours.

[20] These are obtained by dividing the nominal wages by the producer price index.

respectively. As we have already argued above, if indeed the discretionary and automatic components of fiscal policy have different effects, an attenuated response to a discretionary tax shock is what we should expect.

Mertens-Ravn IV specification Figure 3 displays responses from the IV M-R specification. The responses are now much stronger, and the standard errors bands tighter. GDP falls by 1.2 percent after 6 quarters, less than half the decline estimated by R-R, but still much more than the F-G estimate; private consumption falls by 1 percent (about .7 percentage points of GDP), again in between the R-R and F-G estimates. For both variables, the IV M-R response is significant at the 95 percent level. Private investment also declines, but the response is significant only at the trough of 3 percent after 3 quarters.

Qualitatively, all labor market variables move in a direction which is economically meaningful.[21] In virtually all cases the responses are significant at the 95 percent level, usually after a few quarters. The unemployment rate increases gradually, reaching a peak of about .6 percentage points after 6 quarters, and then stabilizes at that level. The next two panels of the first row show that most of the action comes from the increase in unemployment, but there is also a decline of the labor force participation by about .2 percent , although significant only at the 68 percent level.

The job finding probability falls gradually, reaching a minimum of about three percentage points after 2 years. Similarly, labor market tightness falls gradually by more than 20 percent after 2 years. This decline is due in almost equal measure to a decrease in vacancies and to an increase in unemployment (see the second panel of the first row and the third panel of the second row). The separation rate increases by about .15 percentage point after one year.

The third row displays the responses of private and manufacturing employment and

[21] We do not employ a formal theoretical model in this version of the paper, but these results are all qualitatively consistent with a benchmark RBC model with search and matching frictions in the labor market, like the in Monacelli, Perotti and Trigari . (2010), which we use to study the effects of government spending. See more below on this point.

hours. Hours decline, by about 1.5 percent in the private sector and by about 1 percent in manufacturing after 6 quarters; both are significant at the 95 percent. Virtually all the response of hours is due to the extensive margin: employment tracks hours almost exactly. Finally, the real wage and the markup in manufacturing and in the business sector (last row) move little, and the standard errors tend to be large.

The OLS estimates of all these responses obtained under the Mertens and Ravn specification (not shown) are very similar to the IV estimates displayed here; as discussed above, this is consistent with the effect of the automatic component of tax changes, captured by $D(L)$, being small. In contrast, the IV responses of the Favero-Giavazzi specification (also not shown)[22] are very different from the corresponding OLS responses displayed in Figure 2: this is consistent with a large difference between the effects of the discretionary and of the automatic components of tax changes.

Romer and Romer augmented MA specification As a comparison, it is interesting to display the responses of the *augmented* OLS R-R MA specification (see Figure 4). As we have seen, this is a multidimensional extension of the original R-R one-equation regression. The responses are often slightly stronger than the IV M-R responses, and the standard errors bands tighter. In particular, unemployment increases more, and hours, employment and GDP decline more. There is also more evidence of an increase in the product wage, particularly in manufacturing, where it rises by 2 percent after 2 years, and significant at 95 percent level. These results are consistent with Perotti (2010a), who shows that IV M-R responses of output are often in between the large responses estimated by R-R (though with a single equation approach rather than an augmented R-R specification as here) and the small responses estimated by F-G.

[22] As discussed above, IV F-G responses are very similar to IV M-R responses, and numerically identical if the same instruments are used to estimate equation (4).

Multipliers Table 1 summarizes the main results in terms of "tax multipliers". It displays the (point estimates of the) impulse responses of the main variables of interest, respectively at 6 and 12 quarters, for the three alternative methodologies: OLS F-G, IV M-R, and OLS R-R augmented MA. In addition, in the first two rows we also display responses from the one equation R-R specification, estimated with the original R-R data and with our data. Recall that the underlying tax shock is normalized to 1 percent point of GDP.

Four observations stand out. First, the R-R one equation specification does deliver much stronger responses. In the first row, where we use the original R-R data on the tax shocks, the unemployment effect at 12 quarters is 1.10, the GDP effect -2.74 (as in Romer and Romer (2010)), and the investment effect an impressive -9.69 percent. These numbers are about 2 to 3 times larger than the IV M-R effects.

Second, the tax data do make a difference: in the second row, where we use our own estimates of the tax shocks, the effects on virtually all variables decline in absolute value, although they usually remain larger than in the IV M-R specification. From now on, the results we report use our estimates of the tax shocks.

Third, the augmented R-R specification (the multivariate extension of the one equation R-R specification) still tends to deliver higher estimates of the unemployment and the GDP effects than the IV M-R specification. In contrast, and as we discussed, the F-G specification features much smaller and often insignificant multipliers. Under our preferred specification (IV M-R), the unemployment rate rises by .54 percentage points after 6 quarters, whereas GDP falls by .93 percent; the responses at 12 quarters are almost identical. Noticeably, both the unemployment and the GDP multipliers estimated under the IV M-R specification are a bit smaller than the corresponding multipliers of government spending that we estimated in Monacelli, Perotti and Trigari (2010). An issue in order, however, concerns the sub-sample stability of the government spending multipliers (both on GDP and unemployment), which, in the estimates of Monacelli, Perotti and Trigari (2010), fall substantially after 1980. Thus below we investigate also the sub-sample stability of the tax multipliers.

Fourth, the investment multiplier is sizeable, both in the IV M-R and in the augmented R-R specifications (after 6 quarters, -3.88 percent and -2.93 percent respectively, although in the latter case it is estimated rather imprecisely). Once again, and at both horizons, the effect on investment under the F-G specification is smaller and not statistically significant.

Table 1: **Tax Multipliers under Alternative Specifications**

	6 qrts	*12 qrts*	*6 qrts*	*12 qrts*	*6 qrts*	*12 qrts*
	unemployment rate		job finding prob.		private employment	
OLS R-R one eq. (R-R data)	.32*	1.10*	-1.98*	-4.76*	-.44*	-2.07*
OLS R-R one eq. (our data)	.32**	.77**	-.99**	-2.77*	-.76*	-1.72*
OLS augmented R-R	.71**	.82**	-2.37**	-1.78**	-1.24**	-1.58**
OLS F-G	.15*	.11	-.15	-.21	-.17	-.15
IV M-R	.54**	.56**	-2.36*	-2.65**	-.93*	-1.06**
	business wage		private investment		GDP	
OLS R-R one eq. (R-R data)	-.58*	-.51*	-3.56*	-9.69*	-1.17**	-2.74**
OLS R-R one eq. (our data)	.22*	.39*	-.71*	-2.99**	-.76**	-1.68**
OLS augmented R-R	.45*	.57*	-4.08*	-2.93	-1.31**	-1.53**
OLS F-G	.07	.07	-1.19	-1.33	-.23	-.16
IV M-R	.27	.16	-4.00*	-3.88*	-1.20**	-1.12**

Note: * denotes 32% significance level, ** denotes 5% significance level. See Section 4.1 for the details of the alternative specifications.

5 Labor and corporate income taxes

One benefit of the dataset we use is that it allows us to distinguish between different types of taxes. Table 2 lists the four main categories of taxes and their subcategories. The sum of all these items is the aggregate taxes that have been used so far.

We now re-group taxes into three main categories: (i) *Labor income* taxes; (ii) *Business taxes I*; (iii) *Business taxes II*. Labor income taxes include personal income taxes, except for

Table 2: **Breakdown of taxes**

	Personal	**Corporate**	**Indirect**	**Soc. Sec.**
1.	Tax rates	Tax rates	Indirect taxes	Tax rates
2.	Deductions. allowances	Employment credit		Earnings base
3.	Tax credits	Investment tax credit		Others
4.	Capital gains	Depreciation		
5.	Depreciation	Others		
6.	Earned Income Tax Credit			
7.	Rebates			
8.	Estate and gift			
9.	Others			

items 4 and 5 (capital gains taxes and depreciation allowances), and social security taxes. Business taxes I include corporate income taxes and items 4 and 5 of personal income taxes; Business taxes II also includes indirect taxes. We summarize our categories in Table 3 below.

Table 3: **Labor and business taxes**

Labor income taxes	**Business taxes I**	**Business taxes II**
Personal income	Corporate income	Corporate income
Social security	Capital gains, personal	Capital gains, personal
	Depreciation, personal	Depreciation, personal
		Indirect taxes

Figure 5 displays the results. We only display the responses of the main variables: for instance, we have seen that the impulse responses of tightness and of vacancies track the response of the job finding probability very closely, hence we only display the latter. The effects of labor income taxes are virtually identical to those of all taxes combined. In contrast, the effects of the two types of business taxes are stronger, particularly under the second definition; the first definition tracks the second one closely in the first year, but then returns to the stochastic trend more quickly.

Under the second definition, a shock to business taxes raises the unemployment rate by almost twice as much as a shock to labor income taxes of the same size; similarly, it causes a decline in the job finding probability, employment in the private sector, GDP and private investment by twice as much or more.

Figures 6 and 7 display the responses to shocks to labor income taxes and to the second definition of business taxes, respectively, now including their 68 and 95 percent standard error bands. The figures display also the responses to shocks to total taxes (the broken line). As we have seen, the responses to labor income taxes differ minimally from the responses to total taxes, and the standard errors are only slightly larger. Standard errors are larger in the case of business taxes. Except for GDP, the responses are now significant only at the 68 percent level; and they are significantly different from the responses to total taxes at the same level of confidence.

6 Subsamples

Several papers find that the government spending multiplier from a SVAR à la Blanchard and Perotti (2002) seems to have strongly declined from the first part of the postwar sample to the second part: see, e.g., Perotti (2002), Perotti (2007), and Bilbiie, Meier and Müller (2008). In addition, Perotti (2010b) finds that the results on the defense spending multiplier in Barro and Redlick (2009), Hall (2009), and Ramey (2010) are heavily influenced by just a few quarters during the Korean War.

Figure 8 displays responses to total taxes from the whole sample and from two subsamples: 1945:1-1975:4 and 1976:1-2009:4. We do find evidence that the responses of all variables are considerably stronger in the first part of the post war period (excluding the Korean war has a very limited effect on these responses). However, the responses in the second part of the sample, 1976:1 to 2009:4, are still large, and very similar to those of the whole sample. In both subsamples the responses (except for the real wage in the business sector) remain significant at the 95 percent level.

Overall, the above results point to a greater sub-sample stability of tax multipliers relative to government spending multipliers. This issue raises interesting theoretical points. For instance, some have suggested that the decline of the government spending multipliers might be explained by the gradually deeper integration of financial markets from the early 1980s on.[23] The argument goes that greater ability to smooth consumption reduces, on average, the share of agents that are liquidity constrained (or, to an extreme, that consume "hand-to-mouth"). The same line of reasoning, however, should apply to the effects of taxes, but still we do not observe, according to our results, that tax multipliers have significantly declined in the later sample (or at least much less than corresponding government spending multipliers).

7 Conclusions

We have investigated the effects of exogenous variations in taxes on a series of macroeconomic variables, with special emphasis on the unemployment rate and the labor market. Our analysis differs from the Romer and Romer (2010) seminal contribution in three main respects: first, in extending their data set of narrative records of exogenous tax innovations; second, in showing that methodological assumptions on both the specification and the estimation of the empirical model are crucial to quantify the size of the tax multipliers; third, in devoting special attention to the labor market implications of the changes in taxes.

We have shown that an increase in tax receipts of one percent of GDP has a sizeable positive impact on the unemployment rate, and a negative impact on hours worked, labor market tightness and job finding probability. The negative effect on GDP is also sizeable, but somewhat in the mid range of other values found in the literature. We have shown that this depends on a series of methodological details, involving both the econometric specification and the estimation method. We have also shown that the unemployment multiplier of business taxes is larger than the one of personal income taxes, although the former is

[23] See, e.g., Perotti (2007), Bilbie et al. (2008).

estimated a bit more imprecisely than the latter.

Obtaining larger unemployment multipliers from business taxes than from personal income taxes poses a series of interesting theoretical challenges. In Monacelli et al. (2010) we build an RBC model with search and matching frictions to analyze the effects of variations in government purchases. In that model we clarify that changes in government spending affect the hiring rate via variations in the value of non-work relative to work activity, which in turn affects the surplus from the job matching process. Importantly, the relative value of non-work activity captures not only the marginal value of leisure, but broadly the value of all non-market activities, including home production and unemployment benefits.

One can employ the same model to analyze the labor market effects of exogenous changes in distortionary taxes. Similarly, variations in labor income taxes would affect the hiring rate via their effect on the relative value of non-work activity. However, if frictions in the labor market are needed to generate equilibrium unemployment fluctuations, variations in labor income taxes are likely to always generate more sizeable effects than variations in capital income taxes. Obtaining the opposite result may therefore be an interesting goal for future research.

References

[1] Alesina Alberto and Luigi Zingales (2009), "Let's Stimulate Private Risk Taking", *Wall Street Journal* (January 21).

[2] Barro, Robert, and Charles Redlick (2009). "Macroeconomic Effects from Government Purchases and Taxes", NBER Working Paper No. 15369, September.

[3] Bilbiie, Florin, André Meier, and Gernot J. Müller (2008): "What Accounts for the Changes in U.S. Fiscal Policy Transmission?," *Journal of Money, Credit and Banking*, Blackwell Publishing, vol. 40(7), pages 1439-1470, October;

[4] Blanchard, Olivier J. and Roberto Perotti (2002): "An Empirical Investigation of the Dynamic Effects of Government Spending and Taxes on Output", *Quarterly Journal of Economics*, 117(4), 1329-1368.

[5] Congessional Budget Office (2010), "Policies for Increasing Economic Growth and Employment in 2010 and 2011".

[6] Favero, Carlo and Francesco Giavazzi (2010): "Reconciling VAR-based and Narrative Measures of the Tax Multiplier", mimeo, IGIER - Università Bocconi.

[7] Gale William G. (2010), "Five Myths about the Bush Tax Cut", *The Washington Post* (August 1).

[8] Gale William G. Gale and Benjamin Harris (2010), "A Guide to the Fight Over the Bush Tax Cuts", *Brooking Institution* (October).

[9] Galí, Jordi, David López-Salido, and Javier Vallés (2007): "Understanding the Effects of Government Spending on Consumption", *Journal of the European Economic Association*, March, Vol. 5, No. 1, Pages 227-270.

[10] Hall Robert (2009), "By How Much Does GDP Rise if the Government Buys More Output?" *Brookings Papers on Economic Activity*, 2, pp. 183-231.

[11] Marr, Chuck "Letting High-Income Tax Cuts Expire Is Proper Response to Nation's Short- and Long-Term Challenges", *Center on Budget and Policy Priorities.*

[12] Mertens, Karel and Morten O. Ravn (2009): "Empirical Evidence on The Aggregate Effects of Anticipated and Unanticipated U.S. Tax Policy Shocks", CEPR Discussion Paper No 7370, July.

[13] Monacelli, Tommaso, and Roberto Perotti (2010): "Tax Changes for the Poor and for the Rich", work in progress, Bocconi University.

[14] Monacelli, Tommaso, Roberto Perotti and Antonella Trigari (2010), "Unemployment Fiscal Multipliers", *Journal of Monetary Economics,* 57, 531–553.

[15] Pappa, Evi, and Markus Bruckner (2010), "Fiscal Expansions Can Increase Unemployment: Theory and Evidence from OECD Countries", Mimeo Universitat Autonoma.

[16] Perotti, Roberto (2002): "Estimating the Effects of Fiscal Policy in OECD Countries", ECB Working Paper No. 168, August.

[17] Perotti, Roberto (2007): "In Search of the Transmission Mechanism of Fiscal Policy", *NBER Macroeconomics Annual*

[18] Perotti, Roberto (2010a): "The Effects of Tax Shocks on Output: Not So Large, But Not Small Either", mimeo, Bocconi University

[19] Perotti, Roberto (2010b): "The Effects of Government Spending Shocks: A Comment on Barro and Redlick, Hall, and Ramey", work in progress, Bocconi University

[20] Ramey Valerie (2010), "Identifying Government Spending Shocks: It's All in the Timing", *Quarterly Journal of Economics,* forthcoming.

[21] Roubini Nouriel (2010), "What America needs is a payroll tax cut", *Washington Post* (September 17).

[22] Romer, Christina and David Romer (2008): "A Narrative Analysis of Postwar Tax Changes", mimeo, University of California, Berkeley

[23] Romer, Christina and David Romer (2010): "The Macroeconomic Effects of Tax Changes: Estimates Based on a New Measure of Fiscal Shocks", *American Economic Review,* vol. 100(3), pages 763-801, June.

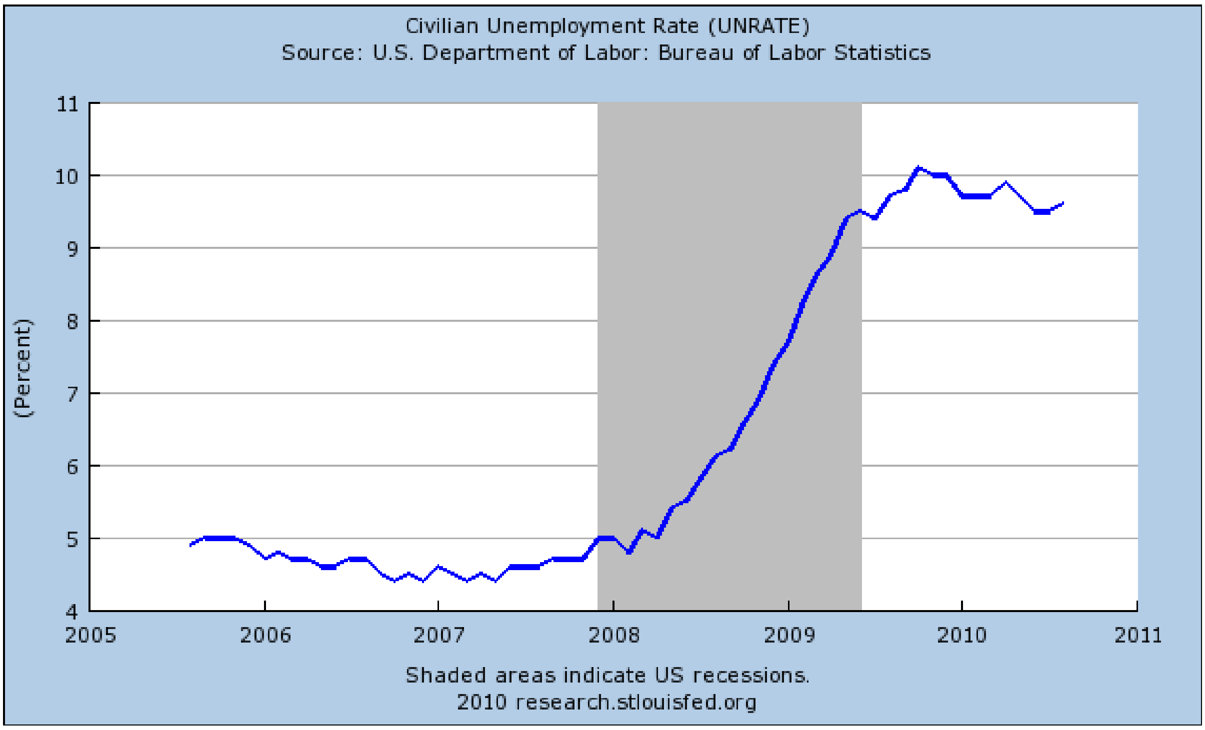

Figure 1: Unemployment rate

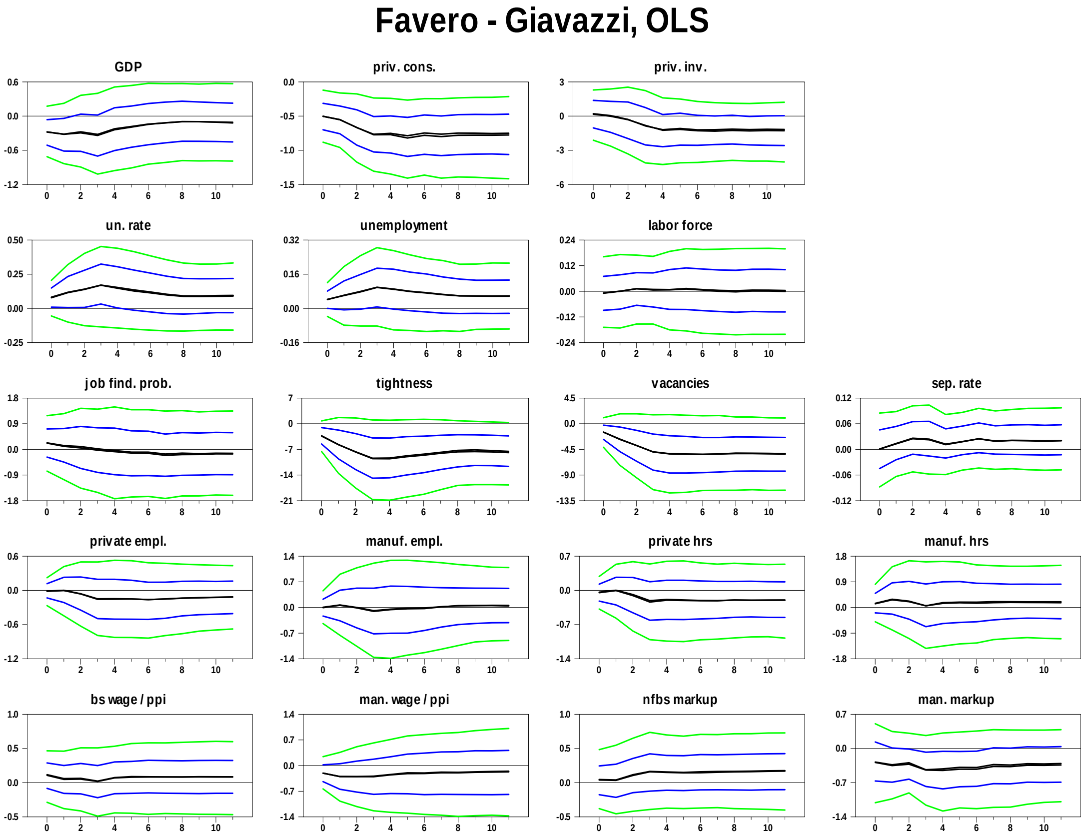

Figure 2: Favero - Giavazzi OLS specification.

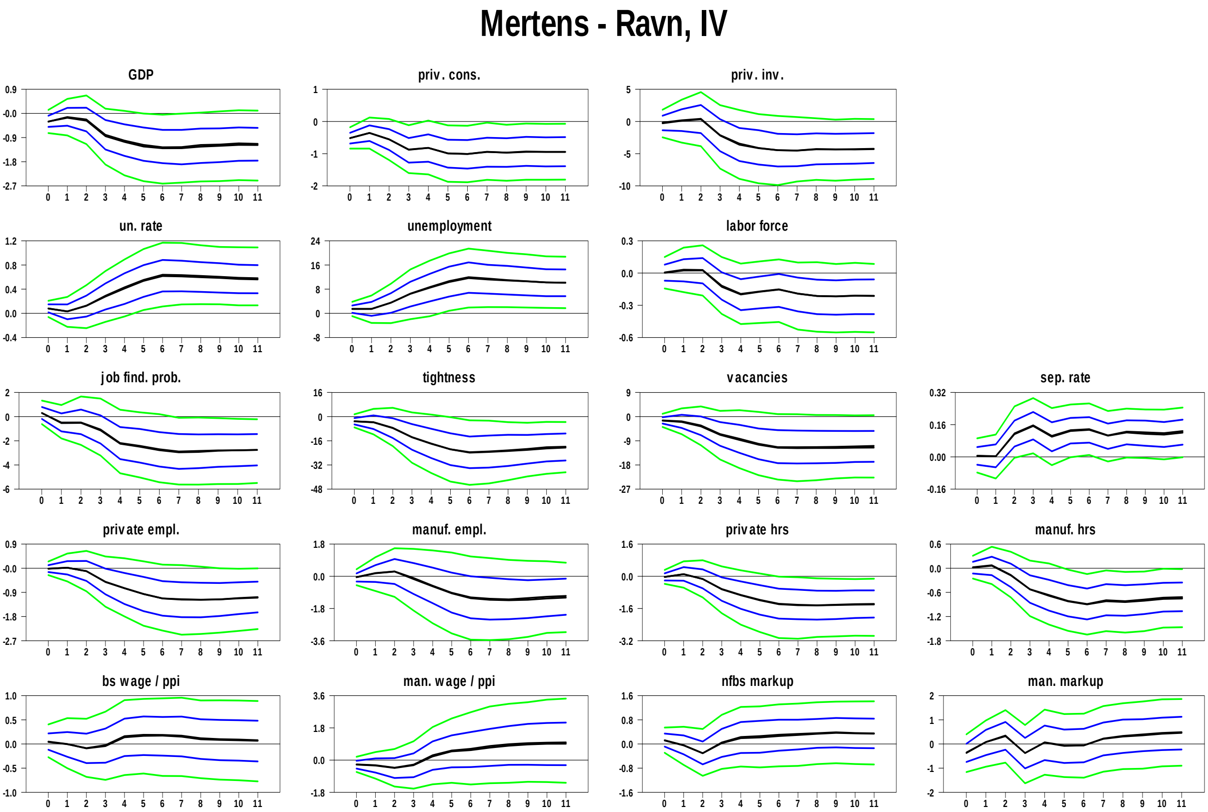

Figure 3: Mertens - Ravn IV specification

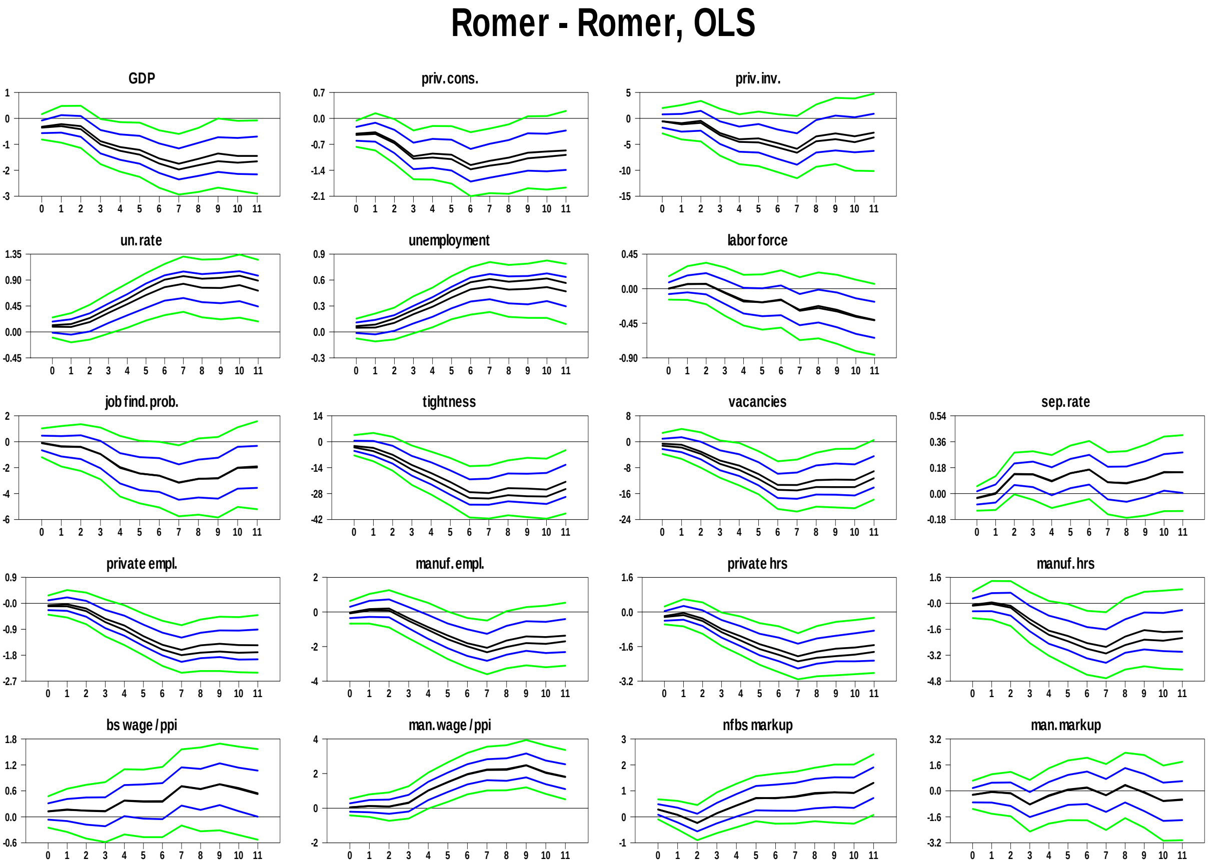

Figure 4: Augmented Romer - Romer OLS specification.

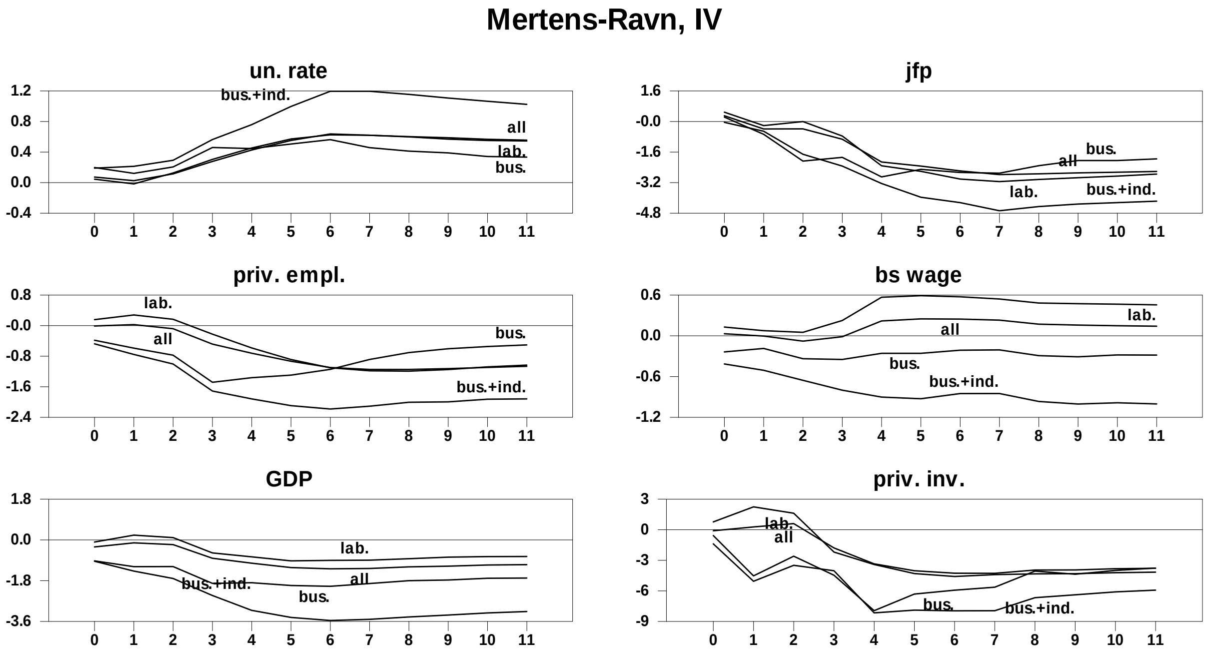

Figure 5: Mertens and Ravn IV specification: different types of taxes.

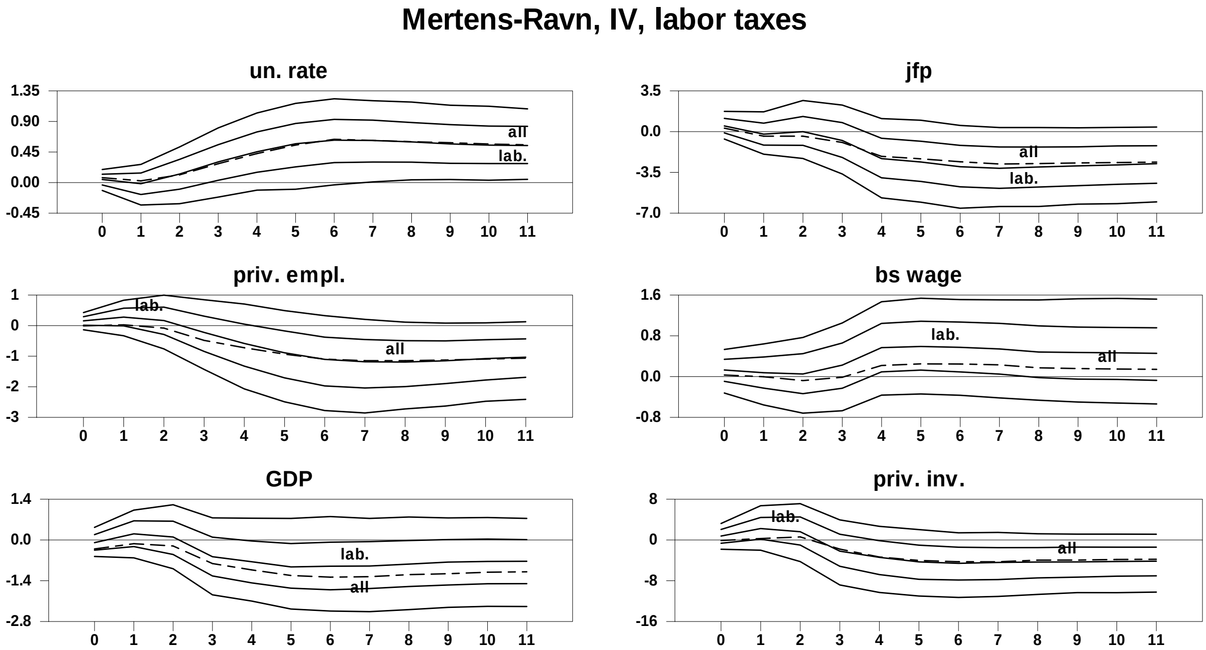

Figure 6: Mertens and Ravn IV specification: labor taxes

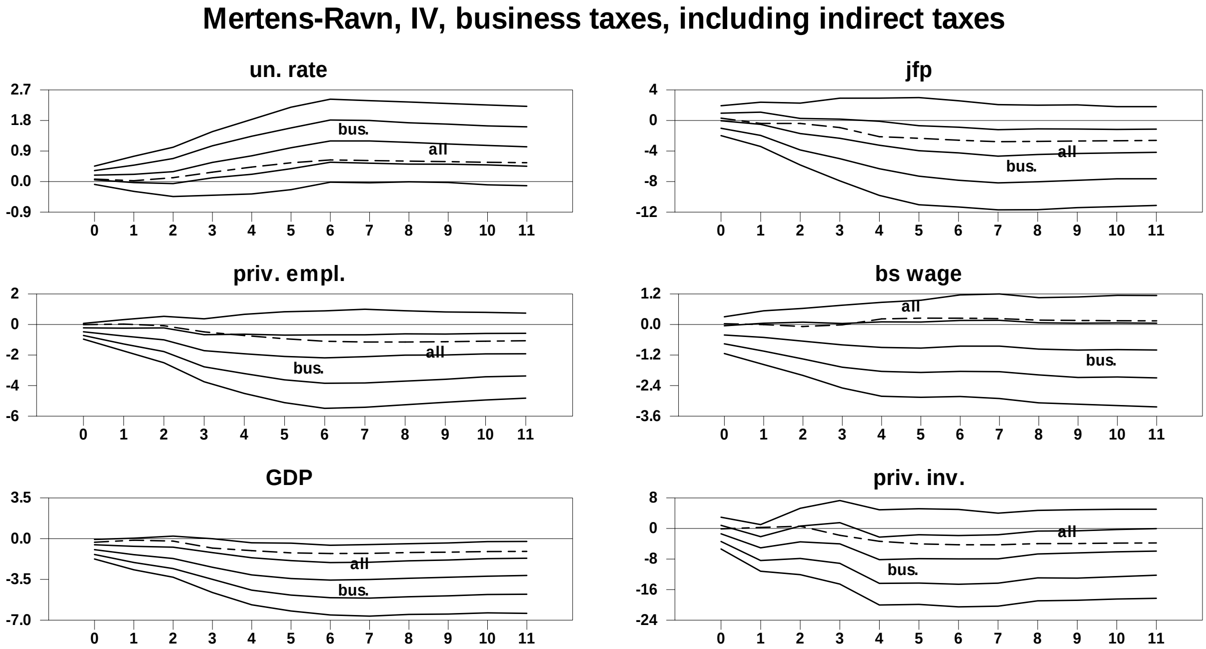

Figure 7: Mertens and Ravn IV specification: business taxes (including indirect taxes).

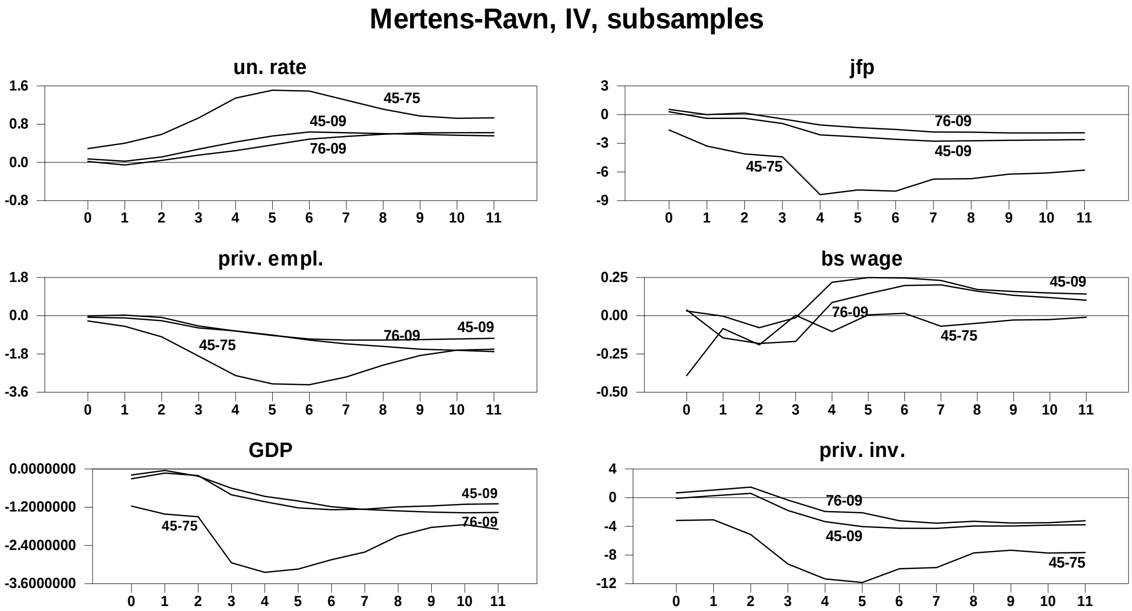

Figure 8: Mertens and Ravn, IV specification: subsamples