Banco de Portugal
EUROSISTEMA

Estudos e Documentos de Trabalho

Working Papers

13 | 2008

EMPIRICAL EVIDENCE ON THE BEHAVIOR AND STABILIZING ROLE OF FISCAL AND MONETARY POLICIES IN THE US

Manuel Coutinho Pereira

September 2008

The analyses, opinions and findings of these papers represent the views of the authors, they are not necessarily those of the Banco de Portugal or the Eurosystem.

Please address correspondence to
Manuel Coutinho Pereira
Economics and Research Department
Banco de Portugal, Av. Almirante Reis no. 71, 1150-012 Lisboa, Portugal;
Tel.: 351 21 3130737, Email: mpereira@bportugal.pt

BANCO DE PORTUGAL

Economics and Research Department
Av. Almirante Reis, 71-6th floor
1150-012 Lisboa
www.bportugal.pt

Printed and distributed by
Administrative Services Department
Av. Almirante Reis, 71-2nd floor
1150-012 Lisboa

Number of copies printed
170 issues

Legal Deposit no. 3664/83
ISSN 0870-0117
ISBN 978-989-8061-45-4

Empirical evidence on the behavior and stabilizing role of fiscal and monetary policies in the US*

Manuel Coutinho Pereira†
Banco de Portugal & CEMAPRE, ISEG-TULisbon

September 2008

Abstract

In this paper, standard SVAR tools and counterfactual simulation techniques are applied to study the behavior and countercyclical role of monetary and fiscal policies in the US. In order to set up the model properly, different issues raised by joint identification of monetary and fiscal policy shocks are addressed, in particular, the contemporaneous response of taxes to the federal funds rate.

I conclude that the federal funds rate and taxes net of transfers have moved mostly for endogenous reasons and, in the latter case, this reflects automatic rather than discretionary policy. In contrast, government expenditure has been basically driven by exogenous forces. Further, I reach evidence that (automatic) fiscal policy has been the most important stabilizing force in the course of postwar recessions, surpassing the role of monetary policy, while both policies have contributed similarly to narrowing the output gap at early stages of the recovery.

JEL: E63, C32

Keywords: fiscal policy, monetary policy, stabilization, structural vector autoregression

1 Introduction

The goal of the work presented here is to gather evidence about the behavior and stabilizing effects of fiscal and monetary policies over the last decades in the US. This is done, firstly, by constructing an identified VAR in which both policies are considered in conjunction, and then by applying counterfactual simulation techniques, in the spirit of Sims and Zha (1998) and

---

[*] Comments from Artur Silva Lopes and Luís Costa are gratefully acknowledged. All remaining errors are mine.

[†] Address: Banco de Portugal, Economic Research Department, Av. Almirante Reis, 71-6^o, 1150-012 Lisboa, Portugal. Tel.: +351 21 313 0737; fax: +351 21 310 7804. E-mail address: mpereira@bportugal.pt.

Bernanke et al. (1997), to estimate the endogenous and exogenous components of the change in policy variables and their impact on GDP during contractionary periods.

There are a few examples of studies dealing with joint identification and the effects of monetary and fiscal policy innovations using SVARs, such as Perotti (2002) and Canzoneri et al. (2002), that appeared in the wake of well know literature considering each policy in isolation (as in Bernanke and Blinder (1992), Christiano et al. (1999) and Blanchard and Perotti (2002)). Nevertheless, the most prominent simultaneity issue arising when both policies are taken together - the co-movement between taxes and the monetary policy instrument, the federal funds rate - has not received much attention before. In order to model this appropriately, I argue, one has to allow a contemporaneous nonzero elasticity of taxes to the short-term interest rate. Other simultaneity issues to be taken into account are the contemporaneous relationship between fiscal and monetary policy variables and the business cycle and inflation. A general remark about the approach followed in this paper is that I take it as given that policies (endogenous and exogenous) have real effects and attempt to estimate them (this is a stand similar, for instance, to that taken in Romer and Romer (1994)). Also as preliminary point, I address in Section 2 the ability of identified VARs to estimate the effects of fiscal policy on GDP, which has been forcefully questioned (see Ramey (2008)) on the grounds that SVAR fiscal disturbances are anticipated by agents.

The system I consider throughout the paper has five equations: three of them are structural - a monetary policy rule and equations for government revenue and expenditure, the latter capturing both the reaction function of fiscal authorities and automatic responses to macroeconomic variables. There are two additional equations which are solved out versions, respectively, for GDP and inflation, of standard aggregated supply and IS curves. The disturbances in these last equations do not have, contrary to the policy disturbances, a structural interpretation (that is, I do not disentangle aggregate supply and private aggregate demand innovations). This system is described in Section 3 and is a textbook-like macroeconomic system (such as those presented in Walsh (2003, ch. 5)) in which monetary policy is set through interest-rate targeting. According to the objective of the analysis, however, I single out the fiscal role as well. This approach has common points with that of Blanchard and Watson (1984), one of the earliest contributions to the SVAR literature, but they used money supply and a single fiscal index as the policy instruments, and identified the non-policy innovations.

Some of the contemporaneous coefficients in the equations for the fiscal variables are calibrated using non-sample information following Blanchard and Perotti (2002). This requires that I generalize the OECD method to derive of the elasticity of personal income taxes to GDP that they use, in order to encompass the semi-elasticities to inflation and the short-term interest rate. This is done in Section 4 and Appendix A, where I also consider whether it is feasible to compute such semi-elasticities on the basis of the information available, and the calculation of the corresponding parameters for the other kinds of taxes and transfers. Section 5 describes the identification and estimation of the system which depends in particular on the assumptions made about the ordering of the monetary policy instrument and the non-policy variables, GDP and prices.

I present a first set of empirical results in Section 6 using standard SVAR tools. The impacts on GDP are broadly similar to those in previous studies considering each policy in isolation but, as far as fiscal policy is concerned, they indicate less effectiveness in stimulating activity on the side of taxes and transfers. There is evidence that this is basically accounted for by subsample sensitivity, which is a marked feature of the results, rather than by controlling for the short-term interest rate and prices. Further, I conclude that the changes in the federal funds rate and taxes are dominated by the respective systematic components, reflecting discretionary actions in the first case and, I argue, automatic movements in the second. The endogenous component is, by contrast, much less important for government expenditure. One also gets evidence that the short-term feedback between the two sides of the budget is weaker than normally thought. Finally, in the same vein as the monetary policy VARs literature, I conclude that neither of the policy disturbances are the primary source of business cycle fluctuations.

Section 7 presents a decomposition of the changes in the policy variables into an endogenous and an exogenous part, for each of the eight business cycle contractions since the beginning of my sample (1955), as dated by the NBER. In order to do this, I compare the historical behavior of the variables with the implied behavior when the system is simulated under counterfactual assumptions. In addition, the output gain brought about by the endogenous and exogenous components is measured at the trough of the recession and two quarters afterwards. In general, one concludes that the automatic stabilizers built in taxes and transfers have been the most important force attenuating the severity of recessions. Their contribution continues to be relevant to enhance growth in the initial quarters after the trough but, at that point, on an equal footing with systematic monetary policy. Discretionary fiscal policy, on both sides of the budget, appears to have been of secondary importance.

2 On the meaning of fiscal policy shocks and the ability of SVARs to capture them

A correct measurement of the effects of fiscal policy in an SVAR context requires, in the first place, that the shocks are exogenous in relation to the variable, say GDP, on which the impact is being determined. Meaning that the portion of the fiscal variables labelled as the «shock» must not respond to GDP nor, more generally, to variables correlated with it. Perhaps the most obvious candidates in this respect are interest rates and prices. As a first point, it is important to ascertain whether there are fiscal policy actions meeting such requirements in practice. Romer and Romer (2007) investigated the legislated tax changes in the US since World War II and found four types of motivations behind them: to react to the business cycle, to finance changes in spending, to raise long-run growth and to cope with an inherited deficit (which could be also stated as to cope with growing debt). The Romers classify the last two as exogenous with respect to output fluctuations,[1] and show that they have been clearly more prevalent than their endogenous counterparts throughout the postwar period. Turning to budget outlays, examples of exogenous, or at least party exogenous, interventions are also not difficult to find. These include the build-ups in defense spending on which the so-called «event study» literature has focused,[2] as well as the creation and extension of certain social programs largely unrelated to the business cycle (like Medicaid). Another fiscal intervention concerns the normally annual decision about across-the-board adjustments to the pay of government employees. Such adjustments are partly endogenous to past inflation to the extent that they make up for it (adding to the other increases in pay related to the advancement of employees), but they are also determined by exogenous policy goals as, for instance, expenditure restraint or achieving wage rates comparable with those in the private sector. The last kind of goals can be very important in practice. This can be seen by analyzing the pay adjustments in the General Schedule which covers most Federal government civilian employees, in the years spanning since mid-fifties.[3] Until the beginning of the seventies, a time when the comparability principle ranked high on the political agenda (see Smith (1982)), the cumulative increase stood over 70 p.p. above the variation in the CPI. By contrast, during the high inflation period from 1973 to 1981 that followed, pay updates fell systematically short of the rise in prices (more than 50 p.p. below, in cumulative terms). Since 1982 the adjustments have been more in line with inflation (negative difference of 19 p.p. in relation to the CPI from 1983 to 2005). Changes in social transfers and purchases of goods and services undertaken in response to business cycle conditions have been infrequent and small over the last decades (Romer and Romer (1994)). Hence, contrary to monetary policy for which the existence of exogenous interventions has been a matter of debate, in the case of fiscal policy many actions fall within this category, even if identification assumptions are generally needed to isolate them.

---

[1] As the Romers recognize, tax changes to cope with growing debt may have some degree of endogeneity with GDP, if they are accompanied by similar measures on the expenditure side (note that the same applies if debt as such has a systematic effect on GDP).

[2] Although it is legitimate to consider separately the effects of military episodes, given the added claim to exogeneity, it is often thought that shocks to purchases of goods and services relate only to defense contracts. To put things in perspective, purchases related to defense (as measured by NIPAs) are about 1/3 of the total and, excluding compensation of employees from the aggregate, about 40 per cent. In terms of the contribution to the overall variance (series in real and per capita terms, sample 1955:1-2005:4) the defense component has a coefficient of variation of 0.13, much smaller than the one of non-defense expenditure which is 0.36.

[3] The Federal Civilian Workforce Statistics (US Office of Personnel Management) present a chronology of the General Schedule Pay Legislation since 1945.

A second requirement for a correct measurement of the effects of fiscal policy is that the timing of the shocks corresponds to the moment in which they actually impacted economic activity. If fiscal shocks, albeit exogenous, can be anticipated by agents *and* if agents modify their behavior accordingly, identified VARs will still not estimate properly their effects on GDP. This issue is clearly of potential importance in the case of fiscal policy because changes to taxes and spending typically have to go through a legislative process, and thus agents get information about them about them ahead of the implementation. The problem was already recognized in the early SVAR papers on the effects of fiscal policy (Blanchard and Perotti (2002)). Recent contributions to the event study literature (Ramey (2008) and previous work in the same vein) argued forcefully that the anticipation effects are likely to invalidate inferences relating to fiscal policy drawn from SVARs. As it is known, the event study approach focus on the impact of increases in defense spending in the wake of the major postwar military episodes, and dates the shocks when the news about the likely rise in defense spending first came up in the media. Since I employ the SVAR methodology, it is appropriate to put forward some considerations about how serious the issue of anticipation may be.

Note, to start with, that neither the SVAR nor the event study approach present evidence as to the importance of anticipation effects. In order to get it, one has to turn to micro studies addressing the actual behavior of agents in face of information about pending fiscal shocks. There is a large body of empirical evidence about the way households react to changes in taxes (also some about the reaction to changes in social benefits and, in any case, one might expect that the same type of behavior applies in this case). This has been gathered by the literature documenting the so-called «natural tax experiments» (see Johnston et al. (2006) and the references they cite), and provides support to the hypothesis that tax changes do affect households' behavior at the time revenue is collected. For instance, predictable tax liabilities and refunds have significant contemporaneous impacts on consumption. It is illustrative, in this respect, that although Romer and Romer (2007) follow a methodology akin to the event study approach, they date «their» tax shocks according to when the legislated changes impacted revenue (note that the narrative sources they use have information about alternative dates e.g. the time when tax bills were signed). In the same vein, one can assume that households do not smooth consumption in anticipation of changes in disposable income resulting from shocks to compensation of government employees.

No comparable micro evidence as to the behavior of firms in face of information about pending fiscal changes is (to the best of my knowledge) available. The relevant budget items in this respect are, on the receipt side, taxes on profits and part of social security contributions and, on the outlay side, intermediate consumption and investment. The event study approach has chiefly raised the anticipation issue in relation to military component of these last items. I note that the timing of shocks followed by that approach is not undisputable. Indeed, considerable uncertainty remains at the point the news about the likely military build-up first come up, for instance, as to its actual size, the weapon systems government will purchase, who among competing contractors will be chosen as the supplier, and so on. Thus, it may well be that the relevant timing is when contracts are awarded. It is not unreasonable to think that anticipation matters more for the financial markets, which react to news (see Wachtel and Young (1987) and related literature on the impact of fiscal news on interest rates) than for the labor and product markets.

An issue that admittedly may disturb the measurement of fiscal shocks is raised by the way purchases of durable goods are recorded in NIPAs. NIPAs mostly record such purchases on a cash disbursements basis (see BEA (2005) and the discussion in Perotti (2004)) while the full amount of the acquisition (known by the supplier from the moment the contract is signed) is likely to be the relevant fact from the private sector's viewpoint. Thus National Accounts will typically record an initial payment which does not reflect the full size of the «true» shock. Still, an important part of purchases of goods and services is not affected by the issue.

3 The equations in the system and identifying restrictions

3.1 General characterization

The results presented in this paper are based on the following system:

$$g_t = a_0^{g,p} p_t + a_0^{g,ff} ff_t + \textstyle\sum_{i=1}^{4} \mathbf{a}_i^{g} \mathbf{x}_{t-i} + b_0^{g,nt} e_t^{nt} + e_t^{g}, \tag{1}$$

$$nt_t = a_0^{nt,y} y_t + a_0^{nt,p} p_t + a_0^{nt,ff} ff_t + \textstyle\sum_{i=1}^{4} \mathbf{a}_i^{nt} \mathbf{x}_{t-i} + b_0^{nt,g} e_t^{g} + e_t^{nt}, \tag{2}$$

$$ff_t = a_0^{ff,y} y_t + a_0^{ff,p} p_t + \textstyle\sum_{i=1}^{4} \mathbf{a}_i^{ff} \mathbf{x}_{t-i} + e_t^{ff}, \tag{3}$$

$$y_t = a_0^{y,g} g_t + a_0^{y,nt} nt_t + a_0^{y,ff} ff_t + \textstyle\sum_{i=1}^{4} \mathbf{a}_i^{y} \mathbf{x}_{t-i} + w_{1t}, \tag{4}$$

$$p_t = a_0^{p,g} g_t + a_0^{p,nt} nt_t + a_0^{p,ff} ff_t + \textstyle\sum_{i=1}^{4} \mathbf{a}_i^{p} \mathbf{x}_{t-i} + w_{2t}, \tag{5}$$

where I assume that either $a_0^{y,ff} = a_0^{p,ff} = 0$ or $a_0^{ff,y} = a_0^{ff,p} = 0$, and either $b_0^{g,nt} = 0$ or $b_0^{nt,g} = 0$. Purchases of goods and services (including of capital goods) are denoted by g_t, taxes net of transfers by nt_t, the federal funds rate by ff_t, detrended GDP (i.e. the output gap) by y_t and inflation by p_t. The fiscal variables and output are the logarithms of the levels measured in real and *per capita* terms. Inflation is calculated from the GDP deflator and, like the federal funds rate, is measured at annual rates. I give more details about the definition of the fiscal variables and sources in Appendix C. Throughout the paper, nt_t is also sometimes called simply «taxes», and g_t «expenditure» or «spending». The vector $\mathbf{x}_t$ includes the variables in the system: $\mathbf{x}_t = [g_t, nt_t, ff_t, y_t, p_t]'$. The structural policy innovations (e_t^g, e_t^{nt} and e_t^{ff}) are ortogonal to each other and also to w_{1t} and w_{2t}, while these two innovations will be in general correlated. As usual in the SVAR methodology, the identification restrictions are imposed on the contemporaneous coefficients (the a_0's), while the lag structure of the model (the $\mathbf{a}$'s) is left unrestricted. The system is estimated with quarterly data and the lag length is set to 4. I did not include deterministic terms in equations (1) to (5): the discussion of the assumptions about the low-frequency properties of the data is deferred to a separate subsection below.

The first two equations above are those for government expenditure and net taxes.[4] If one assumes, following Blanchard and Perotti (2002), that any government reaction to macroeconomic conditions takes more than one quarter to be implemented, the a_0's in (1) and (2) can be interpreted as the *automatic* contemporaneous response of the fiscal variables to macroeconomic conditions. Such a response may be brought about, in particular, by mechanisms built in the tax code, transfer programs and budgeting procedures. Since the fiscal variables are in real terms, deflated by the GDP deflator, this also induces a contemporaneous co-movement of g_t and nt_t with p_t (these points are detailed in the discussion of the calibration of the parameters). The parameters $a_0^{nt,y}$ and $a_0^{nt,p}$ will capture the automatic responses of net taxes to activity and prices within the quarter, and $a_0^{g,p}$ of government spending to prices. It appears relatively undisputable that spending does not react to contemporaneous movements in activity, and therefore current GDP is absent from equation (1). Turning to the semi-elasticity of taxes to the short-term interest rate, can $a_0^{nt,ff}$ be set to zero? I argue it cannot. This point deserves special attention since it lies at the very heart of the joint identification of monetary and fiscal policy, and has hardly been dealt with by the literature. It is therefore addressed separately in a moment. As to the corresponding parameter in the expenditure equation, $a_0^{g,ff}$, one expects it to be indeed equal to zero, since there is no obvious mechanism linking purchases of goods and services and interest rates within the quarter. However, as shown in the section devoted to the identification of the system, once $a_0^{nt,ff} \neq 0$, the estimation of $a_0^{g,ff}$ comes at no additional cost. Hence I estimate this coefficient rather than impose a zero restriction, in order to have exact identification of the parameters in the fiscal and monetary policy equations, and complete ortogonality of the respective structural disturbances. Note further that I allow either the structural innovation to net taxes to enter the equation for g_t, or the structural innovation to expenditure to enter the equation for nt_t (borrowing from Blanchard and Perotti). It makes sense to do so because when setting fiscal policy, government observes and takes into consideration both sides of the budget. Identification of the respective parameters ($b_0^{g,nt}$ and $b_0^{nt,g}$) requires that one of them is set to zero or, equivalently, that net taxes and spending are ordered one after the other. Given that such an identification restriction is arbitrary, the results have to be checked under both possibilities.

---

[4] To consider each side of the budget separately, rather than the deficit, allows us to investigate potential differentiated behavior and impacts. The definition of revenue as taxes net of transfers, and of expenditure as purchases of goods and services, assumes implicitly that their impact operates through the standard aggregate demand channel. Such definitions have also the practical advantage of lumping together in the revenue variable the budget categories sensitive to the business cycle.

The coefficients in $\mathbf{a}^g$ and $\mathbf{a}^{nt}$ will reflect any systematic response of government to macroeconomic developments - the fiscal policy rule, the lagged automatic reaction to the economy, and the persistence in budget variables brought about by the way fiscal policy is set (since the government budget and tax laws are not designed from scratch each year).[5] Non-systematic policy is captured by the structural fiscal shocks (e_t^g and e_t^{nt}) whose effects one endeavours to trace using the SVAR methodology.

Since equations (1) and (2) are supposed to capture fiscal policy rules, the following remark is in order. Some literature on this issue for the US (e.g. Bohn (1998)) argued that fiscal authorities have acted according to a government debt stabilization motive besides an output stabilization one. The cited work by Romer and Romer (2007) includes the correction of inherited deficits, which could be equally stated as concern over growing debt, among the motives for legislated tax changes. Examples changes in outlays undertaken for the same reasons could be pointed out as well. Since lags of net taxes and expenditure enter all equations, the possibility that fiscal authorities react to very recent imbalances is covered. But it might be the debt level that matters, and such indicator is missing. The empirical evidence that government debt enters significantly the fiscal equations is, however, weak. For this reason, debt was not taken on board in the system. Indeed, in order to examine the issue, I estimated the system in the reduced-form, with lags of the variables in $\mathbf{x}_t$ and the lagged debt to GDP ratio as regressors. I experimented with lags 1 to 4 of debt, each in turn, since it is the level of the variable that is supposed to matter. On the basis of the reference sample, 1955:1-2005:4, the additional regressor was not significant at any reasonable level (though the coefficient signs were the expected ones, that is, negative in the expenditure equation and positive in the revenue equation). An open possibility that I did not explore is that the fiscal variables do respond to government debt but in an nonlinear fashion. Looking at the chart depicting net taxes and expenditure over time (Figure 1 below) one sees that the budget imbalances sometimes lasted several years in a row. Thus corrective action may be triggered only upon the cumulative imbalance reaching a certain threshold.

---

[5] Here it is interesting to draw a parallel with monetary policy rules based on interest rate targeting, in which the Federal Reserve is, in principle, freer to set the interest rate at a given level. Nevertheless, the literature has assumed that the Fed smooths the changes in interest rates, implying that the rule includes lags of the policy variable (see, for instance, Clarida et al. (2000)). In the case of fiscal policy there are even more reasons to follow such a specification.

Equation (3) is the monetary policy rule that builds on well known literature showing that (i) the federal funds rate provides a good measure of the monetary policy instrument, and (ii) the rule can be modelled as the federal funds rate responding to output gap and to the deviation of inflation from a target (see e.g. Bernanke and Blinder (1992), Taylor (1993) and Christiano et al. (1999)). In this context it is common to assume that monetary authorities observe the developments in activity and inflation and react accordingly within the quarter, whereas GDP and inflation are slow-moving variables that respond with a certain delay to changes in the interest rates.[6] This corresponds to the case $a_0^{y,ff} = a_0^{p,ff} = 0$. However, as this assumption is more compelling with monthly data, and also because I do allow a contemporaneous reaction of the macroeconomic block to the fiscal variables (see below), the results under the converse case $a_0^{ff,y} = a_0^{ff,p} = 0$ are considered as well. A systematic response of monetary authorities to contemporaneous fiscal developments is ruled out, that is, the current values of government budget variables do not enter the monetary policy rule. As it is well known, monetary policy VARs usually include a commodity price indicator in order to eliminate the so-called «price puzzle». I deviated from this practice because, anticipating results, the puzzle I get is not as dramatic as the one reported in Christiano et al. (1999), in that the punctual response of inflation does become negative some quarters after the shock. Moreover, the focus here is not on the effects of monetary policy in general, but a narrower one concentrating on activity.

Considering finally equations (4) and (5), they are solved-out versions for y_t and p_t of an IS and an aggregate supply curves, as described next. I assume that the current fiscal variables enter the aggregate demand schedule while, depending on the ordering assumptions made in the monetary policy rule above, the current short-term interest rate may be or not part of it. Contemporaneous inflation is allowed to enter the aggregate demand schedule, in order to account for the effects of this variable on spending intentions. I assume a simple aggregate supply schedule linking current GDP and prices. Under these conditions, the two relationships can be solved out for y_t and p_t yielding (4) and (5).[7] The disturbances w_{1t} and w_{2t} will be a function of the underlying structural private aggregate spending and aggregate supply innovations, and thus mutually correlated. Moreover the same policy variables will enter each of the equations (4) and (5).

---

[6] There is also an empirical reason for so doing. As Christiano et al. (1999) note, there is a positive correlation between the reduced-form residuals of the GDP and federal funds rate equations (that also shows up in our results - see Table B1 in Appendix B). If one rules out that this effect is brought about by the behavior of monetary authorities, then one has to explain the awkward result that a tightening in monetary policy causes a *positive* reaction on GDP.

3.2 The semi-elasticity of net taxes to the short-term rate

I address first a preliminary issue concerning the definition of net taxes which has a direct implication for the way this variable responds to the interest rate. Net taxes are equal to taxes minus transfers and the latter can be computed either *including* or *excluding* interest paid (there are examples of both treatments in the literature). The first definition implicitly assumes that the fiscal structural shocks originate in the full budget, and the second one that they originate in the primary budget. I argue that the latter is the appropriate definition. SVARs are supposed to identify and trace the effects of discretionary non-systematic fiscal policy. However, the direct determinants of interest outlays are the interest rates and the stock of debt and not (except in very particular cases) discretionary fiscal policy actions. In other words, the structural fiscal innovations do not enter an equation (actually, rather an identity) explaining government interest outlays. From the point of view of empirical work, sticking to the primary budget implies that the econometrician has to deal with only one channel through which the unexpected movements in interest rates may impact movements in net taxes - the tax base - ruling out an additional impact via the interest bill. Thus the precise issue is whether $a_0^{nt,ff}$ can be set to zero, when net taxes are defined *without* considering interest paid, as in this paper.

Note that the correlation between the residuals of the reduced-form equations for nt_t and ff_t, shown in Table B1, is around 0.33 and thus quite high (in contrast, the corresponding correlation between the residuals of ff_t and g_t equations is close to zero). Naturally that correlation is partly caused by a common response of the two variables to the business cycle, nt_t reflecting the action of the automatic stabilizers, ff_t due to the action of the Federal Reserve (and a similar argument applies to inflation). Therefore, it is important to see whether it remains after this latter effect has been netted out. Consider, as a first approximation, the values of $a_0^{nt,y}$ and $a_0^{nt,p}$ coming from a previous study, Perotti (2002) (I will recompute these figures in Appendix A). The corresponding correlation taking now the reduced-form residuals for the nt_t equation *adjusted* for unexpected movements in GDP and prices[8] is 0.26. This indicates a contemporaneous link between net taxes and the short-term interest rate going beyond simultaneity with third variables. The researcher must come to terms with the causality underlying it. I argue that it reflects the response of net taxes within the quarter, namely of personal income taxes, to movements in the short-term interest rate. If this is the case, then the tax base related to personal income on assets should react to the contemporaneous funds rate. There is evidence that it does.[9] Note that the opposite causality would imply that monetary policy responded systematically to fiscal variables during the sample period, which is usually considered not to have taken place. Finally, the negligible correlation between the reduced-form residuals of ff_t and g_t equations points in the same direction. Christiano et al. (1996), working with flow of funds data, reported an initial contraction of government borrowing following a tightening in monetary policy, which they attributed to an ensuing rise in personal income tax collection. The same phenomenon is disclosed here.

---

[7] Let the contemporaneous part of aggregate demand, when ff_t enters it, be given by $y_t = \alpha_1 g_t + \alpha_2 nt_t + \alpha_3 ff_t + \alpha_4 p_t + \varepsilon_t^d$ and aggregate supply by $y_t = \beta_1 p_t + \varepsilon_t^s$. The respective structural innovations are ε_t^d and ε_t^s. Equation (4) obtains solving out this system for y_t and (5) solving it out for p_t.

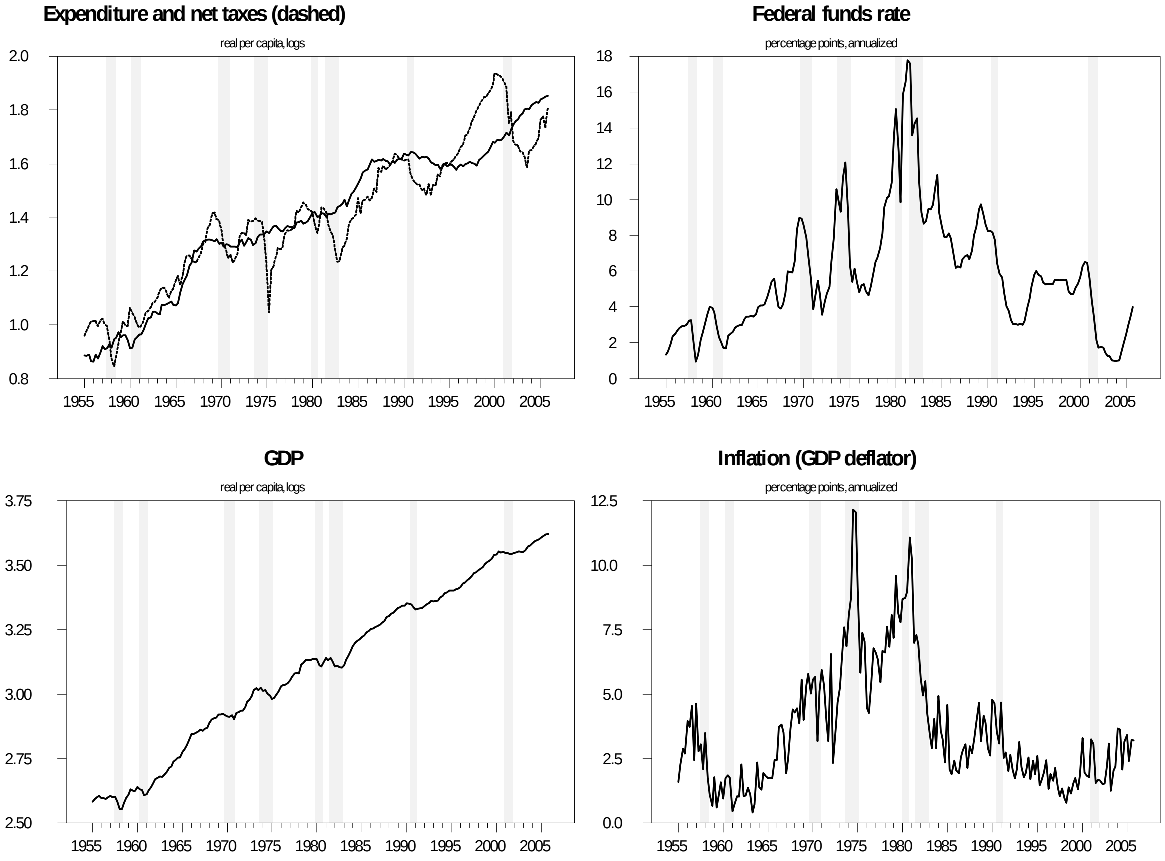
[8] That is, the correlation between $\hat{u}_t^{ff}$ and $\hat{u}_t^{nt*} = \hat{u}_t^{nt} - 2.1\hat{u}_t^{y} - 0.275\hat{u}_t^{p}$, where the $\hat{u}_t$'s are the reduced-form residuals of the respective equations.

3.3 Assumptions regarding the low-frequency properties of the data

Although the analysis in this paper is confined to the short-term effects of policies and does not rely on long-run identification restrictions, the sample spans over 50 years and, hence, some discussion of the assumptions about the low-frequency properties of the data is in order. There is no point in entering here the debate about unit root behavior versus stationarity around a deterministic linear trend of GDP for the US. In addition, none of those hypotheses accommodates the observed decline in the long-run GDP growth over the last decades (as noted by Blanchard (1989)). Note that the evolution of the fiscal variables throughout the sample (Figure 1) is also well characterized by a decreasing long-run growth rate. Therefore, in the benchmark specification I formalize the trends in GDP and budget variables as deterministic, but allow for a quadratic term in order to capture the change in average growth over time. This specification was used in Blanchard and Perotti (2002) and is also one of the measures of the output gap considered by Clarida et al. (2000) in the estimation of a monetary policy rule for the US. Nevertheless, in the empirical part, I discuss briefly how the results change when no trend, only a constant, enters the equations for those variables, which may be seen as covering the stochastic (and constant) growth alternative. To foreshadow, this matters mostly as far as the persistence of responses is concerned. Reference will be made in due course to yet another low-frequency specification: cointegration between the revenue and expenditure variables. As

---

[9] Specifically, the tax base of the personal income tax, excluding labor income, was approximated using NIPAs data (see Appendix C). In order to estimate a semi-elasticity to the funds rate, the change in the log personal income on assets (*per capita*) was regressed on lags 0 to 4 of the change in the funds rate and lags 1 to 4 of the change in inflation and change in log GDP (sample 1955:1-2005:4). The coefficient for the contemporaneous semi-elasticity to the funds rate is highly significant ($\hat{t} = 5.1$). However, this regression is very likely to have simultaneity problems to the extent that the dependent variable and the current funds rate are correlated with GDP. We ran the same regression but using lagged changes in the funds rate as an instrument; the coefficient remains significant ($\hat{t} = 2.4$).


Expenditure and net taxes (dashed)

Federal funds rate

GDP

Inflation (GDP deflator)

Figure 1: Macroeconomic variables, 1955:1-2005:4, and NBER recession dates

the system also includes an interest rate and inflation for which it does not make sense to assume a trending behavior, the deterministic trends in GDP and fiscal variables are removed by OLS regression prior to estimation of the system (in the benchmark specification).

If the time-series properties of GDP are controversial, those of the short-term interest rate and inflation are hardly less. Stationarity of both series follows from a great deal of theoretical models that rationalize the use of monetary policy rules. Visual inspection of the respective charts in Figure 1, however, indicates a long-run path difficult to square with stationarity around a single long-run mean - a driftless random walk appearing more appropriate. However, alternative stationary characterizations would be equally plausible, such as around a long-run mean with an upward shift in the period from mid-seventies to mid-eighties. This assumption could be rationalized as a temporary increase in expected inflation implicit in the monetary policy rule, brought about by the inflationary process in the seventies. Nevertheless, as it would have some degree of arbitrariness - in particular, as to the moment of the upward shift in the mean - a more conventional specification was chosen, including only a constant in the interest rate and inflation equations.

4 Calibration of elasticities of the government budget items

Before one looks into the identification and estimation of the system, it is appropriate to consider the possibility of calibrating some of the parameters in the net tax and expenditure equations on the basis of institutional information, following Blanchard and Perotti (2002). They relied on the framework developed by the OECD (Giorno et al. (1995), updated in van den Noord (2000) and Girouard and André (2005)) to compute the elasticity of personal income taxes to GDP. In Appendix A, I extend this by deriving analytical expressions for the elasticity of personal income taxes to prices and the semi-elasticity to the short-term interest rate. As discussed there, however, this latter parameter cannot be calibrated on the basis of the data made available by the OECD and remaining assumptions. I give in the appendix, in addition, the details underlying the calculation of the elasticities of the remaining taxes and transfers to activity and prices. Summing up, one is able to obtain $a_0^{nt,y}$, $a_0^{nt,p}$ and $a_0^{g,p}$ from non-sample information, but not $a_0^{nt,ff}$ which has to be estimated along with the other elements of the matrix of the contemporaneous coefficients.

Note that Perotti (2002) studied the effects of fiscal policy in a system with the interest rate and prices, but imposing a zero semi-elasticity of net taxes to the sort-term interest rate (and also using assumptions different from the ones here in order to derive the responses to prices). This simplifies the identification task but, as seen, is not adequate in the US context (Perotti's study deals with a group of OECD countries, not specifically with the US).[10]

5 Identification and estimation

It is useful to write down the matrices with the contemporaneous structural coefficients, denoted by $\mathbf{A}_0$ and $\mathbf{B}_0$, in order to highlight the identification and estimation issues to be tackled. These matrices are

---

[10] Canzoneri et al. (2002) also consider a system with the federal funds rate and prices, but concentrated on modelling the impact of the short-term rate on government interest outlays. The definition of variables adopted here rules out this sort of co-movement, as already explained.

$$\mathbf{A}_0 = \begin{bmatrix} 1 & 0 & -a_0^{g,ff} & 0 & -(a_0^{g,p}) \\ 0 & 1 & -a_0^{nt,ff} & -(a_0^{nt,y}) & -(a_0^{nt,p}) \\ 0 & 0 & 1 & -a_0^{ff,y} & -a_0^{ff,p} \\ -a_0^{y,g} & -a_0^{y,nt} & -a_0^{y,ff} & 1 & 0 \\ -a_0^{p,g} & -a_0^{p,nt} & -a_0^{p,ff} & 0 & 1 \end{bmatrix} \mathbf{B}_0 = \begin{bmatrix} 1 & b_0^{g,nt} & 0 & 0 & 0 \\ b_0^{nt,g} & 1 & 0 & 0 & 0 \\ 0 & 0 & 1 & 0 & 0 \\ 0 & 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 0 & 1 \end{bmatrix}, \quad (6)$$

in which the calibrated parameters are in parentheses and, I recall, it is assumed that either $a_0^{y,ff} = a_0^{p,ff} = 0$ or $a_0^{ff,y} = a_0^{ff,p} = 0$, and either $b_0^{nt,g} = 0$ or $b_0^{g,nt} = 0$.

There are 15 independent moments in the covariance matrix of the reduced-form system. Excluding the information needed to obtain the 5 standard deviations of the disturbances and the covariance the reduced-form residuals of the equations for p_t and y_t (which has information about the contemporaneous relationship between these two variables that I do not attempt to identify), one is left with 9 usable moments. Given the restrictions I impose on the contemporaneous coefficients and since I am able to compute $a_0^{nt,y}$, $a_0^{nt,p}$ and $a_0^{g,p}$ on the basis of non-sample information, there are equally 9 parameters to estimate. Therefore, the order condition is fulfilled. This is only a necessary condition though, and the identification and estimation details depend on the assumptions made about the contemporaneous relationship between the short-term interest rate, activity and prices, as explained next (assuming that $b_0^{g,nt} = 0$; the converse case $b_0^{nt,g} = 0$ requires only minor modifications).

I tackle first the estimation of the system under the assumption $a_0^{ff,y} = a_0^{ff,p} = 0$. With the calibrated elasticities to GDP and prices in hand, one can compute the net taxes and expenditure series *adjusted* for the contemporaneous movements in GDP and prices, denoted by $nt_t^* = nt_t - \hat{a}_0^{nt,y} y_t - \hat{a}_0^{nt,p} p_t$ and $g_t^* = g_t - \hat{a}_0^{g,p} p_t$. Since ff_t is predetermined with respect to all the other variables in the system, equation (1) can be simply estimated by OLS regression of g_t^* on ff_t and lagged endogenous variables, yielding in addition $\hat{e}_t^g$. Estimation of equation (2) follows by OLS regression of nt_t^* on ff_t, $\hat{e}_t^g$ and lagged endogenous variables. The equations for y_t and p_t are then estimated by instrumental variables using g_t^* and nt_t^* (or $\hat{e}_t^g$ and $\hat{e}_t^{nt}$) as instruments for nt_t and g_t, and ff_t and the lagged endogenous variables as instruments for themselves. Finally, equation (3) can be estimated directly by OLS. I carry out one-step estimation of the system rather than the usual one in two steps in which the reduced form is estimated first and then $\mathbf{A}_0$ and $\mathbf{B}_0$ on the basis of the respective residuals. In fact, since the calibrated parameters vary over time, the two methods do not yield exactly the same results and one-step estimation appears slightly more correct.[11]

---

[11] The reduced form with constant coefficients estimated in the first step is not fully consistent with a structural form in which some parameters vary. Note that the calibrated parameters are time-varying because so are the

The estimation of the system is trickier under the assumption $a_0^{y,ff} = a_0^{p,ff} = 0$, i.e. when contemporaneous prices and output enter the equation for the federal funds rate. In this case, since ff_t is not ortogonal to e_t^g and e_t^{nt}, OLS estimation of the fiscal equations is not possible. Standard estimation of the system by maximum likelihood is, however, feasible. In this case the information about the calibrated parameters is incorporated as known entries of $\mathbf{A}_0$ and $\mathbf{B}_0$ (average values over the sample, so in this case it is not possible to allow time-variation). I searched over reasonable initial values for the parameters in order to build confidence on the maximum likelihood estimates, as far as global identification was concerned.

6 Dynamic effects of structural policy shocks

This section presents a first set of conclusions about the dynamic effects of fiscal policy and monetary policy innovations, with the aid of the customary tools in an SVAR context, namely, impulse responses and variance decompositions. I recall that the system was estimated with quarterly data, which were seasonally adjusted (except for the funds rate) at source. Government expenditure, net taxes and GDP are in real and *per capita* terms and in loglevels (see Appendix C for more on the variables and sources). Inflation is measured as the change in log GDP deflator. Both inflation and the federal funds rate are annualized. The full sample covers 1955:1-2005:4.

6.1 Contemporaneous impacts and impulse-responses

Table B2 in Appendix B gives the estimates of the contemporaneous coefficients, under the two alternative schemes above as to the ordering of the federal funds rate versus GDP and inflation. Given the length of the sample, it is appropriate to present some evidence regarding subsample sensitivity. Thus I show also those estimates for two subsamples, 1955:1-1979:4 and 1980:1-2005:4 - the breakpoint was chosen as the midpoint. Figure 2 depicts the impulse-responses to positive one-standard deviation shocks (corresponding to about 0.8 p.p. in the case of the interest rate and, respectively, 2.4 and 1.2 percent in the case of net taxes and expenditure).[12] They are for the case in which the macroeconomic variables are ordered before the short-term interest rate, benchmark specification of trends and full sample. I signal in the text how results change when one deviates from those assumptions or restricts the estimation period to the subsamples. In

---

elasticities of the average tax rate to the wage, for personal income taxes and social security contributions, and the weights of the different taxes and transfers in the total.

[12] I present the average response and one-standard error bands, computed by Monte Carlo simulation (as described in Estima (2007)) on the basis of 1000 replications. The responses are measured as a percentage of the variable for GDP, net taxes and expenditure, and in percentage points (annualized) for the interest rate and inflation.

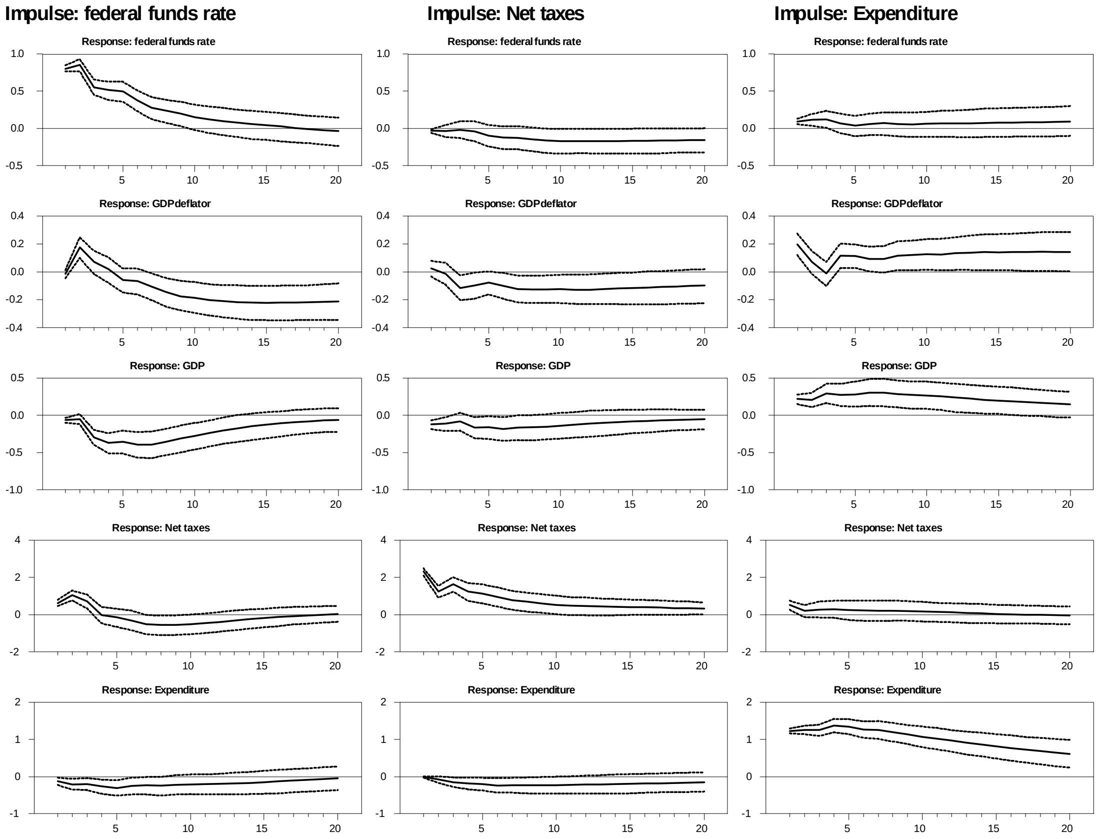


Figure 2: Responses to fiscal and monetary policy shocks

what follows one concentrates mostly on aspects that are new or diverge from the conclusions reached by the work considering each policy in isolation.

Controlling for one policy when measuring the effects of the other (and, in addition, controlling for prices when measuring the effects of fiscal policy) should provide a more accurate measure of the impacts. For instance, if the funds rate is omitted from equation (2), net tax shocks will partly capture the movements in this variable, and their (negative) measured impact on GDP is likely to be overstated for this reason.[13] The size of this kind of effects does not appear to be dramatic though, since the responses depicted in Figure 2 are broadly consistent with those in the mentioned studies taking each policy in isolation (comparison of precise magnitudes may be misplaced given the subsample sensitivity reported below). In general the dynamics of

---

[13] As net taxes respond positively to the federal funds rate, the same will happen with the misestimated shock. Given that the federal funds rate has a negative impact on GDP, this will amplify the depressing effects of the fiscal shock.

GDP take more time to build up following monetary policy shocks, by comparison with their fiscal counterparts, but the relative size of the response (one standard deviation shocks are being compared) is larger.

The assumptions about the ordering of ff_t vis-a-vis y_t and p_t do not matter much for the estimated parameters in the fiscal equations, nor for the contemporaneous impacts on activity and inflation (Table B2). The same holds for the effects of fiscal policy innovations over time, but not, of course, for the effects of monetary policy shocks, in particular, the ensuing decline in GDP depicted in Figure 2 is delayed by three to four quarters after the shock - the effect on impact being positive instead of negative - and becomes overall weaker (similarly to Christiano et al. (1999)). The data clearly reject a zero semi-elasticity of net taxes to the short-term interest rate.[14] This is estimated at around 0.8-0.9 (and rather precisely) in both schemes, implying that a 1 p.p. increase in the interest rate leads to a rise in net taxes not far from 1 percent, on impact. Over time, the automatic positive response of net taxes to a tightening in monetary policy seems to dominate initially (perhaps reinforced by the reaction to the rise in inflation in line with the price puzzle), it then weakens and, after about 1 year, the effect becomes negative as recession takes hold. This squares with the initial decline in the government deficit following a monetary policy shock that Christiano et al. (1996) report.

I now turn to the response of real GDP to fiscal policy disturbances. Overall, the picture is consistent with the conventional Keynesian prior about the effects of such disturbances on real activity[15] (and also on prices). The figures in Table B2 show a positive and significant contemporaneous effect of structural innovations in government spending on activity, in particular, a 1 percent shock raises GDP by around 0.2 percent on impact - corresponding to a 1.07 dollar-for-dollar increase, slightly above the figure estimated in Blanchard and Perotti (2002) (96 to 99 cents). The peak response is reached around the seventh quarter, with a multiplier (the ratio of the peak response of GDP to the initial shock) of about 1.35. The negative contemporaneous impact of structural net tax innovations is, in absolute value, much smaller: less than 30 cents in dollar-for-dollar terms (the estimate is reasonably precise though). The response over time is on the brink of non-significance, and the multiplier stands only at 0.40 (the magnitude depicted in Figure 2 is nevertheless similar to that for spending shocks, because the size of net tax shocks in dollars is about twice larger). Blanchard and Perotti obtain a stronger negative effect of net taxes on output: around 87 cents on impact and a multiplier that varies between 0.8 and 1.3

---

[14] In contrast, the parameter $a^{g,ff}$ is non-significant, as anticipated. Although this is a bit less marked when the short-term rate is allowed to react to macroeconomic developments within the quarter, even in this case both the responses on impact and over time (Figure 2) are very close to zero.

[15] Such evidence can also be reconciled with neoclassical models. A distinction between macro theories could only be made by going deeper and studying, for instance, the effects on output components and transmission channels. This is not the objective of the work presented here. Note, however, that the definition of variables and timing of shocks chosen is suited for investigating the effects of fiscal policy in a Keynesian framework.

depending on the specification. I checked this issue further and, reestimating the system on the basis of their sample (1960:1-1997:4), got a more pronounced impact, in particular the multiplier rises to 1.1. The difference seems thus accounted for by the estimation period, rather than by the inclusion of the interest rate and prices in the system. In fact, the results obtained have a marked subsample sensitivity with respect to effectiveness of fiscal policy to stimulate activity - as the inspection of the figures in Table B2 already hints. The response of output to fiscal disturbances, for both sides of the budget, is markedly stronger in the first half of the sample. In the case of net taxes, in particular, it is not significantly different from zero when the estimation period starts in 1980. Such a weakening of the effectiveness in the second half of the sample also happens in the case of monetary policy.

Romer and Romer (2007) found as well a negative effect of tax shocks and a large multiplier, which depends on the precise specification but is in general well over 2.0. The Romers considered taxes (not net taxes) and constructed a series for the shocks directly from the legislated tax changes described in the narrative sources. They then estimated the impact of the shocks exogenous to economic activity and spending, according policymakers' statements. The large impact they get could suggest that their shock measure is comparatively less polluted by endogeneity with countercyclical fiscal policy, which leads to an underestimation of the respective effects. But note that, by construction, the shocks derived in this paper are ortogonal to the business cycle as well, and also to spending, prices and the funds rate. This should by and large exclude automatic and endogenous legislated changes in taxes. There are important differences between the two methodologies nonetheless, for instance, as far as the magnitude of the shocks is concerned. In the SVAR approach this magnitude is given by the deviation of the variable from the average endogenous component over the sample period, while in the Romers's methodology it is determined on a case by case basis, from the narrative sources. Such differences may account for the observed discrepancy in the results.

The magnitude of the effects of the fiscal disturbances on inflation is slightly above 0.1 p.p., in absolute terms. The responses are barely significant though, and the dynamic path of the variable following spending innovations is a bit awkward, going down quickly toward zero and becoming significant again at about the fifth quarter. As to the plausibility of the point estimates, since the path of inflation presumably reflects the departure of output from the flexible price level, one can assess it against standard Phillips curve results. The deviation of the level inflation from the steady state in p.p. is about one half of the percentage deviation of GDP from trend, which seems reasonable according to the evidence presented, for instance, in Gordon (1997). Given the targeting of the federal funds rate, its response to shocks to government budget should derive, indirectly, from the impacts on activity and inflation. For government expenditure shocks, it is a very tiny one and actually not significant.

The structural disturbances to government expenditure do not enter significantly the net tax equation - a finding already reported in Blanchard and Perotti. Switching the order of net taxes and expenditure, i.e. considering $b^{g,nt} \neq 0$, leads to a similar conclusion.[16] Over time, innovations to net taxes and purchases of goods and services do not trigger a mutual response, irrespective of the ordering of the two variables. This finding is confirmed by the variance decompositions (and discussed in more detail below) and is surprising. One would expect a stronger feedback between these variables, given the presumable tendency by government to partly finance changes in one of them with changes in the other, which should originate a short-run response, and the obvious long-run relationship depicted in Figure 1.

When the system is estimated including only a constant, without detrending GDP and the fiscal variables, the fiscal policy shocks have a much more persistent effect on GDP. In contrast to Figure 1, the responses hardly go back to trend within the 5 years after the shock and, in addition, the peak and trough impacts become more pronounced (another change is that the path of inflation following a shock to net taxes becomes positive after about 5 quarters). This increase in persistence also occurs, but is less evident, for monetary policy. However, as said, the specification without detrending may not capture the output gap well, as it does not allow for the decrease in long-run growth of GDP over recent decades.

6.2 Variance decompositions

Table 1 shows the decomposition of the forecast error variance for the policy variables into the portion accounted for by each of the three identified policy shocks and the non-policy shocks considered jointly.[17] The first interesting point emerging from the table is that own shocks to the federal funds rate and net taxes explain, respectively, only 1/4 and 1/5 of the long-run fluctuation in the variables. In other words, the movements in these variables are mostly endogenous, happening in response to macroeconomic conditions. By contrast, own innovations to government expenditure explain about 3/4 of the long-run variation.

The overwhelming contribution of the own innovation to the variance decomposition of government expenditure indicates that most movements affecting this variable pursued policy goals that cannot be traced back (and hence are exogenous) to macroeconomic conditions. Among these goals feature, as alluded to in Section 2, national security, expenditure restraint or wage comparability with the private sector. There is nevertheless a response of this variable to prices through which most the role of non-policy innovations in the decomposition reported in Table

---

[16] The figures corresponding to the ones in Table B2 (full sample) are, respectively, $\hat{b}^{g,nt} = -0.02[\hat{t} = 0.6]$ and $\hat{b}^{g,nt} = -0.02[\hat{t} = 0.5]$.

[17] The latter is equal to the contribution associated with the variances and covariance of w_{1t} and w_{2t}. As explained in Section 3, these ultimately reflect the variances of the underlying structural disturbances to private aggregate demand and aggregate supply.

1 is likely to materialize. Net taxes have a strong endogenous content, notably reflecting responses to the business cycle and prices. The difference vis-a-vis the behavior of spending hints that the latter are basically automatic responses. This conclusion is also corroborated by the fact shown by Romer and Romer (2007) that the legislated tax changes responding to cyclical developments were infrequent and almost confined to the decade 1965-1975.[18] As a whole these findings underpin the conclusion that the concept of policy reaction function is much less compelling in the case of fiscal policy than of monetary policy. The strong endogenous content of the monetary policy instrument has been acknowledged in the literature (see, for instance, Sims and Zha (1998)): it reflects the conduct of stabilization actions by the Federal Reserve through the policy rule (when y_t and p_t are ordered before ff_t the effect remains although less markedly - non-policy shocks account for slightly less than 60 per cent of total variance).

Table 1: Variance decomposition: policy variables

Shocks	Expenditure				Net taxes				Federal funds rate			
	Policy			Non-pol.	Policy			Non-pol.	Policy			Non-pol.
	e^g	e^{nt}	e^{ff}		e^g	e^{nt}	e^{ff}		e^g	e^{nt}	e^{ff}	
1Q ah.	94.6	0.0	0.9	4.3	2.8	55.9	4.0	37.3	1.1	0.1	91.3	7.9
4Q ah.	92.2	0.1	2.3	5.2	1.1	25.7	4.7	68.5	1.1	0.1	55.6	43.1
12Q ah.	83.8	2.1	2.9	14.5	1.0	19.1	4.8	75.1	0.8	2.3	31.2	65.1
24Q ah.	74.6	2.4	2.3	27.6	1.0	19.3	4.8	74.9	1.3	4.7	24.4	69.6

Notes: Percentage of the variance of the error in forecasting government spending, net taxes and the funds rate accounted for by the structural policy disturbances (government spending, net taxes and funds rate) and non-policy disturbances.

A second point coming out of the table is the already noted lack of mutual response between the fiscal variables: each one never explains more than a residual amount of the variance of the other. Note that, given the definition of the budget variables adopted here, in which social benefits are netted out against taxes, this concerns the absence of a short-term response between revenue and purchases of goods and services that are only part of total budget outlays. In any case, there seems to be less an important short-term feedback between the two sides of the budget than usually assumed. Inspection of Figure 1 shows that there is nevertheless a low frequency co-movement linking net taxes and spending that, by consequence, is not accounted for by a short-run one. Such long-run relationship must originate in the fiscal actions toward correcting budget imbalances but, as mentioned in Section 3, these seem to be follow a non-linear pattern perhaps related the size of the cumulative imbalance, which causes them to take place at infrequent intervals. The system does not have a mechanism to capture such an effect, and so this may translate ultimately into some bias in figures in Table 1 against the contribution of each budget variable to the variance of its counterpart.[19] One way to get an idea about the size of the bias is to impose a long-run relationship, even if not a fully adequate one, by assuming cointegration between net taxes and expenditure (instead of extracting the trends). When this is done, spending (ordered first) explains about 18 per cent of the variation in taxes in the long-run and triggers a positive and persistent reaction of this variable. The contribution of non-policy innovations to that variation remains high, nevertheless, at 60 per cent. The variance decomposition of spending continues to be dominated by the own innovation - with a share of 85 per cent in the long run.

---

[18] That the intensity of the discretionary fiscal response to the business cycle has changed over time implies that there would be gains in introducing time-variation in the system. In fact, the subsample sensitivity found points in the same direction.

Table 2 shows the variance decomposition of forecast errors for GDP and inflation. There is not much to be taken out of these results except that exogenous policy explains a relatively small part of movements in GDP - about one quarter, considering both policies. In other words, such interventions are not the primary source of business cycle fluctuations (the same holds for movements in prices). Monetary policy VARs have come to a similar finding - see Sims and Zha (1998). On the other hand, it is well known that the figures in the table - referring to exogenous policy - do not do justice to the stabilizing role of policy when it operates mostly in a systematic way, be it automatic or discretionary.

Table 2: Variance decomposition: non-policy variables

	GDP				Inflation			
	Policy			Non-pol.	Policy			Non-pol.
Shocks	e^g	e^{nt}	e^{ff}		e^g	e^{nt}	e^{ff}	
1Q ah.	7.5	2.4	0.5	89.6	3.9	0.0	0.0	96.0
4Q ah.	5.9	1.5	5.3	87.3	3.4	1.4	2.2	92.9
12Q ah.	9.6	3.0	11.9	75.5	4.2	3.5	5.9	86.4
24Q ah.	11.9	3.3	12.0	72.8	6.8	4.8	13.4	75.0

Notes: Percentage of the variance of the error in forecasting GDP and inflation accounted for by structural policy disturbances (government spending, net taxes and funds rate) and non-policy disturbances.

7 The role of fiscal and monetary policies during contractions

In this section, the identified VAR estimated previously is used to shed some light on the behavior and effects of monetary and fiscal policies during postwar business cycle contractions. Such an analysis has of course to include systematic policy that appears to be the dominant source of variation in the federal funds rate and net taxes. This is impossible using the standard VAR tools since they provide a way to evaluate the impact of *exogenous* policy only. I resort to a methodology employed by Sims and Zha (1998) and Bernanke et al. (1997) to overcome that difficulty. The basic idea behind it is to compare the historical behavior of the variables of interest with the implied behavior when the system is simulated under counterfactual assumptions, which here concern modifications in the policy responses and paths of exogenous policy shocks. I undertake this exercise for each of the eight business cycle contractions - as given by the NBER dates - over the sample period 1955:1-2005:4. It is well known that the implementation of such policy analyses in a VAR context is not without caveats given the issues raised by the Lucas critique: one can argue that if endogenous policy had been different from the historical path, agents could have reacted differently. In defense of this approach, one can put forward the argument of Sims and Zha that it may provide acceptable results if the deviation of policy from its historical path is not too protracted. The episodes considered lasted on average less than 4 quarters.[20] Beyond that issue of a more theoretical nature, another caveat to be made concerns the reliance on a model with constant coefficients throughout an extended period and on the identification assumptions. Analyses like the one carried out here have been pursued by previous literature using different methodologies - a particularly well-known example being Romer and Romer (1994), who nevertheless do not differentiate between endogenous and exogenous policies. Some of the findings will be assessed against the description provided by the Romers of the conduct of monetary and fiscal policies around recessionary episodes.

---

[19] Anther issue arising is that some fiscal actions to cope with protracted deficits will be captured by the estimated fiscal shocks. To the extent that this category of shocks is approximately unrelated to current economic developments, the implications should not be dramatic.

The detailed methodology of the counterfactual exercises is as follows. For each contraction and each policy variable, I simulate the system (1) to (5) under two scenarios: (i) absence of the *exogenous* component of policy and (ii) absence of the *endogenous* component of policy. The simulation period starts at the first quarter after the peak and ends at the quarter of the trough (for GDP I also present the results for two quarters afterwards). More precisely, taking g_t as an example, exercise (i) is carried out with the parameters in all equations at their estimated values and the shocks set to their estimated paths during the simulation period, except for $\hat{e}_t^g$ which is set to zero. Exercise (ii) shuts down any systematic reaction of g_t so that during the simulation period the variable in driven only by exogenous shocks. This is done by setting all parameters in (1) to zero, except for the first lag of the policy variable at issue which is set to one. Otherwise the shocks to all variables, including $\hat{e}_t^g$, are set to their estimated paths and the parameters in the remaining equations are at their estimated values. The exogenous and endogenous components obtain as the difference between the actual level and the simulated level of the policy variable at the trough. Similarly, the effect on GDP is measured as the difference between the actual level of output gap and the level implied by the simulation.

---

[20] Although it is difficult to assess what «not too protracted» might be in this context, Blanchard (1984) concluded that it took more than one year for financial markets to believe the Volcker deflation, and perhaps more than that in the case of labor markets.

Table 3 breaks down the actual peak-to-trough change in expenditure, net taxes and the federal funds rate into the systematic and exogenous components. Note that the change in each policy variable is not exactly matched by the sum of two components, because there is an interaction between them (as each policy variable incorporates the own structural shocks in previous periods) that the simulation exercise by definition does not capture. Nonetheless, in general, this is not as important as to prevent a reasonable approximation.

Table 3: Decomposition of changes in the policy variables during contractions

Business cycle contractions	Expenditure (%, cumulative) actual change	cf. decomp. exog.	endog.	Net taxes (%, cumulative) actual change	cf. decomp. exog.	endog.	Fed. funds rate (p.p., cumulative) actual change	cf. decomp. exog.	endog.
57:03-58:02	1.2	0.6	0.5	-16.0	-1.6	-14.1	-2.3	1.5	-4.1
60:02-61:01	2.9	3.4	-0.7	-6.9	4.5	-14.3	-1.7	0.5	-2.1
69:04-70:04	-2.5	-1.3	-1.0	-15.8	0.6	-15.6	-3.4	-1.4	-2.0
73:04-75:01	1.8	3.7	-1.8	-18.4	6.0	-28.0	-3.7	-3.9	-0.3
80:01-80:03	-2.5	-2.9	0.5	-8.7	2.0	-11.0	-5.2	-2.6	-2.6
81:03-82:04	1.8	1.0	0.7	-20.5	-0.5	-20.0	-8.3	-1.1	-7.5
90:03-91:01	0.6	0.5	0.0	-8.6	-1.4	-6.5	-1.7	0.1	-1.8
01:01-01:04	1.9	-0.5	2.3	-12.6	0.8	-10.5	-3.5	-2.0	-1.1

Notes: The dates indicate the peak and trough quarters. Actual change in the variable is measured as the variation peak-to-trough. The components are equal to the difference, at the trough, between the actual figure for the policy variable and the simulated figure shutting down the exogenous or the endogenous response, respectively. The simulation period starts in the first quarter after the peak.

The first fact coming out of Table 3 is the consistent pattern of anti-recessionary endogenous movements in the federal funds rate and net taxes. Nothing comparable happens for government expenditure whose endogenous variation is not even uniformly countercyclical (i.e. positive). This reinforces the idea that the endogenous movements in spending are mostly related to prices and, given the marked difference between the behavior of the two fiscal variables, that the automatic stabilizers are the driving force behind net taxes. As one would expect, the exogenous components of the change in the policy variables do not follow a defined pattern.

The estimated monetary policy rule is compatible with systematic actions building the backbone of the countercyclical behavior of monetary policy throughout recessions. In the 1973-75 and 1980 recessions, however, an important part of the countercyclical movement was captured by the exogenous component. In other words, the actual loosening was larger than implied by the estimated rule. Note that inflation went up substantially during those episodes giving rise, according to that rule, to a smaller response than the usual one given the sharp contraction in output (see Figure 1). This fits in with the reading of the Fed's behavior during the two recessions in Romer and Romer (1994), in that, the Fed recognized at an early stage the downturns in activity but hesitated to take action (in what can be seen as acting according to the rule) due to concerns about inflation. Only later, in view of the unfavorable output developments, decided to cut the funds rate more sharply. In the most recent contraction there was almost an overreaction of the instrument as a whole, given the comparatively mild decline in activity (but the caveat made about the assumption of constant coefficients throughout the sample period is in order here)[21].

The overall change in net taxes is clearly dominated by the endogenous component, suggesting a high degree of responsiveness to the business cycle. The exogenous component is small, by comparison. No important tax measures that could be classified as exogenous were enacted in the course of the periods considered, with exception of the Reagan tax cuts coinciding with the 1981-82 recession. Nevertheless, during the first half of the sample, personal income tax brackets used to remain unchanged for some time - as it happened in the periods overlapping with all recessions up to and including 1980 (see Tax Foundation (2007)). This amounted to a tax increase even without legislation passed, for recessions stretching over two taxable years, in particular in times of high inflation. It may explain the positive sign and large size of the exogenous component in the 1973-75 recession.[22] The exogenous component of net taxes is also impacted by the evolution of social transfers. Looking at the growth rate of social transfers in real and per capita terms, excluding the category most responsive to the business cycle, unemployment insurance, one observes that such rate used to be somewhat higher in the contractions occurring in the first half of the sample, and thus contributed to shrink the exogenous component (of *net* taxes) at those times.[23] It is worth noting that the large tax cuts of the sixties and seventies occurred outside contractionary episodes, as dated by the NBER. This is partly due to the delay in fiscal policy implementation: the 1975 tax rebate and other measures enacted by the Nixon administration, though countercyclical, were felt mostly in the second quarter of the year, that is one quarter after the trough. The 1964 tax cut happened in the middle of an expansion and, according to the Romers' reading, it was motivated by concerns about sluggish growth and incentives.

---

[21] Figures in Table B2 indicate that the coefficients in the monetary rule are larger in the second half of the sample (this is in line with the evidence in Clarida et al. (2000)). Thus, the use of an «average» rule for the full sample period may entail a certain underestimation of the endogenous component in recent decades.

[22] Such movement could be partly captured by the endogenous component, to the extent that it was a systematic reaction to inflation. Note, however, that this was not a persistent feature throughout the sample.

[23] As explained in Appendix A, in the calculation of the elasticities I only considered a current response to GDP for unemployment benefits. Other categories of transfers may have some sensitivity to it. Visual inspection of the chart with the growth rate of transfers not related to unemployment indicates that this may have been the case over the last two decades (covering the recessions at the beginning of the 1990s and 2000s), perhaps reflecting an increased weight of programs to fight poverty. This tends to overstate the exogenous component of transfers vis-a-vis the endogenous one in the two last contractions.

The size of the movements in government expenditure during contractions have been much smaller than for the other variables: they averaged 1.5 standard deviations[24] against almost 5 in the case of the funds rate, and almost 6 in the case of net taxes. In this case, it is the exogenous component that dominates, again suggesting that the countercyclical role is unimportant. That component captures the buildups in defense spending coinciding with recessionary episodes, but there is only one such case in the postwar period: the rise in military expenditure during the Reagan administration (1981-82). Defense outlays also increased much in the wake of the 11/9 which happened toward the end of the 2001 contraction. However, this affected only the last quarter of the episode and did not have much influence on the behavior of spending in the course of it, as a whole. Variations in the exogenous component of expenditure were larger in absolute value in the first half of the sample (without an uniform direction) and this may be related with the mentioned fact that compensation of employees varied much largely until the beginning of the 80s. It is difficult, nevertheless, to relate the figures and magnitudes in the tables with precise wage increases taking place in the periods. There may be other influences at work and, as said, part of the variation in real compensation of employees is endogenous - the exogenous shock is, broadly speaking, the deviation of the actual response to inflation from that average estimated endogenous response. Such endogenous response encompasses a negative reaction to current inflation (as calibrated above), given the absence of contemporaneous indexation and, one would expect, a positive one to lagged inflation. One expects that this will reduce the endogenous component in periods of rising inflation and the opposite in times of declining inflation. As Figure 1 shows, two of the recessions considered coincided with such periods: 1973-75 (rise) and 1981-82 (decline). The mentioned effect appears to be present in the first one but not so clearly in the second.[25]

---

[24] Considering only the positive (i.e. countercyclical) changes.

[25] The endogenous component of spending in the 1981-82 recession is nonetheless the largest (positive) of all episodes, with exception of that in the most recent one whose magnitude is difficult to explain.

Table 4: Impact of fiscal and monetary policies on output

Business cycle contractions	Impact (%, cumulative) of changes in:					
	Expenditure		Net taxes		Fed. funds rate	
	exog.	endog.	exog.	endog.	exog.	endog.
57:03-58:02						
at the trough	0.1	0.1	0.1	1.0	-0.4	0.6
2Q afterwards	0.3	0.2	0.0	1.1	-0.8	1.9
60:02-61:01						
at the trough	0.7	-0.1	-0.3	1.0	0.1	0.2
2Q afterwards	0.7	0.0	-0.4	1.1	-0.1	0.9
69:04-70:04						
at the trough	-0.3	-0.2	0.0	1.1	0.1	0.5
2Q afterwards	-0.5	-0.3	0.2	1.5	0.7	1.0
73:04-75:01						
at the trough	0.8	-0.4	-0.5	2.1	-0.3	-0.2
2Q afterwards	0.8	-0.4	-0.4	2.8	1.3	0.0
80:01-80:03						
at the trough	-0.5	0.1	-0.1	0.7	0.2	0.2
2Q afterwards	-0.4	-0.1	-0.1	0.3	0.8	1.0
81:03-82:04						
at the trough	0.2	0.1	0.0	1.7	-0.3	2.2
2Q afterwards	0.2	0.2	-0.2	2.4	0.3	4.2
90:03-91:01						
at the trough	0.1	0.0	0.1	0.5	0.0	0.1
2Q afterwards	-0.4	0.1	0.1	0.8	-0.1	0.8
01:01-01:04						
at the trough	0.1	0.4	0.1	0.7	0.4	0.2
2Q afterwards	0.1	0.8	0.8	1.3	0.9	0.6

Notes: The impact on GDP is equal to the difference, at the trough and two quarters afterwards, between the actual GDP level and the simulated level, shutting down the endogenous policy response. The simulation period starts in the first quarter after the peak.

What was the impact on GDP of the outlined pattern of changes in policy variables during contractions? The figures in Table 4 try to answer that question, presenting the estimated output gain, both at the trough and two quarters afterwards.[26] The second figure will capture the impact of movements in policy variables occurring before but close to the trough, that might not be reflected in the first one, if the reaction of GDP takes time to build up (as it happens with exogenous monetary policy, as documented above). The automatic stabilizing role of taxes comes out very clearly from the figures in Table 4: it can be quantified at around 1 per cent in terms of output loss avoided at the trough (it stood over 2 per cent in the 1973-75 contractions). By comparison, the role of systematic monetary policy is somewhat less important at that point (the 1981-82 contraction builds an exception), but it rises to equal importance two quarters afterwards. In short, taxes and transfers have contributed more than the monetary policy instrument to moderate the severity of recessions, and both contribute similarly to the strength of the recovery at early stages. Government spending has played a minor role as a stabilizing tool since mid-fifties. In most recessions, the difference in the impact of the endogenous component on GDP at trough and following 2 quarters is larger in the case of the funds rate than in the case of net taxes, which indicates that the full-impact of monetary policy on GDP is comparatively delayed.

---

[26] The latter includes the contribution of changes in policy taking place within the two quarters following the trough.

8 Conclusions

In this paper an SVAR system was estimated, identifying monetary and fiscal policy disturbances, and counterfactual simulations were carried out in order to gauge the impacts of systematic versus non-systematic policies. The following main conclusions were reached:

- The consideration of fiscal and monetary policies in conjunction does not change, in broad terms, the pattern of responses of activity to policy shocks, documented by previous studies taking each policy in isolation. Nevertheless, a weaker impact of net taxes on activity was found which can be mainly ascribed to subsample sensitivity. This is a marked feature of the results for fiscal policy that warrants further exploration. Results also point to a relatively unimportant short-term feedback between net taxes and purchases of goods and services.

- Variance decompositions show that the federal funds rate and net taxes have a large endogenous content while government expenditure is mostly driven by own shocks. The behavior of the federal funds rate reflects the operation of the monetary policy rule. The difference in the behavior of net taxes and spending is basically accounted for by the automatic stabilizers built in the tax and transfer system. In general, the concept of policy reaction function seems to fit in much better with the way monetary policy is conducted, in comparison to fiscal policy.

- The main forces playing a stabilizing role during the contractions in activity since the fifties were discretionary monetary policy and automatic fiscal policy. The latter has the largest impact in terms of reduction in output foregone at the trough of recessions, but they contribute similarly in the ensuing quarters to narrow the output gap.

9 Appendices

A Detailed computation of the contemporaneous fiscal elasticities

A.1 Personal income taxes

The derivation of theoretical expressions for the elasticity to GDP, prices and the interest rate of personal income taxes (which also applies with small changes to the elasticity of social contributions to activity and prices) is a bit more involved than for the remaining types of taxes. I assume that the personal income tax base reacts to prices, as nominal wages adjust to it to some degree, and also to the short-term interest rate, as the latter affects asset income earned by households. Each individual in the population (assumed to be equal to the labor force) earns labour income and/or asset income. Let the real personal income tax revenue be given by $T = [t((W(L,P) + A(FF))(W(L,P) + A(FF))L(Y)]/P$ where $t(.)$ is the average tax rate, W the nominal wage, A individual income on assets, P prices, L employment, Y GDP and FF the federal funds rate.[1] The nominal tax base per worker is $B = W + A$. I assume that the income on assets reacts contemporaneously only to the federal funds rate because, as regards personal interest income, the underlying stock is mostly determined by past economic conditions, while dividends are also linked to past profits.

The elasticity of real personal income tax revenue to output is given by

$$\begin{aligned} a_{PIT,Y} = \frac{\partial \ln T}{\partial \ln Y} = \frac{\partial \ln t}{\partial \ln W}\frac{\partial \ln W}{\partial \ln L}\frac{d \ln L}{d \ln Y} + \frac{\partial \ln B}{\partial \ln W}\frac{\partial \ln W}{\partial \ln L}\frac{d \ln L}{d \ln Y} + \frac{d \ln L}{d \ln Y} \\ = a_{W,L}a_{L,Y}(a_{t,W} + s_W) + a_{L,Y}, \end{aligned} \tag{A1}$$

where $a_{W,L}$ the elasticity of wages to employment, $a_{L,Y}$ the elasticity of employment to output, $a_{t,W}$ is the elasticity of the (average) tax rate to the wage and $s_W = \frac{W}{W+A}$ is the share of labour income in total income. Note that the expression for $a_{PIT,Y}$ appearing in OECD's work (in Giorno et al. (1995)) corresponds to the one above but with s_W is equal to 1, as they consider labor income only.

---

[1] I assumed in the computation of the elasticities of purchases of goods and services that the wage bill in the government sector does not respond to macroeconomic developments (see below). One would have to consider a separate elasticity for government's wage bill, as a component of the tax base, to be fully consistent. I have not done so, in order to simplify matters.

The elasticity of the real tax revenue to prices is given by

$$a_{PIT,P} = \frac{\partial \ln T}{\partial \ln P} = \frac{\partial \ln t}{\partial \ln W}\frac{\partial \ln W}{\partial \ln P} + \frac{\partial \ln B}{\partial \ln W}\frac{\partial \ln W}{\partial \ln P} - 1/4 = a_{W,P}(a_{t,W} + s_W) - 1/4, \tag{A2}$$

in which $a_{W,P}$ is the elasticity of wages to prices and the changes in prices are measured at annual rates.

The semi-elasticity of real tax revenue to the short-term interest rate is given by

$$a_{PIT,FF} = \frac{\partial \ln T}{\partial FF} = \frac{\partial \ln t}{\partial \ln A}\frac{d \ln A}{dFF} + \frac{\partial \ln B}{\partial \ln A}\frac{d \ln A}{dFF} = a_{A,FF}(a_{t,A} + s_A), \tag{A3}$$

where $a_{A,FF}$ is the semi-elasticity of asset income to the interest rate and $s_A = \frac{A}{W+A}$ is the share of asset income in total income.

The expressions above are based on the partial derivatives of the real income tax revenue with respect to each one of the variables of interest which assume, by definition, that the *other* variables in the expressions remain constant. This assumption does not raise problems because such partial effect is exactly what the contemporaneous coefficients in the structural equations are supposed to measure.[2] I now examine the assumptions underlying the computation of the elasticities of the average tax rate to the wage and asset income per worker, $a_{t,W}$ and $a_{t,A}$ (the remaining parameters are estimated by means of econometric regressions - see below). It is clear that these elasticities will not be constant throughout the wage and asset income distribution. Nevertheless, one needs a summary measure in order to compute the figures using the expressions given above. The OECD approach copes with this, for the labor income case, by computing the average and the marginal tax rates of a representative family with certain characteristics, at different points of the wage distribution. Afterwards a weighted average of each of the two tax rates is computed on the basis of the weight of wage income at each point in total. The ratio of the two weighted averages yields the summary elasticity measure. This procedure is carried out for several years so to incorporate modifications in the tax code.

In order to describe precisely how to extend this procedure to the case of labor and asset income, and to illustrate the difficulties to compute $a_{t,A}$, I now denote *with ij* the magnitudes above evaluated at the arbitrary cohort (W^i, A^j) of the wage and individual asset income distribution, and *without ij* the corresponding aggregate magnitudes. Assuming that the elasticity to the base at a given cohort (W^i, A^j) is the same irrespective of whether there is a marginal variation in the wage or individual asset income[3], and denoting that elasticity by $a_{t,B}^{ij}$, then one can write $a_{t,W}^{ij}{=}s_W^{ij}a_{t,B}^{ij}$ and $a_{t,A}^{ij}{=}s_A^{ij}a_{t,B}^{ij}$. The corresponding aggregate elasticities are given by

---

[2] That is, the derivative of real direct taxes with respect to Y assumes that FF and P are unchanged when Y varies. Of course, when GDP changes, the federal funds rate and prices may change as well, but this is captured by other contemporaneous coefficients than $a_0^{nt,y}$.

$$a_{t,W}{=}\textstyle\sum_i\sum_j\phi^{ij}s_W^{ij}a_{t,B}^{ij}\qquad\text{and}\qquad a_{t,A}{=}\textstyle\sum_i\sum_j\phi^{ij}s_A^{ij}a_{t,B}^{ij},\tag{A4}$$

where the ϕ^{ij}'s are the weights computed as the share of wage and asset income associated with the cohort (W^i, A^j) in total income from both sources ($\phi^{ij} = L^{ij}B^{ij}/\sum_i\sum_j L^{ij}B^{ij}$ with B^{ij} equal to $W^i + A^j$ and L^{ij} equal to the number of individuals associated with the cohort (W^i, A^j)). The computation of precise figures for $a_{t,W}$ and $a_{t,A}$ would thus require information about the distribution of (W, A) and the corresponding values for $a_{t,B}^{ij}$, for several years, which is not available.

Nevertheless, the OECD figure should provide a good basis to compute $a_{t,W}$. Note that, if $a_{t,B}^{ij}$ was constant for a given wage level W^i (i.e. it did not depend upon j because all individuals would concentrate in a given cohort A), then $a_{t,W}{=}s_W\sum_i\psi_W^i a_{t,B}^i$ would hold, with the weights ψ_W^i given by the share of wage income associated with the cohort W^i in total, according to the marginal distribution of W. This relationship should provide a reasonable approximation in practice, as there is a higher concentration of individuals (at lower cohorts) for individual asset income than for wages. Further, as labor income represents the bulk of personal income, the elasticities calculated considering only labor income as the tax base (as in OECD) should not be too far from $a_{t,B}^i$. By contrast, such elasticities and information about the the marginal distribution of W would not be suitable for the calibration of $a_{t,A}$.

The OECD figures correspond to $\sum_i\psi_W^i a_{t,B}^i + 1$ (as they refer to the elasticity of the tax revenue not of the tax rate) and vary considerably over time, ranging from 1.3 to 3.9 over the last three decades. The computation of aggregate figures for the shares of labor and asset income - s_W and s_A - does not raise problems since they are just the shares of wage and asset income for the economy as a whole[4] (see Appendix C for the series used). The figure for s_W ranges from 0.75 to 0.85 over the period 1955:1-2005:4.

The remaining parameters in (A1) and (A2) are computed through econometric regressions, following the method in Blanchard and Perotti (2002). Specifically, $\hat{a}_{W,L} = 0.33[\hat{t} = 4.0]$ and $\hat{a}_{W,P} = 0.09[\hat{t} = 1.6]$ are the lag 0 coefficients of a regression of log change in wages on the first lead and lags 0 to 4 of log change in employment and change in annualized inflation (sample 1955:1-2005:4).[5] Note that I take as the price variable inflation measured at annual rates.

---

[3] This may not happen for every (W^i, A^j). For instance, if there are tax deductions applying only to labor income, say the first \$X dollars of employment income are exempt from tax, then for wage levels below \$X the marginal change in tax revenue is zero when the wage changes but positive when asset income changes.

[4] As $s_W = \sum_i\sum_j\phi^{ij}s_W^{ij}$ and $s_A{=}\sum_i\sum_j\phi^{ij}s_A^{ij}$.

[5] One could raise the issue of simultaneity in relation to the regressions used to compute some of the parameters in (A1) and analogous expressions. I checked the results of corresponding regressions excluding the leads and using

Likewise $\hat{a}_{L,Y}$ =0.68[$\hat{t} = 12.1$] is the lag 0 coefficient of a regression of log change in employment on the first lead and lags 0 to 4 of log change in GDP. The average figures for $\hat{a}_{PIT,Y}$ and $\hat{a}_{PIT,P}$ are equal, respectively, to 1.1 and -0.09.

A.2 Social security contributions

The responses of social contributions are based on the corresponding expression for the real revenue $T = [t((W(L,P))W(L,P)L(Y)]/P$, where $t(.)$ is the average tax rate and the other variables are as above. The elasticities of real social contributions revenue to output and prices are, respectively,

$$a_{SC,Y} = \frac{\partial \ln t}{\partial \ln W}\frac{\partial \ln W}{\partial \ln L}\frac{d \ln L}{d \ln Y} + \frac{\partial \ln W}{\partial \ln L}\frac{d \ln L}{d \ln Y} + \frac{d \ln L}{d \ln Y} = a_{W,L}a_{L,Y}(a_{t,W} + 1) + a_{L,Y}, \tag{A5}$$

$$a_{SC,P} = \frac{\partial \ln t}{\partial \ln W}\frac{\partial \ln W}{\partial \ln P} + \frac{\partial \ln W}{\partial \ln P} - 1/4 = a_{W,P}(1 + a_{t,W}) - 1/4. \tag{A6}$$

The average figures for $\hat{a}_{SC,Y}$ and $\hat{a}_{SC,P}$ are equal, respectively, to 0.88 and -0.17.

A.3 Corporate income taxes

The tax base of the corporate income tax, corporate profits, is supposed to react to GDP and prices. I assume that the tax is proportional (note further that the corporate income tax is recorded on an accrual basis by NIPAs, which should approximately undo the lag between the earning of profits and the payment of the tax). Therefore, real corporate income tax revenue is given by $T = tPR(Y,P)/P$, where t is the tax rate and PR are corporate profits. The elasticities of corporate income taxes to GDP and prices are, respectively,

$$a_{CIT,Y} = \frac{\partial \ln PR}{\partial \ln Y} = a_{PR,Y}, \tag{A7}$$

$$a_{CIT,P} = \frac{\partial \ln PR}{\partial \ln P} - 1 = a_{PR,P} - 1/4, \tag{A8}$$

where $a_{PR,Y}$ and $a_{PR,P}$ are the elasticities of profits to GDP and prices. These parameters were computed as the coefficients for lag 0 of a regression of the first differences of log profits on the first lead and lags 0 to 4 of the change in log GDP and the change in annualized inflation. This yielded $\hat{a}_{PR,Y} = 4.6[\hat{t} = 10.4]$ and $\hat{a}_{PR,P} = 1.8[\hat{t} = 4.7]$. Accordingly, $\hat{a}_{CIT,Y} = 4.6$ and $\hat{a}_{CIT,P} = 1.6$.

---

lags of the right-hand side variables as instruments and they differed by little.

A.4 Indirect taxes

The tax base of indirect taxes is assumed to be nominal GDP and the tax to be proportional. The revenue of indirect taxes in real terms is given by $T = tY$, where t is the tax rate, implying a 1.0 elasticity to activity and a 0.0 elasticity to prices.

A.5 Transfers to households

Transfers to households are expected to only to activity mainly through unemployment insurance payments. Such payments have represented on average only about 3 percent of social benefits over the last decade, though at the beginning of the sample they represented a bit more than that, averaging 5 to10 percent. Let real transfers to households be equal to $T = (\bar{T}+UB(Y))/P$, where $\bar{T}$ is the component of transfers that does not react to activity and $UB(Y)$ is the amount of unemployment benefits. The elasticity of transfers to households to GDP is approximately (ignoring the term related to the response of labor force to the business cycle) given by

$$a_{TH,Y} = s_{UB}\frac{d\ln UB}{d\ln Y} = s_{UB}\frac{du}{d\ln Y}\frac{1}{u} = s_{UB}a_{u,Y}\frac{1}{u}, \tag{A9}$$

where s_{UB} is the share of unemployment benefits in total transfers, $a_{u,Y}$ is the unit variation of the unemployment rate in response to a 1 percent increase in GDP and u is the unemployment rate. I set $a_{u,Y}$ equal to -0.24 from Blanchard (1989). The average figure for $\hat{a}_{TH,Y}$ is -0.26.

As to the contemporaneous response to prices, many categories of social benefits such as old-age and unemployment benefits are not indexed within the quarter, and thus a -1.0 elasticity for real outlays seems adequate. By contrast payments related to health programs are likely to be sensitive to change in prices. I assume for them a zero elasticity in real terms. These payments were rather small in the fifties and sixties, but they have become one of the most important components of social benefits, weighting currently over 40 percent. The elasticity of transfers to households to prices is based on an expression analogous to the one above, but picking out the part of transfers that reacts to prices, i.e. health benefits. That is,

$$a_{TH,P} = \frac{d\ln T}{d\ln P} = (s_{HB} - 1)/4, \tag{A10}$$

where s_{HB} is the share of health benefits in total. The average figure for $\hat{a}_{TH,P}$ is -0.19.

A.6 Purchases of goods and services

Purchases of goods and services are composed of compensation of government employees and intermediate consumption and investment (one does not have to consider here the consumption of fixed capital since it is excluded from the measure of purchases used - see Appendix C). The share of compensation of employees in total was slightly below 50 per cent in the initial years of the sample, but it has represented a bit more than half of the total since mid-sixties. In general one expects intermediate consumption and investment spending to be determined by the nominal amount budgeted, implying a -1.0 elasticity of real purchases to contemporaneous inflation. Also the wage updating process in the government sector is such that price developments typically affect wages with some lag. There may be indexation but with a certain delay, for instance, pay adjustments for the blue-collar occupations in the Federal government (Federal Wage System) are indexed to lagged changes in private sector wages, according to the areas where the services are located (see Office for Personnel Management (2002)). The semi-elasticity of real purchases of goods and services to annualized changes in prices is assumed to be constant:

$$\hat{a}_{G,P} = -1/4. \tag{A11}$$

B Further estimation results

B.1 Reduced-form results

Table B1: Correlations between the reduced-form residuals

	g	nt	ff	y	p
g	1.00				
nt	0.11	1.00			
ff	-0.03	0.33	1.00		
y	0.26	0.48	0.17	1.00	
p	-0.01	0.13	0.16	-0.05	1.00

Notes: Correlation coefficients. Residuals of OLS estimation of the reduced-form system with government expenditure, net taxes, federal funds rate, GDP and inflation. Equations include 4 lags of each variable. Sample: 1955:1-2005:4.

B.2 Structural results

Table B2: Contemporaneous coefficients

Scheme $a^{y,ff} = a^{p,ff} = 0$							Scheme $a^{ff,y} = a^{ff,p} = 0$						
Sample 1955:1-2005:4							Sample 1955:1-2005:4						
	g	nt	ff	y	p	e^g		g	nt	ff	y	p	e^g
g	1	0	-0.16	0	(-0.25)		g	1	0	0.01	0	(-0.25)	
			[-1.3]							[0.0]			
nt	0	1	0.93	(2.19)	(0.26)	-0.08	nt	0	1	0.80	(2.19)	(0.26)	-0.08
			[3.9]			[-0.5]				[3.5]			[-0.5]
ff	0	0	1	0.26	0.15		ff	0	0	1	0	0	
				[3.2]	[2.5]								
y	0.20	-0.05	0	1	0		y	0.18	-0.05	0.23	1	0	
	[4.0]	[-2.2]						[3.5]	[-1.8]	[2.8]			
p	0.16	0.01	0	0	1		p	0.14	0.01	0.18	0	1	
	[2.6]	[0.5]						[2.3]	[0.4]	[1.8]			
Subsample 1955:1-1979:4							Subsample 1955:1-1979:4						
	g	nt	ff	y	p	e^g		g	nt	ff	y	p	e^g
g	1	0	-0.04	0	(-0.25)		g	1	0	0.13	0	(-0.25)	
			[-0.1]							[0.5]			
nt	0	1	0.62	(2.19)	(0.32)	0.04	nt	0	1	0.47	(2.19)	(0.32)	0.07
			[1.4]			[0.3]				[1.1]			[0.3]
ff	0	0	1	0.11	0.05		ff	0	0	1	0	0	
				[1.4]	[0.8]								
y	0.36	-0.17	0	1	0		y	0.34	-0.17	0.28	1	0	
	[3.7]	[-2.5]						[3.3]	[-2.2]	[1.3]			
p	0.06	0.04	0	0	1		p	0.04	0.06	0.06	0	1	
	[0.8]	[1.1]						[0.5]	[1.0]	[0.3]			
Subsample 1980:1-2005:4							Subsample 1980:1-2005:4						
	g	nt	ff	y	p	e^g		g	nt	ff	y	p	e^g
g	1	0	-0.09	0	(-0.25)		g	1	0	0.01	0	(-0.25)	
			[-0.7]							[0.1]			
nt	0	1	1.01	(2.20)	(0.21)	-0.19	nt	0	1	0.91	(2.20)	(0.21)	-0.18
			[3.2]			[-0.8]				[2.7]			[-0.7]
ff	0	0	1	0.51	0.13		ff	0	0	1	0	0	
				[3.4]	[1.3]								
y	0.09	-0.02	0	1	0		y	0.09	-0.02	0.25	1	0	
	[1.6]	[-0.7]						[1.6]	[0.7]	[3.1]			
p	0.13	0.04	0	0	1		p	0.13	0.01	0.19	0	1	
	[1.0]	[1.7]						[1.5]	[0.3]	[1.6]			

Notes: Calibrated values, sample period averages (in parentheses), and estimates of the contemporaneous coefficients in equations (1) to (5). Government expenditure ordered before taxes. Estimates on the left-hand side panels are by maximum likelihood and on the right hand side panels by instrumental variables. t-ratios in square brackets.

C Variable definition and data sources

Fiscal data are from NIPAs Table 3.1. *Government Current Receipts and Expenditures*; data on the components of government consumption, including the breakdown defense/non-defense, are from NIPAs Table 3.10.5 *Government Consumption Expenditures and General Government Gross Output*; data on social benefits including unemployment and health-related benefits are from NIPAs Table 3.12. *Government social benefits* (annual data, the share for the year as a whole was assumed for the quarter).

Taxes = Personal current taxes + Taxes on production and imports + Taxes on corporate income + Contributions for government social insurance + Capital transfer receipts (the latter item is composed mostly by gift and inheritance taxes).

Transfers = Subsidies + Government social benefits to persons + capital transfers paid - Current transfer receipts (from business and persons).

Net taxes = Taxes - Transfers.

Purchases of goods and services = Government consumption - Consumption of fixed capital[1] + Government investment.

Gross domestic product is from NIPAs Table 1.1.5. *Gross Domestic Product.*

Gross domestic product deflator is from NIPAs Table 1.1.4. *Price Indexes for Gross Domestic Product.*

Federal funds rate (quarterly averages of daily data) is from the *FRED database* (Federal Reserve Bank of St. Louis).

Population is from NIPAs Table 2.1. *Personal income and its Disposition.*

Federal debt held by the public (Section 3.1) is from the *FRED database* (Federal Reserve Bank of St. Louis).

Labor income and personal asset income (Section 3.2 and Appendix A) are equal, respectively, to wages and salaries and to the sum of interest income, dividend income and rental income, all from NIPAs Table 2.1. *Personal income and its Disposition.* Proprietors' income was not considered, since there is no obvious way to allocate it between labor and asset income.

Employment in the manufacturing and Average hourly earnings in the manufacturing (Appendix A) are from the *FRED database* (Federal Reserve Bank of St. Louis).

Corporate profits (Appendix A) is from NIPAs Table 1.10. *Gross domestic income, by type of income* (the inventory valuation and capital consumption adjustments were undone).

---

[1] Consumption of fixed capital is excluded on two grounds. Firstly, there are no shocks to this variable which is fully determined by the existing capital stock and depreciation rules. Secondly, from the viewpoint of the impact on aggregate demand, it is the cost of capital goods *at time of acquisition* (already recorded in government investment) that matters and not *at time of consumption.*

References

BEA (2005). Government transactions. Methodology papers: U.S. national income and product accounts, Bureau of Economic Analysis.

Bernanke, B. and A. Blinder (1992). The federal funds rate and the channels of monetary transmission. *The American Economic Review 82*(4), 901–921.

Bernanke, B., M. Gertler, and M. Watson (1997). Systematic monetary policy and the effect of oil price shocks. Economic Research Reports 25, C.V. Starr Center for Applied Economics.

Blanchard, O. (1984). The Lucas critique and the Volcker deflation. Working Paper 1326, National Bureau of Economic Research.

Blanchard, O. (1989). A traditional interpretation of macroeconomic fluctuations. *American Economic Review 79*(5), 1046–1064.

Blanchard, O. and R. Perotti (2002). An empirical characterization of the dynamic effects of changes in government spending and taxes on output. *Quarterly Journal of Economics 117*(4), 1329–1368.

Blanchard, O. and M. Watson (1984). Are business cycles all alike? Working Paper 1392, National Bureau of Economic Research.

Bohn, H. (1998). The behaviour of U.S. public debt and deficits. *The Quarterly Journal of Economics 113*(3), 949–963.

Canzoneri, M., R. Cumby, and B. Diba (2002). Should the European Central Bank and the Federal Reserve be concerned about fiscal policy? *Federal Reserve Bank of Kansas City Symposium on "Rethinking Stabilization Policy"*, 333–389.

Christiano, L., M. Eichenbaum, and C. Evans (1996). The effects of monetary policy shocks: Evidence from the flow of funds. *The Review of Economics and Statistics 78*(1), 16–34.

Christiano, L., M. Eichenbaum, and C. Evans (1999). Monetary policy shocks: What have we learned and to what end? In J. Taylor and M. Woodford (Eds.), *Handbook of Macroeconomics*, Volume 1A, pp. 91–157. Amsterdam: Elsevier Sccience BV.

Clarida, R., J. Galí, and M. Gertler (2000). Monetary policy rules and macroeconomic stability: Evidence and some theory. *The Quarterly Journal of Economics 115*(1), 147–180.

Estima (2007). *RATS version 7 User Guide.* Evanston, Illinois: Estima.

Giorno, C., P. Richardson, D. Roseveare, and P. van den Noord (1995). Estimating potential output, output gaps and structural budget balances. Economics Department Working Papers 152, OECD.

Girouard, N. and C. André (2005). Measuring cyclically adjusted budget balances for OECD countries. Economics Department Working Papers 21, OECD.

Gordon, R. (1997). The time-varying NAIRU and its implications for economic policy. *The Journal of Economic Perspectives 11*(1), 11–32.

Johnston, D., J. Parker, and N. Souleles (2006). Household expenditure and the Income Tax rebates of 2001. *American Economic Review 96*(5), 1589–1610.

Office for Personnel Management (2002). Costs of administering the Federal Wage System. Report to Congress, available at www.opm.gov.

Perotti, R. (2002). Estimating the effects of fiscal policy in OECD countries. Working Paper 168, European Central Bank.

Perotti, R. (2004). Estimating the effects of fiscal policy in OECD countries. Unpublished.

Ramey, V. (2008). Identifying government spending shocks: It's all in the timing. Unpublished.

Romer, C. and D. Romer (1994). What ends recessions? Working Paper 4765, National Bureau of Economic Research.

Romer, C. and D. Romer (2007). The macroeconomic effects of tax changes: Estimates based on a new measure of fiscal shocks. Working Paper 13264, National Bureau of Economic Research.

Sims, C. and T. Zha (1998). Does monetary policy generate recessions? Working Paper 12, Federal Reserve Bank of Atlanta.

Smith, S. (1982). Pay, pensions, and unemployment in government. *American Economic Review 72*(2), 273–277.

Tax Foundation (2007). Federal individual income tax rates history. Tables, available at www.taxfoundation.org.

Taylor, J. (1993). Discretion versus policy rules in practice. *Carnegie-Rochester Series in Public Policy*.

van den Noord, P. (2000). The size and role of automatic fiscal stabilizers in the 1990s and beyond. Economics Department Working Papers 230, OECD.

Wachtel, P. and J. Young (1987). Deficit announcements and interest rates. *American Economic Review 77*(5), 1006–1012.

Walsh, C. (2003). *Monetary Theory and Policy*. Cambridge, Massachusetts: Massachusetts Institute of Technology.

WORKING PAPERS

2000

1/00 UNEMPLOYMENT DURATION: COMPETING AND DEFECTIVE RISKS
— *John T. Addison, Pedro Portugal*

2/00 THE ESTIMATION OF RISK PREMIUM IMPLICIT IN OIL PRICES
— *Jorge Barros Luís*

3/00 EVALUATING CORE INFLATION INDICATORS
— *Carlos Robalo Marques, Pedro Duarte Neves, Luís Morais Sarmento*

4/00 LABOR MARKETS AND KALEIDOSCOPIC COMPARATIVE ADVANTAGE
— *Daniel A. Traça*

5/00 WHY SHOULD CENTRAL BANKS AVOID THE USE OF THE UNDERLYING INFLATION INDICATOR?
— *Carlos Robalo Marques, Pedro Duarte Neves, Afonso Gonçalves da Silva*

6/00 USING THE ASYMMETRIC TRIMMED MEAN AS A CORE INFLATION INDICATOR
— *Carlos Robalo Marques, João Machado Mota*

2001

1/01 THE SURVIVAL OF NEW DOMESTIC AND FOREIGN OWNED FIRMS
— *José Mata, Pedro Portugal*

2/01 GAPS AND TRIANGLES
— *Bernardino Adão, Isabel Correia, Pedro Teles*

3/01 A NEW REPRESENTATION FOR THE FOREIGN CURRENCY RISK PREMIUM
— *Bernardino Adão, Fátima Silva*

4/01 ENTRY MISTAKES WITH STRATEGIC PRICING
— *Bernardino Adão*

5/01 FINANCING IN THE EUROSYSTEM: FIXED VERSUS VARIABLE RATE TENDERS
— *Margarida Catalão-Lopes*

6/01 AGGREGATION, PERSISTENCE AND VOLATILITY IN A MACROMODEL
— *Karim Abadir, Gabriel Talmain*

7/01 SOME FACTS ABOUT THE CYCLICAL CONVERGENCE IN THE EURO ZONE
— *Frederico Belo*

8/01 TENURE, BUSINESS CYCLE AND THE WAGE-SETTING PROCESS
— *Leandro Arozamena, Mário Centeno*

9/01 USING THE FIRST PRINCIPAL COMPONENT AS A CORE INFLATION INDICATOR
— *José Ferreira Machado, Carlos Robalo Marques, Pedro Duarte Neves, Afonso Gonçalves da Silva*

10/01 IDENTIFICATION WITH AVERAGED DATA AND IMPLICATIONS FOR HEDONIC REGRESSION STUDIES
— *José A.F. Machado, João M.C. Santos Silva*

2002

1/02 QUANTILE REGRESSION ANALYSIS OF TRANSITION DATA
— *José A.F. Machado, Pedro Portugal*

2/02 SHOULD WE DISTINGUISH BETWEEN STATIC AND DYNAMIC LONG RUN EQUILIBRIUM IN ERROR CORRECTION MODELS?
— *Susana Botas, Carlos Robalo Marques*

3/02 MODELLING TAYLOR RULE UNCERTAINTY
— *Fernando Martins, José A. F. Machado, Paulo Soares Esteves*

4/02 PATTERNS OF ENTRY, POST-ENTRY GROWTH AND SURVIVAL: A COMPARISON BETWEEN DOMESTIC AND FOREIGN OWNED FIRMS
— *José Mata, Pedro Portugal*

5/02 BUSINESS CYCLES: CYCLICAL COMOVEMENT WITHIN THE EUROPEAN UNION IN THE PERIOD 1960-1999. A FREQUENCY DOMAIN APPROACH
— *João Valle e Azevedo*

6/02 AN “ART”, NOT A “SCIENCE”? CENTRAL BANK MANAGEMENT IN PORTUGAL UNDER THE GOLD STANDARD, 1854 -1891
— *Jaime Reis*

7/02 MERGE OR CONCENTRATE? SOME INSIGHTS FOR ANTITRUST POLICY
— *Margarida Catalão-Lopes*

8/02 DISENTANGLING THE MINIMUM WAGE PUZZLE: ANALYSIS OF WORKER ACCESSIONS AND SEPARATIONS FROM A LONGITUDINAL MATCHED EMPLOYER-EMPLOYEE DATA SET
— *Pedro Portugal, Ana Rute Cardoso*

9/02 THE MATCH QUALITY GAINS FROM UNEMPLOYMENT INSURANCE
— *Mário Centeno*

10/02 HEDONIC PRICES INDEXES FOR NEW PASSENGER CARS IN PORTUGAL (1997-2001)
— *Hugo J. Reis, J.M.C. Santos Silva*

11/02 THE ANALYSIS OF SEASONAL RETURN ANOMALIES IN THE PORTUGUESE STOCK MARKET
— *Miguel Balbina, Nuno C. Martins*

12/02 DOES MONEY GRANGER CAUSE INFLATION IN THE EURO AREA?
— *Carlos Robalo Marques, Joaquim Pina*

13/02 INSTITUTIONS AND ECONOMIC DEVELOPMENT: HOW STRONG IS THE RELATION?
— *Tiago V.de V. Cavalcanti, Álvaro A. Novo*

2003

1/03 FOUNDING CONDITIONS AND THE SURVIVAL OF NEW FIRMS
— *P.A. Geroski, José Mata, Pedro Portugal*

2/03 THE TIMING AND PROBABILITY OF FDI: AN APPLICATION TO THE UNITED STATES MULTINATIONAL ENTERPRISES
— *José Brandão de Brito, Felipa de Mello Sampayo*

3/03 OPTIMAL FISCAL AND MONETARY POLICY: EQUIVALENCE RESULTS
— *Isabel Correia, Juan Pablo Nicolini, Pedro Teles*

4/03 FORECASTING EURO AREA AGGREGATES WITH BAYESIAN VAR AND VECM MODELS
— *Ricardo Mourinho Félix, Luís C. Nunes*

5/03 CONTAGIOUS CURRENCY CRISES: A SPATIAL PROBIT APPROACH
— *Álvaro Novo*

6/03 THE DISTRIBUTION OF LIQUIDITY IN A MONETARY UNION WITH DIFFERENT PORTFOLIO RIGIDITIES
— *Nuno Alves*

7/03 COINCIDENT AND LEADING INDICATORS FOR THE EURO AREA: A FREQUENCY BAND APPROACH
— *António Rua, Luís C. Nunes*

8/03 WHY DO FIRMS USE FIXED-TERM CONTRACTS?
— *José Varejão, Pedro Portugal*

9/03 NONLINEARITIES OVER THE BUSINESS CYCLE: AN APPLICATION OF THE SMOOTH TRANSITION AUTOREGRESSIVE MODEL TO CHARACTERIZE GDP DYNAMICS FOR THE EURO-AREA AND PORTUGAL
— *Francisco Craveiro Dias*

10/03 WAGES AND THE RISK OF DISPLACEMENT
— *Anabela Carneiro, Pedro Portugal*

11/03 SIX WAYS TO LEAVE UNEMPLOYMENT
— *Pedro Portugal, John T. Addison*

12/03 EMPLOYMENT DYNAMICS AND THE STRUCTURE OF LABOR ADJUSTMENT COSTS
— *José Varejão, Pedro Portugal*

13/03 THE MONETARY TRANSMISSION MECHANISM: IS IT RELEVANT FOR POLICY?
— *Bernardino Adão, Isabel Correia, Pedro Teles*

14/03 THE IMPACT OF INTEREST-RATE SUBSIDIES ON LONG-TERM HOUSEHOLD DEBT: EVIDENCE FROM A LARGE PROGRAM
— *Nuno C. Martins, Ernesto Villanueva*

15/03 THE CAREERS OF TOP MANAGERS AND FIRM OPENNESS: INTERNAL VERSUS EXTERNAL LABOUR MARKETS
— *Francisco Lima, Mário Centeno*

16/03 TRACKING GROWTH AND THE BUSINESS CYCLE: A STOCHASTIC COMMON CYCLE MODEL FOR THE EURO AREA
— *João Valle e Azevedo, Siem Jan Koopman, António Rua*

17/03 CORRUPTION, CREDIT MARKET IMPERFECTIONS, AND ECONOMIC DEVELOPMENT
— *António R. Antunes, Tiago V. Cavalcanti*

18/03 BARGAINED WAGES, WAGE DRIFT AND THE DESIGN OF THE WAGE SETTING SYSTEM
— *Ana Rute Cardoso, Pedro Portugal*

19/03 UNCERTAINTY AND RISK ANALYSIS OF MACROECONOMIC FORECASTS: FAN CHARTS REVISITED
— *Álvaro Novo, Maximiano Pinheiro*

2004

1/04 HOW DOES THE UNEMPLOYMENT INSURANCE SYSTEM SHAPE THE TIME PROFILE OF JOBLESS DURATION?
— *John T. Addison, Pedro Portugal*

2/04 REAL EXCHANGE RATE AND HUMAN CAPITAL IN THE EMPIRICS OF ECONOMIC GROWTH
— *Delfim Gomes Neto*

3/04 ON THE USE OF THE FIRST PRINCIPAL COMPONENT AS A CORE INFLATION INDICATOR
— *José Ramos Maria*

4/04 OIL PRICES ASSUMPTIONS IN MACROECONOMIC FORECASTS: SHOULD WE FOLLOW FUTURES MARKET EXPECTATIONS?
— *Carlos Coimbra, Paulo Soares Esteves*

5/04 STYLISED FEATURES OF PRICE SETTING BEHAVIOUR IN PORTUGAL: 1992-2001
— *Mónica Dias, Daniel Dias, Pedro D. Neves*

6/04 A FLEXIBLE VIEW ON PRICES
— *Nuno Alves*

7/04 ON THE FISHER-KONIECZNY INDEX OF PRICE CHANGES SYNCHRONIZATION
— *D.A. Dias, C. Robalo Marques, P.D. Neves, J.M.C. Santos Silva*

8/04 INFLATION PERSISTENCE: FACTS OR ARTEFACTS?
— *Carlos Robalo Marques*

9/04 WORKERS' FLOWS AND REAL WAGE CYCLICALITY
— *Anabela Carneiro, Pedro Portugal*

10/04 MATCHING WORKERS TO JOBS IN THE FAST LANE: THE OPERATION OF FIXED-TERM CONTRACTS
— *José Varejão, Pedro Portugal*

11/04 THE LOCATIONAL DETERMINANTS OF THE U.S. MULTINATIONALS ACTIVITIES
— *José Brandão de Brito, Felipa Mello Sampayo*

12/04 KEY ELASTICITIES IN JOB SEARCH THEORY: INTERNATIONAL EVIDENCE
— *John T. Addison, Mário Centeno, Pedro Portugal*

13/04 RESERVATION WAGES, SEARCH DURATION AND ACCEPTED WAGES IN EUROPE
— *John T. Addison, Mário Centeno, Pedro Portugal*

14/04 THE MONETARY TRANSMISSION N THE US AND THE EURO AREA: COMMON FEATURES AND COMMON FRICTIONS
— *Nuno Alves*

15/04 NOMINAL WAGE INERTIA IN GENERAL EQUILIBRIUM MODELS
— *Nuno Alves*

16/04 MONETARY POLICY IN A CURRENCY UNION WITH NATIONAL PRICE ASYMMETRIES
— *Sandra Gomes*

17/04 NEOCLASSICAL INVESTMENT WITH MORAL HAZARD
— *João Ejarque*

18/04 MONETARY POLICY WITH STATE CONTINGENT INTEREST RATES
— *Bernardino Adão, Isabel Correia, Pedro Teles*

19/04 MONETARY POLICY WITH SINGLE INSTRUMENT FEEDBACK RULES
— *Bernardino Adão, Isabel Correia, Pedro Teles*

20/04 ACOUNTING FOR THE HIDDEN ECONOMY: BARRIERS TO LAGALITY AND LEGAL FAILURES
— *António R. Antunes, Tiago V. Cavalcanti*

2005

1/05 SEAM: A SMALL-SCALE EURO AREA MODEL WITH FORWARD-LOOKING ELEMENTS
— *José Brandão de Brito, Rita Duarte*

2/05 FORECASTING INFLATION THROUGH A BOTTOM-UP APPROACH: THE PORTUGUESE CASE
— *Cláudia Duarte, António Rua*

3/05 USING MEAN REVERSION AS A MEASURE OF PERSISTENCE
— *Daniel Dias, Carlos Robalo Marques*

4/05 HOUSEHOLD WEALTH IN PORTUGAL: 1980-2004
— *Fátima Cardoso, Vanda Geraldes da Cunha*

5/05 ANALYSIS OF DELINQUENT FIRMS USING MULTI-STATE TRANSITIONS
— *António Antunes*

6/05 PRICE SETTING IN THE AREA: SOME STYLIZED FACTS FROM INDIVIDUAL CONSUMER PRICE DATA
— *Emmanuel Dhyne, Luis J. Álvarez, Hervé Le Bihan, Giovanni Veronese, Daniel Dias, Johannes Hoffmann, Nicole Jonker, Patrick Lünnemann, Fabio Rumler, Jouko Vilmunen*

7/05 INTERMEDIATION COSTS, INVESTOR PROTECTION AND ECONOMIC DEVELOPMENT
— *António Antunes, Tiago Cavalcanti, Anne Villamil*

8/05 TIME OR STATE DEPENDENT PRICE SETTING RULES? EVIDENCE FROM PORTUGUESE MICRO DATA
— *Daniel Dias, Carlos Robalo Marques, João Santos Silva*

9/05 BUSINESS CYCLE AT A SECTORAL LEVEL: THE PORTUGUESE CASE
— *Hugo Reis*

10/05 THE PRICING BEHAVIOUR OF FIRMS IN THE EURO AREA: NEW SURVEY EVIDENCE
— *S. Fabiani, M. Druant, I. Hernando, C. Kwapil, B. Landau, C. Loupias, F. Martins, T. Mathä, R. Sabbatini, H. Stahl, A. Stokman*

11/05 CONSUMPTION TAXES AND REDISTRIBUTION
— *Isabel Correia*

12/05 UNIQUE EQUILIBRIUM WITH SINGLE MONETARY INSTRUMENT RULES
— *Bernardino Adão, Isabel Correia, Pedro Teles*

13/05 A MACROECONOMIC STRUCTURAL MODEL FOR THE PORTUGUESE ECONOMY
— *Ricardo Mourinho Félix*

14/05 THE EFFECTS OF A GOVERNMENT EXPENDITURES SHOCK
— *Bernardino Adão, José Brandão de Brito*

15/05 MARKET INTEGRATION IN THE GOLDEN PERIPHERY – THE LISBON/LONDON EXCHANGE, 1854-1891
— *Rui Pedro Esteves, Jaime Reis, Fabiano Ferramosca*

2006

1/06 THE EFFECTS OF A TECHNOLOGY SHOCK IN THE EURO AREA
— *Nuno Alves , José Brandão de Brito , Sandra Gomes, João Sousa*

2/02 THE TRANSMISSION OF MONETARY AND TECHNOLOGY SHOCKS IN THE EURO AREA
— *Nuno Alves, José Brandão de Brito, Sandra Gomes, João Sousa*

3/06 MEASURING THE IMPORTANCE OF THE UNIFORM NONSYNCHRONIZATION HYPOTHESIS
— *Daniel Dias, Carlos Robalo Marques, João Santos Silva*

4/06 THE PRICE SETTING BEHAVIOUR OF PORTUGUESE FIRMS EVIDENCE FROM SURVEY DATA
— *Fernando Martins*

5/06 STICKY PRICES IN THE EURO AREA: A SUMMARY OF NEW MICRO EVIDENCE
— *L. J. Álvarez, E. Dhyne, M. Hoeberichts, C. Kwapil, H. Le Bihan, P. Lünnemann, F. Martins, R. Sabbatini, H. Stahl, P. Vermeulen and J. Vilmunen*

6/06 NOMINAL DEBT AS A BURDEN ON MONETARY POLICY
— *Javier Díaz-Giménez, Giorgia Giovannetti , Ramon Marimon, Pedro Teles*

7/06 A DISAGGREGATED FRAMEWORK FOR THE ANALYSIS OF STRUCTURAL DEVELOPMENTS IN PUBLIC FINANCES
— *Jana Kremer, Cláudia Rodrigues Braz, Teunis Brosens, Geert Langenus, Sandro Momigliano, Mikko Spolander*

8/06 IDENTIFYING ASSET PRICE BOOMS AND BUSTS WITH QUANTILE REGRESSIONS
— *José A. F. Machado, João Sousa*

9/06 EXCESS BURDEN AND THE COST OF INEFFICIENCY IN PUBLIC SERVICES PROVISION
— *António Afonso, Vítor Gaspar*

10/06 MARKET POWER, DISMISSAL THREAT AND RENT SHARING: THE ROLE OF INSIDER AND OUTSIDER FORCES IN WAGE BARGAINING
— *Anabela Carneiro, Pedro Portugal*

11/06 MEASURING EXPORT COMPETITIVENESS: REVISITING THE EFFECTIVE EXCHANGE RATE WEIGHTS FOR THE EURO AREA COUNTRIES
— *Paulo Soares Esteves, Carolina Reis*

12/06 THE IMPACT OF UNEMPLOYMENT INSURANCE GENEROSITY ON MATCH QUALITY DISTRIBUTION
— *Mário Centeno, Alvaro A. Novo*

13/06 U.S. UNEMPLOYMENT DURATION: HAS LONG BECOME LONGER OR SHORT BECOME SHORTER?
— *José A.F. Machado, Pedro Portugal e Juliana Guimarães*

14/06 EARNINGS LOSSES OF DISPLACED WORKERS: EVIDENCE FROM A MATCHED EMPLOYER-EMPLOYEE DATA SET
— *Anabela Carneiro, Pedro Portugal*

15/06 COMPUTING GENERAL EQUILIBRIUM MODELS WITH OCCUPATIONAL CHOICE AND FINANCIAL FRICTIONS
— *António Antunes, Tiago Cavalcanti, Anne Villamil*

16/06 ON THE RELEVANCE OF EXCHANGE RATE REGIMES FOR STABILIZATION POLICY
— *Bernardino Adao, Isabel Correia, Pedro Teles*

17/06 AN INPUT-OUTPUT ANALYSIS: LINKAGES VS LEAKAGES
— *Hugo Reis, António Rua*

2007

1/07 RELATIVE EXPORT STRUCTURES AND VERTICAL SPECIALIZATION: A SIMPLE CROSS-COUNTRY INDEX
— *João Amador, Sónia Cabral, José Ramos Maria*

2/07 THE FORWARD PREMIUM OF EURO INTEREST RATES
— *Sónia Costa, Ana Beatriz Galvão*

3/07 ADJUSTING TO THE EURO
— *Gabriel Fagan, Vítor Gaspar*

4/07 SPATIAL AND TEMPORAL AGGREGATION IN THE ESTIMATION OF LABOR DEMAND FUNCTIONS
— *José Varejão, Pedro Portugal*

5/07 PRICE SETTING IN THE EURO AREA: SOME STYLISED FACTS FROM INDIVIDUAL PRODUCER PRICE DATA
— *Philip Vermeulen, Daniel Dias, Maarten Dossche, Erwan Gautier, Ignacio Hernando, Roberto Sabbatini, Harald Stahl*

6/07 A STOCHASTIC FRONTIER ANALYSIS OF SECONDARY EDUCATION OUTPUT IN PORTUGAL
— *Manuel Coutinho Pereira, Sara Moreira*

7/07 CREDIT RISK DRIVERS: EVALUATING THE CONTRIBUTION OF FIRM LEVEL INFORMATION AND OF MACROECONOMIC DYNAMICS
— *Diana Bonfim*

8/07 CHARACTERISTICS OF THE PORTUGUESE ECONOMIC GROWTH: WHAT HAS BEEN MISSING?
— *João Amador, Carlos Coimbra*

9/07 TOTAL FACTOR PRODUCTIVITY GROWTH IN THE G7 COUNTRIES: DIFFERENT OR ALIKE?
— *João Amador, Carlos Coimbra*

10/07 IDENTIFYING UNEMPLOYMENT INSURANCE INCOME EFFECTS WITH A QUASI-NATURAL EXPERIMENT
— *Mário Centeno, Alvaro A. Novo*

11/07 HOW DO DIFFERENT ENTITLEMENTS TO UNEMPLOYMENT BENEFITS AFFECT THE TRANSITIONS FROM UNEMPLOYMENT INTO EMPLOYMENT
— *John T. Addison, Pedro Portugal*

12/07 INTERPRETATION OF THE EFFECTS OF FILTERING INTEGRATED TIME SERIES
— *João Valle e Azevedo*

13/07 EXACT LIMIT OF THE EXPECTED PERIODOGRAM IN THE UNIT-ROOT CASE
— *João Valle e Azevedo*

14/07 INTERNATIONAL TRADE PATTERNS OVER THE LAST FOUR DECADES: HOW DOES PORTUGAL COMPARE WITH OTHER COHESION COUNTRIES?
— *João Amador, Sónia Cabral, José Ramos Maria*

15/07 INFLATION (MIS)PERCEPTIONS IN THE EURO AREA
— *Francisco Dias, Cláudia Duarte, António Rua*

16/07 LABOR ADJUSTMENT COSTS IN A PANEL OF ESTABLISHMENTS: A STRUCTURAL APPROACH
— *João Miguel Ejarque, Pedro Portugal*

17/07 A MULTIVARIATE BAND-PASS FILTER
— *João Valle e Azevedo*

18/07 AN OPEN ECONOMY MODEL OF THE EURO AREA AND THE US
— *Nuno Alves, Sandra Gomes, João Sousa*

19/07 IS TIME RIPE FOR PRICE LEVEL PATH STABILITY?
— *Vitor Gaspar, Frank Smets , David Vestin*

20/07 IS THE EURO AREA M3 ABANDONING US?
— *Nuno Alves, Carlos Robalo Marques, João Sousa*

21/07 DO LABOR MARKET POLICIES AFFECT EMPLOYMENT COMPOSITION? LESSONS FROM EUROPEAN COUNTRIES
— *António Antunes, Mário Centeno*

2008

1/08 THE DETERMINANTS OF PORTUGUESE BANKS' CAPITAL BUFFERS
— *Miguel Boucinha*

2/08 DO RESERVATION WAGES REALLY DECLINE? SOME INTERNATIONAL EVIDENCE ON THE DETERMINANTS OF RESERVATION WAGES
— *John T. Addison, Mário Centeno, Pedro Portugal*

3/08 UNEMPLOYMENT BENEFITS AND RESERVATION WAGES: KEY ELASTICITIES FROM A STRIPPED-DOWN JOB SEARCH APPROACH
— *John T. Addison, Mário Centeno, Pedro Portugal*

4/08 THE EFFECTS OF LOW-COST COUNTRIES ON PORTUGUESE MANUFACTURING IMPORT PRICES
— *Fátima Cardoso, Paulo Soares Esteves*

5/08 WHAT IS BEHIND THE RECENT EVOLUTION OF PORTUGUESE TERMS OF TRADE?
— *Fátima Cardoso, Paulo Soares Esteves*

6/08 EVALUATING JOB SEARCH PROGRAMS FOR OLD AND YOUNG INDIVIDUALS: HETEROGENEOUS IMPACT ON UNEMPLOYMENT DURATION
— *Luis Centeno, Mário Centeno, Álvaro A. Novo*

7/08 FORECASTING USING TARGETED DIFFUSION INDEXES
— *Francisco Dias, Maximiano Pinheiro, António Rua*

8/08 STATISTICAL ARBITRAGE WITH DEFAULT AND COLLATERAL
— *José Fajardo, Ana Lacerda*

9/08 DETERMINING THE NUMBER OF FACTORS IN APPROXIMATE FACTOR MODELS WITH GLOBAL AND GROUP-SPECIFIC FACTORS
— *Francisco Dias, Maximiano Pinheiro, António Rua*

10/08 VERTICAL SPECIALIZATION ACROSS THE WORLD: A RELATIVE MEASURE
— *João Amador, Sónia Cabral*

11/08 INTERNATIONAL FRAGMENTATION OF PRODUCTION IN THE PORTUGUESE ECONOMY: WHAT DO DIFFERENT MEASURES TELL US?
— *João Amador, Sónia Cabral*

12/08 IMPACT OF THE RECENT REFORM OF THE PORTUGUESE PUBLIC EMPLOYEES' PENSION SYSTEM
— *Maria Manuel Campos, Manuel Coutinho Pereira*

13/08 EMPIRICAL EVIDENCE ON THE BEHAVIOR AND STABILIZING ROLE OF FISCAL AND MONETARY POLICIES IN THE US
— *Manuel Coutinho Pereira*