Can we rely upon fiscal policy estimates in countries with a tax evasion of 15 per cent (or more) of GDP?

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Abstract

This paper analyses the effects of fiscal policy in Italy by employing a database containing two statistical novelties, quarterly fiscal variables on accrual basis and a time series estimate of tax evasion for the period 1981:1-2006:4. Following the Agency Revenue suggestions, we use in a VECM the time series of the concealed VAT base as a proxy for the size of “unreported production”, and define a regular GDP measure constructed as GDP net of government expenditure and evaded VAT base. The results reveals that we cannot rely upon the estimates of the fiscal policy’s multipliers in countries with a sizeable tax evasion unless one disentangles the hidden and the regular components of the GDP. Changes in public spending and tax rate generate a reallocation from underground to the regular economy which contributes to obscure the spending and tax effect on total GDP. In this setup the spending multiplier show large long-run effects. The drop in regular output after an increase in tax rate becomes dramatic in a longer period producing a remarkable increase in tax evasion.

Keywords: fiscal policy, VECM, fiscal multipliers, regular GDP, tax evasion

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1. Introduction

In the last years policymakers have implemented a wide array of discretionary fiscal measures to stimulate the economic activity and soften the economic downturn. In 2009 almost all OECD economies and many emerging countries had announced or implemented some sort of fiscal stimulus packages. However, the lack of consensus on the effects of fiscal policy is a fact, and, in the economic literature, the impact of such fiscal measures remains uncertain. This is certainly the case for the euro area, and in particular for Italy, given the scarcity of relevant studies.\(^2\)

Empirical literature often provided numerical estimates of the impact of an increase in government spending on GDP and employment in the United States and in European countries. Such estimates contribute to determine the appropriate size and timing of countercyclical fiscal policy packages. The uncertainty about the quantitative effects of fiscal policy derives not only from the usual errors in empirical estimation but also from different views on the proper theoretical framework and econometric methodology. Here we emphasize that a crucial source of uncertainty is tied up to the size and dynamic of tax evasion. Can we rely upon fiscal policy’s multipliers estimated in countries with a tax evasion of 15 per cent (or more) of GDP? This question naturally arises in many economies such as the Italian economy and most of the Mediterranean European economies. However, it can be generalized to other European countries and even to the US economy, where tax evasion statistics are rare and the methodologies employed to calculate the phenomenon of tax evasion are not entirely clear. Thus, apart from the novelty of the results for Italy itself, we may generalize our findings to those obtained for all the countries with a sizeable tax evasion.\(^3\)

This paper analyses the effects of fiscal policy in Italy by employing a database containing quarterly fiscal variables for the period 1981:1-2006:4; in addition, exploiting the new yearly time series estimate of the unreported VAT (value added tax) base provided by the Italian Revenue Agency (Marigliani and Pisani 2007), we also provide a quarterly time series estimate of tax evasion (see the Appendix A for further details about the construction). This estimate is extremely important, not only because it provides a long enough time series of tax evasion, but also because it allows the size of the underground production to be estimated. Actually, evading VAT means under-reporting production, labor activities and revenues. Hence, the time series of the concealed VAT base, covering the period 1981-2006, can be used as a proxy for the size of “unreported production”. This allow us to construct and use in the models two important GDP measures: the GDP net of government expenditure referred as private GDP and regular GDP defined as GDP net of government expenditure and evaded VAT base. We perform a wide range of simulations with government expenditure and tax rate to assess how these policies impact on regular

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\(^2\) For the Euro area see, Perotti (2004), Biav and Girard (2005), De Castro and Hernandez De Cos (2006), Burriel, et al. (2009) and Alfonso and Sousa (2009), whereas for Italy one of the rare analysis is Giordano et al. (2007).

\(^3\) Cross countries estimates for tax evasion are rare. There are several analyses on the size and the dynamics of the underground economy for most of the industrialized and developing countries. See, for instance, Schneider and Buehn (2009). Although these are different phenomena, is indisputable that there is a close relationship between the two.
GDP. The results are interpreted and compared with the private GDP responses, providing remarkable insights about the role played by underground production in the Italian economy.

Finally, we do not follow the literature that seeks to remedy the shortage of fiscal data of national accounts using OECD quarterly general government data or national quarterly cash-basis data, but we employ quarterly government national account estimates. Quarterly government estimates are computed by making use of a dynamic extension of the disaggregation method currently applied by the Italian Statistical Institute (ISTAT), we compute quarterly economic account estimates avoiding the shortcomings associated with the use of the sources mentioned above.4

Since the works of Fatás and Mihov (2001) and Blanchard and Perotti (2002), there has been a large body of literature which used the structural VAR to estimate the effect of fiscal policy on fiscal and non-fiscal aggregate variables, developing different methodologies to identify fiscal shocks. By contrast, we use a Vector Error Correction framework, and study the short and long run effects of aggregated government spending and net taxes shocks allowing for the tax evasion effects on the fiscal variables and GDP.

There are at least three issues that conduct us to use a different framework. First, as mentioned in Perotti (2004) and many others, there is little guidance, theoretical or empirical, on how to identify the structural shocks. Second, using the SVAR approach, relevant information, particularly useful in fiscal policy, is lost. Generally, economic theory has more to offer on the determination of equilibrium than on the nature of dynamic adjustments. When we perform an empirical policy analysis we like to achieve information on the underlying equilibrium tendency among a set of variables, but we also like to know the short run dynamics and the adjustment coefficients. We are interested to know how, given a shock, the variables react and adjust on their path to equilibrium. Is adjustment slow or fast, do some variable react more quickly and in response to different disequilibria? These dynamic interactions can often be very important and insightful in a policy analysis. Other than disentangling the single components of a shock (short-adjustment and long run reactions) we are interested to the whole effect because is this one that we really observe with an uncritical impulse response analysis.

Finally, in this framework a situation of special interest arises if several variables are driven by one or more stochastic trends, in which case they have a particularly strong link that may be of interest in economic terms.

The most relevant findings of this paper can be summarized as follows. Government spending shocks have, in general, a positive effect on GDP, which becomes increasingly relevant in the model with regular GDP (after one year the multiplier is, in the private and in the regular GDP models, respectively, 2.3 and 2.9). Tax rate shocks strongly reduce regular GDP whereas there is no significant effect on private GDP: they impact significantly on the tax evasion. As to the fiscal variables interactions, a rise in tax rates lead to a fall in government spending, whereas no significant effect is found when looking at the reverse dynamic. Finally, shocks in the GDP (both private and regular) lead to a robust and permanent increase in government expenditure and show that tax evasion is procyclical.

4 In Appendix B we summarize the characteristics of the estimated quarterly series for government variables.
All these points rise economic and policy implications which are extensively discussed in the paper which is organized as follows. Section 2 and the Appendices A-B, describe the data. Section 3 outlines the specification of the VECM model and the identification method. Section 4 presents the results for government spending, tax rate and tax evasion shocks, whereas Appendix C reports the statistical output of the models and the full set of impulse response analysis. Section 5 concludes.

2 The data

The data set used in this paper is characterized by two statistical novelties. First, since National Account data, elaborated on an accrual basis, are available only from 1999, we elaborate quarterly government national account estimates for several aggregates of public expenditure and taxation. Second, we explicitly include in the model a time series for tax evasion based on VAT tax base provided by the Revenue Agency. Due to data availability for the tax evasion variable, we focus on the sample 1981-2006.

Usually, an empirical analysis relying on official quarterly general government data compiled on a national accounts basis would be feasible only if considering few budgetary items, specifically the non-regular sector final consumption expenditure, non-market sector compensation of employees and VAT and other taxes on import, which are available for the period 1981:1-2008:IV.

In particular, in Italy, VAR analysis with fiscal variables has found a serious impediment in the absence of long time series for government accrual data. Empirical applications have been “forced” to relay on either OECD quarterly general government data or quarterly cash-basis data. For instance, the sources of government budget data in recent works in Italy are the Ministry of Economy and Finance which publishes quarterly cash figures since the early eighties, and the Bank of Italy. To quote a recent paper, Giordano et al (2007), provide SVAR estimates using cash quarterly data on the log of public expenditure and net taxes all in real terms and seasonally adjusted. 5

In this paper we elaborate long-run quarterly government accrual estimates by making use of a dynamic extension of the disaggregation method currently applied by ISTAT to compute Quarterly Economic Account estimates. The method is sketched in Appendix B and is based on quarterly related time series, selected according to the economic definitions of fiscal variables. 6

The selection of fiscal variables follows Blanchard and Perotti (2002) and Giordano et al (2007). In particular, direct government spending is defined as the sum of government consumption and investment (which includes wages, current purchasing of public goods and services and public investment) while net taxes are defined as total government receipts, less transfers to households and

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5 In Giordano et al (2007) there is a detailed analysis on the construction of the data and a comparison with national account data. The controversial on cash-basis and accrual basis data for analyzing the fiscal policy effects is explicitly admitted by the authors who, however, emphasize that the effects on aggregate of government consumption for which national account data are available do not present noticeable differences with respect the results obtained using the benchmark specification when considering a public wage shock.

6 We apply the dynamic extension of the Chow-Lin (1971) temporal disaggregation procedure suggested in Proietti (2005), based on the state space representation of a first order Autoregressive Distributed Lag model, which transforms the distribution problem into an unknown observation one.
More concretely, transfers include all expenditure items except public consumption, public investment and interest payments. Differently from most of the literature on fiscal policy effects, we use the average fiscal burden rather than the collected net revenues to better appreciate the complex interaction between tax rate and tax evasion. These fiscal aggregates have become standard in this literature since government spending on goods and services might have different effects, as it affects directly the aggregate demand of the economy, while transfers and taxes exert their effects through real disposable income that could be partially saved.

2.1 Tax evasion and the regular production time series

Data on tax evasion in Italy are currently provided by the Revenue Agency of the Ministry of Economy and Finance, which has recently estimated a yearly time series of the non-reported Value Added Tax base. This fiscal aggregate is relevant for both unreported production and tax evasion. According to the data constructors, Marigliani and Pisani (2007), evading VAT means under-reporting production, labour activities and revenues. Hence, this time series estimate for the period 1981-2006 can be used as a proxy for the size of underground production which, in turn, can be used to estimate the regular production.

With regard to the size of tax evasion, which is calculated multiplying the unreported VAT base by the marginal tax rates, we emphasize that it is only a part of the phenomenon tax evasion. In fact it accounts for the uncollected VAT revenues. However, as outlined above, VAT evasion is a “prerequisite” and contain others forms of non-compliance. Therefore, according to the Revenue Agency, the dynamic of uncollected VAT revenues could well approximate the whole evading patterns, at least on the supply side.

The size of the unreported VAT base ranges between 170 to 280 billion euros (real value) per year. Figure 1 shows the quarterly series for the unreported VAT base and the estimated VAT evasion; both the series display considerable volatility, particularly during the second decade of the observed sample. The first half of the 1990s was characterized by considerable political instability and a fragmented approach to the fiscal policy, whereas during the period 1996-2000 a more stable political framework allowed the start of a process structurally reforming tax collection (Giannini, Guerra 2000). The two downward peaks observed in 1994 and 1999 are affected by a process of institutional reform. In

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7 Similarly to other studies we excluded interest payments as they largely depend on the debt stock and therefore are not a discretionary fiscal policy tool. See amongst others Giordano et al (2007).
8 See Burriel, de Castro et al. (2009).
9 The approach for assessing declared and undeclared VAT taxable amounts, as well as the corresponding income, is based on a comparison of actual values, derived mainly from VAT returns, and theoretical ones, derived from National Account macroeconomic data. The latter aggregates are estimated selecting the national account expenditure categories that comprehensively cover VAT liabilities: i) household spending and non-profit institutions serving household final consumption expenditure; ii) central government current and capital expenditure; iii) exempt sector intermediate consumption; iv) other expenditure which incurs non-refundable VAT. For each of the listed items the most appropriate data source is chosen in order to respect VAT rules.
particular, during the period 1991-93, some minor reforms were introduced, namely the minimum tax and “congruity” coefficients. It is also remarkable that the upward peak registered in VAT evasion in 1996 occurred after the tax amnesty (concordato fiscale) granted in 1994, whose receipts were mainly collected in 1995. The sharp reduction in VAT evasion observed during 1996-99 can be explained by structural innovations, such as the tax on line system (fisco telematico) and the new tax returns filing system (Unico form) introduced in 1998, together with Sector Studies (Studi di Settore), procedures midway between audit selection mechanisms and methods of presumptive (normal) taxation (see Santoro 2007b). These two interventions, together with a reorganization process of the fiscal authority started in 1997, contributed to improve the efficiency of tax administration, indirectly increasing the effectiveness of auditing. The new upward pattern registered in the last years of the sample can be explained by a learning process, with tax evaders being “more skilled” with respect to the new tax collection procedures, and perhaps also by an indirect effect due to the amnesties granted in 2002.

**Figure 1: VAT undeclared tax base (right scale) and VAT evasion (left scale), values in real terms**

(euro millions at 2000 prices)
Given the nature of the concealed VAT base, which can be considered as a measure of the underground production, we are able to provide an estimate of the regular production (Figure 2). Actually, Italian national accounts accomplish the requirement of exhaustiveness, as stated by OECD and Eurostat, including the value added generated in the underground economy. Therefore, subtracting the estimated undeclared VAT base from the official GDP (national accounts), we get the regular production. This way of dealing with the aggregate regular GDP may be considered to be rather crude. However, the literature provides empirical measures of the hidden economy that vary enormously in terms of methodology employed, reliability of the data and magnitudes estimated. Here we try to overcome many of these weaknesses using the official data available, and, without “heroic assumptions”\(^\text{10}\), we explicitly relate the share of national production or income deliberately concealed from observation to the VAT revenues not reported to the tax authorities (i.e. produced in underground activities). These two measures may have much in common, since the unreported VAT base may be considered an important device that helps to conceal the tax base of other taxes, hiding shadow activities.\(^\text{11}\)

**Figure 2. GDP in real terms (Private and Regular) (euro millions, at 2000 prices)**

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\(^{10}\) See, for instance, the Economic Journal symposium on the Hidden Economy and Schneider and Enste (2002).

\(^{11}\) Indeed, Italian national accounts provide an exhaustive estimate of GDP, but only since 1992 have they also distinguished the share to attribute to missing economic activities Marigliani and Pisani (2007) compare their estimate of tax evasion (here exploited) with the Istat estimate of the underground economy for the available common years, i.e. 1992-2004 founding no large differences.
2.2 The fiscal data

The seasonally adjusted figures in real terms for spending on goods and services and net revenues tax rate are plotted in Figures 3 and 4.

Figure 3. Direct public expenditure (consumption + investment, *euro millions, at 2000 prices*)

Figure 4: Net tax rate (percentage rates over total GDP)
Government current spending in goods, services and public investment shows a steadily increase over
the sample period, with the significant exception of the period 1992-1995. This drop should be related
to the remarkable fall in public investments and the striking corrective measures taken by the
government since the 1992 budget law which cut all the public expenditure items in order to contrast a
strong speculation on the exchange rate for default risk. After 1997, the slope of the positive trend
slightly reduces for the consolidation effort in the period before the monetary union, but then rose again
in the last years for the loosening of the policy.

Net revenues tax rate reports a steep increasing trend, passing from 16% in 1981 to 27% in 1997,
followed, in more recent years, by a slightly declining pattern, again, and by a new surge at the end of
the sample considered. However, significant reductions have been occurred over the periods 1984-85;
1994-96; 1998-99 and 2001-2005. These drops in the net revenues are determined by many factors,
fiscal reforms, policy changes and the introduction of new taxes.

The falling in the first two periods reflects the drop in tax revenues due to a fall in economic activity
and to the expiation of temporary tax increases in the previous years: the peaks in the path of the tax
rate, also show the increases in tax revenues due to fiscal amnesties granted in 1982, 1991, and 1994,
whereas the amnesties granted in 2002 are not clearly discernible. The sharp rise in the tax rates,
especially the effective one, observed in 1997 and, to a lesser extent, in 1993, is mainly due to
extraordinary revenues, connected respectively to the so-called tax for Europe (1997) and to asset and
buildings taxation (1993). The introduction of new tax (IRAP) replacing health contributions and many
other taxes may also contribute to explain the reduction in 1998-99.

Finally the fall in interest payments on public debt after 2001 has led to an expansionary policy and
may well explain the new increase in the fiscal burden at the end of the sample.

3. A VECM model for fiscal policy

The system is in four stochastic variables, namely GDP ($Y_i$), tax evasion ($TE_i$), public expenditure ($G_i$)
and tax rate ($\tau_i$) with the intercept restricted to lie in the cointegration space.\(^\text{12}\) As regards the notation
we use for the GDP aggregates, $Y_p, Y_M$, respectively private (total production less government
spending) and regular GDP (total production less underground production and government spending).
The primary objective of our analysis is to quantify the fiscal policy effects on the regular GDP, $Y_M$.
All the variables are in log (except the tax rate) and nonstationary time series.\(^\text{13}\)

3.1. Deterministic variables.

Since the model contains variables both in levels and in differences, the role of the dummy variables
require careful modeling (see Juselius 2007). Our strategy to model appropriately the outliers was
firstly based on a graphical analysis aiming to obtain a tentative recognition of possible outlier
observations in the differenced process. This analysis suggests to augment the VAR by 5 dummy
variables. Two dummies, were included for describing two transitory shocks in quarters 2003:3-4 and
2005:4-2006:1. These dummies variables are used to model situations characterized by a shock at a

\(^{12}\) We have also used different measures of fiscal pressure, utilizing regular GDP in the tax rate ratio.

\(^{13}\) Tests and time series analysis are reported in Appendix C.
time immediately followed by a similar but opposite shock in the aftermath. The two dummies imply a positive outlier in the levels of the involved variable, observed in 2003:3 and in 2005:4. In 2003 government consumption grew at a rate of 2.2%, compared to the 1.9% registered in 2001, whereas public investment registered, in the same year, a sharp negative change, -2.1%. These two opposite patterns of the public expenditure variables, could explain the peak in third quarter of the year. The outlier for 2005:4, is related to the “anno horribilis” for the Italian public finances (Pisauro, 2006), characterized by a maximum peak for primary spending, a minimum registered for fiscal receipts, a deep (upward) revision in the figures of the government deficit and the inevitable official opening of an infraction procedure against Italy (Eurostat, 2005).


Finally, a further shift dummy variable has been included in the system, with shift date 1992:3:

\[ S92 = \begin{cases} 0, & t < 1992 : 3 \\ 1, & t \geq 1992 : 3 \end{cases} \] (1)

This shift function has been included (and restricted in the cointegration space) to account for the “regime” change in fiscal policy after 1992, to cope with the exchange rate and debt crisis and the new pattern required from that data to the members of the future European monetary union. 14

In order to test for cointegration, we conduct our analysis using a VAR with 5 lags on all stochastic variables.15 The VAR model can be represented in a vector error correction form:

\[ \Delta y_t = \Pi y_{t-1} + \sum_{i=1}^{p-1} \Gamma \Delta y_{t-i} + B z_t + \epsilon_t \] (2)

where \( \Pi = \sum_{i=1}^{p} A_i - I \); \( \Gamma = \sum_{j=i+1}^{p} A_j \)

In our case, \( y \) is a \( k \)-vector and contains four nonstationary variables (possibly I(1)), \( z \) is a vector of conditioning variables (non-stochastic variables such as dummies and others that are weakly exogenous) and \( \epsilon_t \) is a vector of innovation. \( A_i \) and \( B \) are matrices of coefficients to be estimated. It is

\[ \text{14} \text{ Of course, since the shift dummy is restricted to lie in the cointegration space, its difference (current and lagged, i.e. a permanent impulse in 1992:3 and 1992:4) is also included as unrestricted in the VAR equations. The year 1992 is also the starting of a deep recession.} \]

\[ \text{15 The appropriateness of the lag order was tested using information criteria (Akaike Information Criterion and Final Prediction Error).} \]
well known that if the coefficient of the \((k \times k)\) matrix \(\Pi\) has a reduced rank \((r<k=2)\) the number of cointegrating relations in our case), there exists matrices \(\alpha\) and \(\beta\) (both \(k \times r\)) such that \(\Pi = \alpha \beta'\) where \(\beta\) is a cointegrating vector and \(\alpha\) are the adjustment parameters.\(^{16}\)

3.2. The stationary space
The estimation is carried out over the period 1981:1-2006:4 using a two stage procedure (S2S).\(^ {17}\) Testing for cointegration (Johansen Trace statistic) in the four-equation system suggests that there is evidence of two cointegrating vectors (and two common trends) in the data set. Identification restrictions were attempted on the unrestricted cointegrating vectors. In particular we test a number of structure, theoretically motivated, on the cointegration space \(Sp(\beta)\):

\[
(Y_i, TE, G, \tau, S92, \mu) \in Sp(\beta)
\]

where \(\mu\) represents a constant term. The results imply that combinations of at least three variables are needed to find cointegration. Therefore, initially, we imposed \(r-1\) exactly identifying restrictions and a normalizing coefficient on each cointegration vector, raising a number of testable questions (does government spending cointegrate with tax rate?, etc). With references to the model with private GDP, this process ends up with the following description of the cointegration space (standard errors in brackets):

\[
\begin{bmatrix}
0 & 1 & -0.38_{(0.14)} & -0.038_{(0.007)} & 0 & -4.08_{(1.5)} \\
1 & 0 & -0.75_{(0.05)} & 0 & -0.16_{(0.01)} & -3.54_{(0.59)} \\
\end{bmatrix}
\begin{bmatrix}
Y_i \\
TE \\
G \\
\tau \\
S92 \\
\mu
\end{bmatrix}
\]

The cointegrating vectors are overidentified as 2 restrictions are imposed on each of them. The Wald test for the beta-restrictions (using Johansen ML estimation), is distributed as \(\chi^2(2)\) and under the null gives a p-value of 0.62. The estimated stationary relations could be thought of as representing constraints that an economic structure imposes on the movement of the variables in the long run. In our case we have two linear combinations for which the variance is bounded. One of these seems to support the existence of a long run positive relationship between \(G\) and regular GDP:


\(^{17}\) See Lutkepohl and Kratzig (2004). Diagnostic tests show a good descriptive power of the system. Diagnostic tests, parsimonious versions of the models and plots of cointegrating vectors are presented in the Appendix C. Further results may be provided by the authors upon request.
\[ ecm_2 = Y_M - 0.75 \cdot G - 0.16 \cdot S92 - 3.54 \cdot \mu \] whereas the other stationary relation clearly emphasize a positive long-run effect of fiscal variables to tax evasion: \[ ecm_1 = TE - 0.4 \cdot G - 0.04 \cdot \tau - 4.08 \cdot \mu \].

However, many authors emphasize that cointegration vectors cannot be interpreted as representing structural equations because they are obtained from the reduced form of a system where all the variables are jointly endogenous. Caution should be used to interpret the estimated coefficients. They cannot be considered as elasticities, even if the variables are in log, because all the other dynamic relations between the variables which are specified in the VAR model are ignored. Impulse response analysis, taking into account the full system, may provide a more reliable conclusion. This means that the coefficients provided by the cointegration analysis are only indicative.\(^{18}\)

### 3.3. Adjustment coefficients

Using a two-stage procedure in which the beta vectors are estimated first and then fixed in the second stage, we may threat alphas in the same way as the short run parameters. The strategy chosen is a sequential elimination of the short run parameters and loading factors, based on model selection criteria (AIC).\(^{19}\) The search for zero-restrictions on loading factors provides the following matrix:

\[
\begin{pmatrix}
\alpha_{y_1} = 0.027_{(0.013)} & \alpha_{y_2} = -0.053_{(0.024)} \\
\alpha_{TE_1} = -0.077_{(0.027)} & \alpha_{TE_2} = 0.185_{(0.057)} \\
\alpha_{G_1} = 0 & \alpha_{G_2} = 0.182_{(0.025)} \\
\alpha_{\tau_1} = 1.74_{(0.37)} & \alpha_{\tau_2} = 0
\end{pmatrix}
\]

The \( \alpha \) coefficients relate the error correction terms \( \beta_1, \beta_2 \) (the long-run) with the first differences (the short-run) of the endogenous variables \( TE, Y, G \) and \( \tau \). Thus, \( \alpha_{TE_1} \) is the adjustment coefficient to the first long-run relation (error correction) in the tax evasion equation; \( \alpha_{TE_2} \) is the adjustment coefficient to the second error correction described above (\( \beta_2 \)) in the tax evasion equation and so on. An interesting dynamic aspect to note concerns the size of the adjustment. Coming to our estimates, for tax evasion the coefficient \( \alpha_{TE} \) indicates that almost 19% of the disequilibrium in the second cointegration relation is removed in a quarter, about 80% in a year. With respect to the first stationary relation, the adjustment is about 30% per year. The speed of the adjustment of the fiscal variables is, as

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\(^{18}\) Lutkepohl (1991, 1994) shows that the ceteris paribus assumption may not have a meaning. See also Dickey, Jansen and Thornton (1991). For an updated work, see Juselius (2007).  

\(^{19}\) Akaike Information Criterion.
expected, rather slow, with the exception of public spending in the second stationary relations: about 18% per quarter (72% per year). Finally, tax rate is a weakly exogenous for the long-run parameters of the second stationary relation while public spending is weakly exogenous for the first ECM.

4. The structural analysis in a VECM framework

4.1 Choleski decomposition and Structural VECM

In the previous section, we discussed the identification of the long run structure, by embedding the two stationary relations in a dynamic equilibrium correction system. In this section we illustrate the results of the impulse response analysis. In order to proceed, however, we need to identify also the short-run structure. We impose short-run zero restrictions by using a Choleski decomposition of the residual covariance matrix.

In this paper, differently from the literature on fiscal policy effects, we order the variables in the estimated system as follows: GDP, tax evasion, government spending and tax rate. Since we do not adjust the tax rate for the automatic response to business cycle, as in Blanchard and Perotti (2002), net tax rate as well as public spending have no immediate effect on real variables, whereas they are affected by GDP. Consistently with the literature we set tax rate to follow government spending, since during the sample period under consideration, Italy has been characterized by sustainability problems and tax rates are usually managed to run a balanced public budget. In addition, average tax rates are affected not only by government spending and business cycle (which have an immediate impact on the tax base), but also, of course, by compliance. As to the ordering of tax evasion and GDP, given that we focus mostly on regular GDP, we claim that undeclared VAT base is plausibly affected by decisions taken in the regular economy and not vice-versa, therefore we order tax evasion after regular GDP.

The decision to identify the short run structure without imposing structural restrictions on the residuals except for adopting the Choleski decomposition of the covariance matrix is justified by two order of reasons. The first one, is related to our purpose of investigating the effects of fiscal shocks on GDP after having explicitly included in the analysis the tax evasion. This latter, as well as regular production value added, is a macroeconomic aggregate mostly pertaining to the aggregate supply, whereas fiscal variables are mainly related to aggregate demand. Starting from the paper by Blanchard and Quah (1989), a plausible empirical identification relies on restricting the long run effect of the demand shocks on output to be zero. We claim that this restriction can also be effective in the very short run (instantaneous relations between the variables), allowing us to order demand shocks after supply shocks. This supports the identification based on the recursive ordering of the supply side variables followed by the demand side aggregates. Public expenditure and tax rate respond to economic conditions, here described by the temporal evolution of the private production which is separated into two components, regular and hidden production. As Figure 5 shows, in the short run fiscal policy is
managed as a function of the business cycle (stabilization policy). The second, motivation we adopt to justify the Choleski decomposition, has been well emphasized by Breitung at al (2004) and Lutkepohl (2009): although imposing structural restrictions may resolve the non uniqueness problem of innovations, it also raises the same order of criticisms already stressed by Sims (1980) with reference to econometric simultaneous equations models.\textsuperscript{20}

**Figure 5. Regular GDP ($Y_{M}$) and Government Spending ($G$) (HP filtered series, percentage changes)**

\begin{figure}
\centering
\includegraphics[width=0.8\textwidth]{figure5.png}
\caption{Regular GDP ($Y_{M}$) and Government Spending ($G$) (HP filtered series, percentage changes).}
\end{figure}

\textsuperscript{20} We also carried out several identification schemes in a VECM structural framework (see, for instance, Breitung at al, 2004 and Juselius 2006). In modelling the Structural VECM, we use an order of the variables more consistent with the standard literature on fiscal policy effects, i.e. $G$, $Y$, $TE$, $\tau$. According to the cointegration analysis, we choose two temporary structural innovations, spending and tax evasion. In addition, to identify permanent shocks, we also restrict the tax rate to display only temporary effects on public spending; finally, the further short run restriction is set in such a way that the first shock, public spending, does not have an instantaneous effect on private GDP. The picture we get from the structural impulse response confirms the fiscal policy multipliers, the significant impact of tax rate on tax evasion, though the opposite channel is no longer working. Finally, an increase in tax rates reduces public spending, whereas a spending shock causes a positive reaction in tax rate. The complete analysis is available upon request.
4.2 The fiscal policy multipliers

4.2.1 The public spending shock

A first remarkable result of our analysis deals with the interaction between fiscal policy and tax evasion. In Italy the GDP statistics are an exhaustive measure of the macroeconomic activity, accounting for the underground economy, as required by Eurostat. Obviously, tax evasion and underground economy do not represent a unique phenomenon, but it is equally obvious, and widely recognized, that there are strong linkages between them.\(^{21}\) In particular, it is plausible that evaded VAT base accounts for the largest part of the estimated underground economy. This fact has remarkable consequences when estimating the size of fiscal multipliers with a measure of the macroeconomic activity that includes underground economy. In order to investigate this issue, we examine the responses of GDP to shocks to government spending with two different versions of the model characterized by the two alternative measures of the GDP. Hence, with regard to the GDP we consider the reaction to the shock of private GDP (i.e. total GDP net of government spending), and regular GDP (i.e. private GDP net of evaded VAT base).

Figure 6 displays the impulse responses to one standard deviation shock to government spending. Notice that government spending and GDP are both measured in logs, the variations in the plots can be read as percentage changes of the GDP consequent to one standard deviation shock to government spending. In Table 1 the original impulse responses are transformed such as to give the GDP response to one-percentage point of GDP shock to government expenditure.

**Figure 6. Fiscal multipliers. The response of GDP to shocks to public spending**

\(^{21}\) Tax evasion and underground economy are polite terms for cheating, the failure to pay what the tax law requires. See amongst others Cowell (1990) and Schneider and Enste (2002).
Throughout the paper we define as “statistically significant” those estimates for which the error band, identified by the fifth and the ninety-fifth percentiles, does not include zero. It is clear from Figure 6 that the dynamic of the fiscal multipliers are largely similar between the two models. However, the reaction in GDP to a positive shock in public spending is quicker and more intense in the model with the regular economy, suggesting that it is the regular economy which drives the expansionary effect.

Table 1: the response of GDP to a positive shocks to public spending and taxation

<table>
<thead>
<tr>
<th>Impact</th>
<th>Model 1 (Private GDP)</th>
<th>Model 2 (Regular GDP)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Shock to G by 1% of GDP</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1 year (+4)</td>
<td>0.8%**</td>
<td>1.1%**</td>
</tr>
<tr>
<td>5 years (+20)</td>
<td>2.5%**</td>
<td>2.5%**</td>
</tr>
<tr>
<td><strong>Shock to tax rate by 1 percentage point</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1 year (+4)</td>
<td>-0.1%</td>
<td>-1.5%**</td>
</tr>
<tr>
<td>5 years (+20)</td>
<td>-0.4%</td>
<td>-2.4%*</td>
</tr>
</tbody>
</table>

** and (*) denote statistical significance, respectively, at the 5% and (10%) level.

On the impact, the output response is weaker for the private GDP. The regular GDP exhibits a substantial and long-lasting increase in response to a government spending shock, following a hump-shaped pattern. The spending multiplier is, on impact 1.1 and peaks after one year at the value of 2.9. The effects are still potent and statistically significant after 5 years (2.5).

These surprising findings show that the public expenditure effects on regular production in Italy are strong and very persistent. The results can, to a large extent, be traced back to differences in the GDP measure used in the models (in the period considered, the total GDP is composed by 27% of direct public spending and 20% of underground production). Moreover, controlling for tax evasion, allows us to take into account some crucial effects otherwise neglected: Figure 8 and Table 2, below, and the whole set of the impulse response plots in Appendix C, show that after an increase in public spending (wages, investment, goods and services) there is a positive effect on the regular economy, whereas the
underground sector tend to shrink, at least for 8 quarters. Hence, changes in public spending generate a reallocation from underground to the regular economy with the regular GDP which increases more than proportionately to government spending and the underground component of the economy which shrinks.\textsuperscript{22} This reallocation effect of the output components contributes to obscure the spending effect on total GDP.

The lesson here should be quite evident. Government manoeuvres involve both the production components. To determine the magnitude of these policies we should decompose their behaviours in order to highlight on the short-run substitutability effects.

The intensity of the fiscal multiplier and the quicker and larger response observed in the specification with regular GDP adds important insights to the evidence available for Italy. Giordano et al. (2007) find that the response of Italian private GDP (net of public expenditure component) to an exogenous one per cent (in terms of private GDP) shock to public consumption expenditure is about 1.2 percentage points on impact, with a humped-shaped pattern. Conversely, a very weak effect of the fiscal multiplier is found, in a different identification framework, by Afonso and Sousa (2009), which support the idea of a crowding-out effect via investment. While results available for US (Blanchard and Perotti, 2002; Caldara and Kamps, 2008) provides support to a positive effect of government spending on GDP, positive shocks in government spending increase output in several European countries although the effects are different: quite small in Germany (Heppke-Falk et al. 2006), limited to the short-run in Spain (De Castro and Hernandez de Cos 2006), large in France (Biau and Girard 2005).\textsuperscript{23}

Our results show that, in addition to the issues mentioned by the authors to motivate their results, for Italy and many countries with similar characteristics, the size of the government spending multiplier should be carefully analyzed, given the possible incorrect modelling of an important component of private supply, i.e. the underground production. As we have seen, the empirical effects of fiscal policy on these two components of the GDP, regular and underground, may be very different. By modelling them as a single production aggregate, the literature has so far omitted to consider that tax evasion is a reaction of a “rational agent” to fiscal pressure, providing potentially misleading results.\textsuperscript{24}

\textsuperscript{22} A complete picture of the impulse response analysis is reported in Appendix C.

\textsuperscript{23} Afonso and Sousa (2009) find that for the US economy the effect on GDP are small, positive, but not significant, whereas the effects of a government spending on German GDP are negative, reflecting a fall in private investment. Beetsma and Giuliodori (2010), estimate a VAR model in a panel format with annual data over the sample 1970-2004 for the EU-14 countries, and show that after a one-percent of GDP increase in government purchases, the GDP rises by 1.2% on impact, and peaks at 1.5% after one year. The authors stress that this substantial multiplier effect is consistent with the fact that most countries in the sample have featured only limited exchange rate flexibility against their main trading partners, which in the context of Mundell-Fleming type model would imply a short-run economic stimulus after a fiscal expansion.

4.2.2 The tax shock

The impulse responses for a tax shock are shown in Figure 7 and Table 1. As regard the output responses, it is well known the disagreement on the effects of a tax shocks in a SVAR framework. Depending on the identification approach, tax shocks in some cases hardly have any effects on the real economy, whereas in others, may display important distortionary effects. Our results emphasize that regular output decreases by 0.1% on impact in response to an increase of a percentage point in net tax rates. The drop in regular output becomes serious over time, peaking to -1.5% after one year and driving the regular economy to a lower equilibrium (-2.4% after five years, but hardly significant). Although the negative pattern is confirmed for the private GDP model, the intensity and the significance of the output responses to a tax shock is substantially reduced, whereas on the impact the model provides a positive multiplier. The figures emphasize that, when considering broader measures of the GDP, the negative impact of the tax rate tends to vanish.

Figure 7. Fiscal multipliers. The response of GDP to shocks to tax rate

The negative sign of the effect of a tax shock on the regular GDP represents a diverging result compared to the estimates for Italy provided by Giordano et al. (2007). They find that a shock to net revenues equal to one percentage point of GDP determines a transitory but positive and significant effect on private GDP. This result is not consistent with our evidence, and obscures the true taxation effect on the economic activity. More recently, Afonso and Sousa (2009) find for the Italian economy that a shock to government revenues reduces GDP, although the effect is not persistent as it vanish after 4 to 6 quarters.

As our impulse responses show, the Giordano et al’s counterintuitive result may well be related to having neglected the underground economy as a component of official estimates of GDP, with the consequence that the effect of tax shocks on the these two components, regular and underground, cannot be disentangled. As shown in Figure 8 (see also Appendix C), an increase in tax rate pushes up the hidden economy and tax evasion entailing a reallocation among sectors which blurs, at best, the total effect. After all, it is well known that the tax burden is the main cause for the growth of the shadow economy (Schnedier and Enste, 2002, Chiarini at al 2008, among others).

Turning to the evidence available for US, Caldara and Kamps (2008) compare the effects of fiscal policy for different econometric / identification approaches in a SVAR framework. While their results always support the view that government spending shocks generate an increase in real GDP, they find strongly diverging results as regard the effects of tax shocks. Overall, there is no evidence of any “expansionary fiscal contraction”.26

### 4.3 Tax evasion and fiscal policy

The high tax burden is usually assessed to be the main determinant of tax evasion, claiming that high taxation encourages taxpayers to expose smaller amount of their revenues to fiscal authorities. The size of tax evasion varies according to the institutional framework as well as to individual characteristics.27 A large size of tax evasion implies severe troubles for tax collection, with a loss of revenues that can be managed through a reduction of the expending side of the public budget, a larger debt and an increase in tax rates.

The analysis performed allows us to provide important elements of discussion useful for interpreting the composite effect of tax evasion on public finances, an issue of remarkable interest for policy analysis. The impulse response for the regular GDP model of an increase in tax rate and public spending on tax evasion is reported in Figure 8 and Table 2 (for both the models).

---

26 Giavazzi and Pagano (1990) were the first to argue that fiscal adjustments (deficit reductions) large, decisive and on the spending side could be expansionary. Alesina and Ardagna (1998) and Alesina and Perotti (1995) investigate various episodes of fiscal adjustments.

27 For instance, the complexity of the tax system is claimed to be an incentive for tax avoidance, evasion and fraud (Veermend et al., 2008; Trandel and Snow, 1999) and tax morale has crucial importance, for many authors, in explaining tax compliance (Torgler, 2007). There exist a large body of literature on tax evasion. See the Economic Journal Symposium on The Hidden Economy (1999) and Cowell (1990a; 1990b) for a survey of the tax evasion models. Many of these models are based on the tax-evader-as-gambler model first analyzed by Allingham and Sandmo (1972). However, in order to overcome some of the shortcomings of this approach, another stream of literature focuses on different determinants, for instance institutional or governance quality, and social norms (Torgler and Schneider, 2006; 2007) or law abidance (Orviska and Hudson, 2003; Orviska et al., 2006). For a study of the phenomenon in Italy, see, amongst others, Busato and Chiarini (2004), Bordignon and Zanardi (1997), Cannari and D’Alessio (2007), Chiarini et al (2008), Chiarini at al (2009), the papers in Guerra and Zanardi (2007), the ISAE Report (2006) and the papers on the Italian Revenue Agency web site: [http://www1.agenziaentrate.it/ufficiostudi/](http://www1.agenziaentrate.it/ufficiostudi/).
Table 2: the response of tax evasion to a positive shocks to public spending and taxation

<table>
<thead>
<tr>
<th></th>
<th>Model 1 (Private GDP)</th>
<th>Model 2 (Regular GDP)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Shock to G by 1% of GDP</strong></td>
<td></td>
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<tr>
<td></td>
<td><strong>Impact</strong></td>
<td><strong>Impact</strong></td>
</tr>
<tr>
<td></td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>$+1$</td>
<td>-0.4%</td>
</tr>
<tr>
<td></td>
<td>$1$ year (+4)</td>
<td>0.1%</td>
</tr>
<tr>
<td></td>
<td>$5$ years (+20)</td>
<td>2.8%</td>
</tr>
<tr>
<td><strong>Shock to tax rate by 1 percentage point</strong></td>
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<td></td>
<td><strong>Impact</strong></td>
<td><strong>Impact</strong></td>
</tr>
<tr>
<td></td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>$+1$</td>
<td>1.1%**</td>
</tr>
<tr>
<td></td>
<td>$1$ year (+4)</td>
<td>2.9%*</td>
</tr>
<tr>
<td></td>
<td>$5$ years (+20)</td>
<td>0.5%</td>
</tr>
</tbody>
</table>

** and (*) denote statistical significance, respectively, at the 5% and (10%) level.

As expected, larger tax rates imply a larger tax evasion; on the impact VAT tax evasion rises by 1.4% after a shock to tax rate of one percentage point, to peak to more than 4% after 1 year. An increase in public spending, reallocating the hidden economy to the regular one, reduces the impact the tax evasion of 2.3% dropping to about -5% after one year.

**Figure 8. Impulse Response: The tax evasion reaction.**
On the other hand, when considering the response of tax rates and public spending to an exogenous shock to tax evasion, Figure 9 shows that on the impact, a larger tax evasion generates a loss of revenues, which explains the initial negative reaction of the average net tax rate, which declines by 0.09 points. However, the long run effect of tax evasion is an increase in the fiscal burden, leading to a rise of the tax rate of about 0.22 percentage points after 10 quarters (less than 3 years). This increase is remarkable, since the measure of fiscal burden here adopted, consistently with literature, is the net tax burden (revenues minus transfers to households and firms/GDP ratio).

With regards to the public expenditure’s response, the data do not show any significant reaction to an increase in tax evasion, suggesting that most of the adjustment of the public budget after a shock to (non) compliance occurs through the revenues side. Finally, it should be emphasized that we are dealing with direct spending net of transfers, whereas a significant component of public spending is accounted for by transfers, which are included in the net tax rate. Hence, the positive reaction displayed by the tax rate to a shock in evasion could also be consequent to a reduction in government spending in transfers.

**Figure 9. Impulse Response. The tax evasion effect.**

### 4.4 Tax and Spending: some unexpected interactions

A large literature has debated about the temporal relationship between tax revenues and public expenditure. The issue is of relevant interest in situations characterized by large budget deficits, since it helps to understand the best strategy to reduce imbalances.

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28 Tax rate is expressed in level and not in logs
As claimed by Hoover and Sheffrin (1992), causality is a slippery concept, but the causal question at stake in this debate is clear: if it is possible to intervene to control one of the variable (spending or taxation) directly, would that yield control over the other variable.

A “fiscal synchronization” of spending and taxation is implicit in many electoral models, based on the individual optimal behaviour. Under majority vote, the median voter supports the amount of public spending on taxation to satisfy the preferences of the community. A clear direction of causation between spending and taxation is emphasized by the “spend-and-tax” hypothesis. Here changes in public spending would lead taxation, therefore, in order to cut public deficit it is compulsory to limit the former. Peacock and Wiseman (1979) argue that even temporary increases of public spending (exceptional events such as war, environmental crisis) eventually lead to a permanent increase in taxation. In macroeconomic literature, the Barro’s (1979) influential tax smoothing hypothesis states that the path of expenditures is exogenously given, and taxes are adjusted in order to minimize distorting costs, while the budget is balanced intertemporally.

In the opposite causal structure, the “tax-and-spend” hypothesis, the level of spending adjusts to the level of tax revenues available. In this view, larger tax revenues would increase spending and not lower public deficit. Authoritative supporters of this view, such as the economists of the “supply side approach”, suggest a reduction in taxes to force subsequent spending cuts. Buchanan and Wagner (1977) share a similar view about the casual ordering but their analysis leads to an opposite interpretation about the sign of the interaction: rising taxes may limit the growth of public spending, since the taxpayer would perceive a too high price of government provided goods, claiming spending reductions.

Recent literature using VAR analysis to evaluate the effect of fiscal policy, seems to support the hypothesis of “spend-and-tax”, since the large part of available structural VAR models always order tax revenues after government spending. Including in the analysis tax evasion, we add to this debate additional issues. As shown in Figure 10, which reports the reciprocal reactions of the fiscal variables to their reciprocal shocks, the responses would suggest that there is no significant reaction of (net) tax rate to government direct spending, i.e. spending does not causes taxation. By contrast, there is significant evidence of the other way working channel, taxes leading spending. However, the sign of the relationship is more consistent with Buchanan and Wagner (1977): a positive shock in net tax rates generates a decline in spending (although in the long-run). This result, already displayed by Giordano et al. (2008), is puzzling and could be related to the sample period here examined, characterized by a remarkable pressure for fiscal consolidation. Tax shocks have been related to restrictive policies to manage fiscal budget sustainability, urging the fiscal authorities to adopt more severe scheme also on the spending side.

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30 Caldara and Kamps (2008) for a review of the various approaches to identify fiscal shocks in structural VAR models, and the implication of the casual ordering of the model variables.
4.5 Tax evasion and regular GDP: some dynamic aspects

In literature it is debatable the role of underground economy and tax evasion in relation to economic growth and business cycle. Though we are dealing with a statistical model, the data generating process here examined underlines two dynamic aspects of the GDP-tax evasion relationship (Figure 11). First, on the impact, there is a weak evidence for a rise tax evasion to be counterproductive for the regular economy; however, in a longer period, i.e. after 10 quarters, there is some evidence of a positive effect, with an increase regular GDP of about 0.7% subsequent to a shock in evasion of 2 percentage points, equivalent to a long run elasticity of 0.35. Second, when looking at the reverse causality, there is significant evidence of a reduction in tax evasion in the short run subsequent to a positive shock in regular economy, approximately for one year, followed by pro-cyclical pattern for the subsequent years. One percentage shock in regular GDP generates a reduction of about 10% of tax evasion lasting for about 3 quarters, followed by a recovery in evasion of about the same intensity, reaching a positive peak of almost 20% after two years. Thus, after an initial substitution effect between sectors (regular and hidden) follows a substantial complementarity between them. This is an important issue, and would indicate that tax evasion is a very structured phenomenon in the Italian economy.

Figure 11. Impulse Response. GDP and Tax Evasion

![Graphs showing impulse responses](image)

**Concluding remarks**

Employing a VECM and breaking up GDP into its regular and hidden components, we have provided striking evidence for Italy on the consequences of a discretionary increase in government spending and tax rate. Moreover, the relationships between fiscal variables and tax evasion have been investigated.

In economies with a sizeable underground sector and tax evasion, the standard aggregate estimate of fiscal effects are not reliable. We find that changes in public spending generate a reallocation from underground to the regular economy with the regular GDP which increases more than proportionately to government spending and the underground component of the economy which shrinks. This reallocation effect of the output components, contributes to obscure the spending effect on total GDP. Similarly, an increase in tax rate pushes up the hidden economy and tax evasion entailing a reallocation among sectors which blurs, at best, the total effect. To see the real effect of fiscal policy, we necessarily need to decompose the regular and the hidden production. In this setup the spending multiplier peak after one year at the value of 2.9 and shows large long-run effects. The drop in regular output after an increase in tax rate is relevant in the short-run (1.5% after one year) and becomes dramatic in a longer period (-2.4% after 5 years), producing a remarkable increase in tax evasion.

This is the first step of a future project research. Natural extensions to search for the transmission mechanism of fiscal policy include the decomposition of both public expenditure and the GDP in consumption and investment components, and the analysis of the labor market reactions (using also the structural vector autoregression approach to cope for the sample size restrictions). Finally, following Favero and Giavazzi (2007), we should consider public debt in the VAR in order to take into account the debt dynamics that arise after a fiscal shock and, more importantly, study how taxes, public spending and tax evasion respond to the level of debt.
Appendix A: Quarterly estimate for the evaded VAT base

In this paper we use quarterly time series for unreported VAT tax base and VAT tax evasion for Italy over the period 1980-2006, based on quarterly economic and fiscal information from national accounts. As explained in Section two, yearly data on unreported VAT tax base has been recently estimated for Italy by the Revenue Agency of the Ministry of Economy and Finance over the period 1980-2006. According to Marigliani and Pisani (2007), undeclared VAT taxable amounts are assessed by comparing theoretical data (Total VAT base) and actual observations (Declared VAT base) derived from VAT returns.

In order to obtain the quarterly series of undeclared VAT base we first applied the temporal disaggregation procedure suggested in Proietti (2006) to the yearly series of Total VAT base and Declared VAT base from the Revenue Agency. Subsequently, we found the quarterly series of undeclared VAT base as difference between the two in the same fashion of Marigliani and Pisani (2007).

It is worth spending some words in describing the main characteristics of the temporal disaggregation methodology used to obtain quarterly estimates for the two mentioned series.

The method used consists of a dynamic extension of standard techniques widely used by National Statistical Institutions to estimate high frequency (monthly or quarterly) series. Many European National Statistical Offices, indeed, make use of indirect methods relying on proxy indicators to compute Quarterly National Economic Account time series. In particular, ISTAT has been using the Chow-Lin (1971) method since the eighties. The method assumes the existence of a multiple regression model at high frequency $t$:

$$
\begin{align*}
  y_t &= x_t \beta + u_t, \quad t = 1, \ldots, n, \\
  u_t &= \phi u_{t-1} + \varepsilon_t, \quad \varepsilon_t \sim NID(0, \sigma^2), \quad -1 < \phi < 1
\end{align*}
$$

(A.1)

In our case $t$ refers to a quarter. The unknown quarterly variable $y_t$, of which only yearly observations are available, is regressed on $k$ proxy indicators which can be observed at quarterly frequency and are included into vector $x_t$. The model, as presented in equation (A.1), assumes quarterly residuals are generated by a first-order Markov model without drift. The model cannot be estimated at quarterly level due to the lack of information on variable $y_t$ and, therefore, estimation is to be performed at
yearly frequency. For, the model is aggregated by multiplying both side of the equation referring to $y_t$ for a suitable aggregation matrix. In particular, as dealing with flow variables, the model is aggregated by using a matrix which allows to sum quarters referring to each year. As a consequence of this time constraint, the sum of computed quarterly estimates of variable $y_t$ in each year is equal to the corresponding yearly observation, so that the mean disaggregation error is zero by construction.

After the revision of national accounts in 2005, ISTAT added the Fernàndez (1981) method to the Chow-Lin benchmark. Differently from the Chow-Lin method, this more recent model implicitly assumes the $y_t$ series and the $k$ indicators are not cointegrated, or if they are, that the model is not the cointegration one. In line with the assumption, quarterly residuals are supposed to be generated by a random walk by posing $\phi=1$ in equation (A.1).

Both the methods provide quarterly BLU estimates which consist of two components: the first includes the effects of indicators, while the second consists of the so called adjustment part, which operates the smoothing of the estimated yearly residuals across the corresponding quarters. Different hypothesis on residuals lead to different shapes of the smoothing matrix, which is a function of parameter $\phi$, and thus leads to different quarterly estimates.

The broader Autoregressive Distributed Lag model of first order in equation (A.2) nests both the Chow-Lin and the Fernandez methods.\(^{32}\)

\[
y_t = \phi y_{t-1} + x_t \beta_0 + x_{t-1} \beta_1 + \epsilon_t, \quad t = 1, \ldots, n.
\]

\[
\epsilon_t \sim NID(0, \sigma^2) \tag{A.2}
\]

The two static aforementioned models can be considered as a restricted version of the Autoregressive Distributed Lag model. It can be showed that under the following restriction:

\[
\beta_1 = -\phi \beta_0 \tag{A.3}
\]

the Autoregressive Distributed Lag model yields the Chow-Lin model while, under both the restrictions in equation (A.3) and (A.4), the model yields the Fernàndez approach:

\(^{32}\) As shown in Proietti (2006), when the Adl model is reformulated according to first differences of $y_t$ and $x_t$ it yields the Litterman (1985) model, which is the third model included into the so called Chow-Lin family.
The estimation of the broader model instead of the Chow-Lin version avoids any potential biases in the coefficients of indicators whenever the common root restriction in (A.3) did not hold. The use of a more general specification allows, therefore, to better select the proper model describing the relationship among the series to be disaggregated and indicators.

The approach suggested in Proietti (2006) also proposes a new estimation procedure which relies on the state space representation of the Autoregressive Distributed Lag model, allowing to transform the distribution problem into an unknown observation ones. The procedure also provides the computation of the standardized Kalman Filter innovations which are useful for checking the statistical properties of quarterly estimates. In line with the recent practice carried out by ISTAT, parameters are computed by using the maximization of likelihood function.\(^{33}\)

Our application consists in a simplified and more parsimonious version of the general procedure considering  \( k \) indicators, as we rely on a single indicator selected according to the economic meaning of variables.

In order to disaggregate the yearly time series of Total VAT base we use a quarterly indicator computed as the sum of GDP and net imports. The indicator assesses the amount of economic resources produced at national level and it is thought to be a good proxy for theoretical VAT base. In the case of Declared VAT base we used the quarterly series of net indirect taxes (net of contributions on production), which includes actual VAT returns. The quarterly indicators are from the CON-ISTAT quarterly conjunctural database, containing Quarterly National Accounts time series. Data, which is available from the first quarter of 1980, is at nominal prices and seasonally adjusted with trading day correction at the source.

For each yearly series we estimated three models: i) the Autoregressive Distributed Lag model (henceforth Adl) in equation (A.2), with the addition of a constant term and a linear trend, ii) the nested Chow-Lin model (henceforth Cl) found by imposing restriction (A.3) into the Adl specification, with the addition of constant term and a linear trend, iii) the Fernàndez model (henceforth Fe) found by imposing restrictions (A.3) and (A.4) into the Adl specification. In the latter case, the model is estimated by using first differences, considering only the constant term.

\(^{33}\) After the 2005 revision, ISTAT moved from the Barbone et al (1981) estimation strategy, which relied on feasible generalized least squares, to the maximum likelihood estimation, which is still performed within an iterative greed-search procedure to estimate the first autoregressive parameter in the restricted range.
The selection of the proper model is based on the stochastic properties of smoothed estimates derived from their standardized Kalman Filter innovations. The latter are computed by the filter as the ahead forecast error at each time $t$. The standardization is made on the base of the standard deviation. Despite filtering is useful for diagnostic, we consider smoothed estimates in order to exploit the whole information contained into the estimation set.

Further, we base the selection of the proper specification on the ability of the models to minimize the revision error associated to quarterly estimates. According to the European System of National Accounts, the revision error can be defined as the difference between quarterly extrapolations for year $t+1$, obtained by the model using information up to time $t$, and the revised quarterly estimates computed once that the $t+1$ yearly observation becomes available. To this end, we performed a rolling forecast experiment consisting in re-estimating the three models with the addition of one more observation at a time, starting from 1992 up to 2006. At the beginning of each year we made dynamic projections for the four subsequent quarters by only using the observations up to the previous year. We then computed the updated quarterly estimates by adding the subsequent yearly observation to the estimation set. In this way, we obtain two values at each quarter over the period 1993-2006: projections, based on old yearly information, and the revised estimates incorporating the new yearly observation. We computed the revision error at each quarter as the difference between the two values. Afterwards, we took the mean for each quarter over the 14-year-period, by obtaining four mean revision errors assessing respectively the error occurred on average in the first, second, third and fourth quarter.

The main results can be summarized in the following three tables.

As regards as Total VAT base, Table A.1 shows that the quarterly indicator referring to the amount of economic resources exerts significant effects both at contemporaneous and one-period lagged.

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Table A.1 Total VAT base, main parameters estimates

<table>
<thead>
<tr>
<th>Method</th>
<th>$\beta_0$ (Student's t in brackets)</th>
<th>$\beta_1$ (Student's t in brackets)</th>
<th>$\phi$</th>
<th>$-\phi \beta_0$</th>
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</thead>
<tbody>
<tr>
<td>Adl</td>
<td>0.42 (5.71)</td>
<td>-0.41 (-5.74)</td>
<td>0.97</td>
<td>-0.41</td>
</tr>
<tr>
<td>Cl</td>
<td>0.39 (4.97)</td>
<td>…</td>
<td>0.97</td>
<td></td>
</tr>
<tr>
<td>Fe</td>
<td>0.39 (5.19)</td>
<td>…</td>
<td>1.00</td>
<td></td>
</tr>
</tbody>
</table>

For a more detailed discussion on the topic see Proietti (2006).
As expected, regression effects are always positive at contemporaneous date, and negative one period lagged in the Adl model. Results also suggest the common root restriction in equation (A.3) can be accepted, and that therefore the use of the Chow-Lin or the Fernandez model would be advisable. The passage to restricted versions allows to gain in efficiency because of the reduction of the number of parameters to be estimated.

No relevant differences can, however, be observed in estimating the three models (Adl, Cl and Fe), even when considering their growth rates. Smoothed estimates referring to the Fe model are presented in left panel of figure A.1.

Figure A.1 Total VAT base, Fernández model

According to results from the diagnostic check in right panel of figure A.1, the estimates show quite good statistical properties. The standardised Kalman Filter innovations can be considered a white noise process, innovations shows a symmetric distribution without any problem of Kurtosis and very close to a Normal one. Finally, autocorrelation seems to be absent.

We considered the results deriving from the rolling estimation to identify the method which is able to provide the best extrapolation and the minimum mean square revision error.
As shown in table A.2, the Fernàndez model is the one whose mean root square revision error is the least over quarters and, therefore, the corresponding smoothed estimates are considered the most correct for constructing the evaded VAT base variable.

As regards as the Declared VAT base, estimation showed less satisfactory results than the one obtained for Total VAT base. As expected, regression effects are positive but the quarterly indicator referring to net indirect taxes does not seem to exert statistical significant effects on the variable to disaggregate, especially in the Adl model, as shown by Student’s t in Table A.3.

Table A.3 Total VAT base, main parameters estimates

<table>
<thead>
<tr>
<th>Method</th>
<th>$\beta_0$</th>
<th>$\beta_1$</th>
<th>$\phi$</th>
<th>$-\phi\beta_0$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Adl</td>
<td>0.13</td>
<td>0.24</td>
<td>0.63</td>
<td>-0.08</td>
</tr>
<tr>
<td>Cl</td>
<td>0.88</td>
<td>...</td>
<td>0.69</td>
<td></td>
</tr>
<tr>
<td>Fe</td>
<td>1.45</td>
<td>...</td>
<td>1.00</td>
<td></td>
</tr>
</tbody>
</table>

(Student’s t in brackets)
The common root condition can be accepted and the Chow-Lin model can be considered the proper specification instead of the broader Adl specification. For a two-side Student’s t test at 5 per cent level of confidence and with 21 degree of freedom, the critical value is 2.08. Being the standard error of $\beta_1$ equal to 0.96, the t statistic for $\beta_1$ is:

$$t_{(25-4)} = \frac{0.24 + 0.08}{0.96} = 0.33$$

The test clearly suggests to accept the $H_0$ hypothesis of $\beta_1 = -\varphi \beta_0$.

However, even when considering the Chow-Lin model, the statistical significance of the quarterly indicator is not accepted either at 5 and 10 per cent level. Differently, $\beta_0$ is statistically significant at the 10 per cent level in the Fernàndez model.

Panel a of Figure A.3 shows smoothed estimates deriving from the Chow-Lin model and their statistical properties. It clearly emerges a larger confidence interval around estimates than the one observed in the previous case (see the lower left panel in Figure A.1 for a comparison). As a major consequence, the smoothed estimates of Declared VAT base are less precise than the one found for Total VAT base.

Figure A.2 Declared VAT base, Chow-Lin model

Panel a                                                                     Panel b

Compared with the estimates found with the Adl and the Fe method, however, the estimates deriving from the Chow-Lin model are the most precise with the lowest root mean square error.
Results from the diagnostic checking on the standardized Kalman Filter innovations suggest the innovations present a symmetric distribution and no significant autocorrelation problems.

The rolling experiment provides additional information. It clearly suggests the Adl model underperforms with respect to its restricted versions. Also, the preponderance between the Chow-Lin and the Fernàndez is not straightforward, except when considering the root mean square revision error. As shown in Table A.4, according to the latter indicator, the Cl model outperforms on average the Fe one in the second, third and fourth quarters of predictions.

<table>
<thead>
<tr>
<th>Tab A.4 Declared VAT base, revision histories</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean percentage revision error</td>
</tr>
<tr>
<td>Adl 0.31</td>
</tr>
<tr>
<td>Cl -0.02</td>
</tr>
<tr>
<td>Fe 0.16</td>
</tr>
<tr>
<td>Mean revision Error</td>
</tr>
<tr>
<td>Adl -55.54</td>
</tr>
<tr>
<td>Cl -190.95</td>
</tr>
<tr>
<td>Fe 105.88</td>
</tr>
<tr>
<td>Mean absolute revision error</td>
</tr>
<tr>
<td>Adl 5,204.70</td>
</tr>
<tr>
<td>Cl 4,154.74</td>
</tr>
<tr>
<td>Fe 1,991.29</td>
</tr>
<tr>
<td>Mean root square revision error</td>
</tr>
<tr>
<td>Adl 7,271.97</td>
</tr>
<tr>
<td>Cl 5,421.41</td>
</tr>
<tr>
<td>Fe 2,652.06</td>
</tr>
</tbody>
</table>

Hence, as a conclusion of the analysis, we consider the smoothed estimates corresponding to the Chow-Lin model as the correct for constructing the declared VAT base.

As a further proof of reliability of data, we also tried to disaggregate the series of Declared VAT by considering two indicators, net indirect taxes and the ratio of employees over self-employed. The ratio of employees over self-employed is computed by using data from the CONISTAT quarterly database and refers to total economy; it is expressed in full-time equivalent and seasonal-adjusted by the source.

First, the inclusion of this second indicator strengthens regression effects exerted by net indirect taxes in the Fernàndez model: the Student’s t associated to contemporaneous effects goes up from 1.96 to 2.26 as shown in Table A.5. Estimation effects of indirect taxes remain still not significant both at 5 and 10 per cent in the other two models under consideration (Adl and Cl).

The ratio of employees over self-employed exerts positive effects on the declared VAT base as expected. Main parameter estimates shown in Table A.5 suggest the existence of significant contemporaneous and one period lag effects in the Fernàndez model and significant contemporaneous
effects in the Adl model, but only at 0.90 per cent of confidence (the Student’s t with 21 degree of freedom is equal to 1.725 in a two-side alternative test).

Tab A.5 Declared VAT base, main parameters using two indicators

<table>
<thead>
<tr>
<th>Method</th>
<th>$\beta_0$</th>
<th>$\beta_1$</th>
<th>$\phi$</th>
<th>$-\phi^*\beta_0$</th>
<th>$-\phi^*\beta_0$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Adl</td>
<td>0.63</td>
<td>-0.30</td>
<td>3.66</td>
<td>-3.43</td>
<td>0.67</td>
</tr>
<tr>
<td></td>
<td>(0.71)</td>
<td>(-0.34)</td>
<td>(1.81)</td>
<td>(-1.61)</td>
<td></td>
</tr>
<tr>
<td>Cl</td>
<td>0.72</td>
<td>...</td>
<td>1.70</td>
<td>0.70</td>
<td></td>
</tr>
<tr>
<td></td>
<td>(1.33)</td>
<td>(1.64)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fe</td>
<td>1.58</td>
<td>...</td>
<td>2.83</td>
<td>1.00</td>
<td></td>
</tr>
<tr>
<td></td>
<td>(2.26)</td>
<td>(1.99)</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Legend: $x_1$ = net indirect taxes; $x_2$ = ratio of employees over self-employed.

As before, the common root condition can be accepted by the data. In the case of net indirect taxes, the standard error of $\beta_1$ is equal to 0.88, yielding the following $t$ statistics:

$$t_{(25-6)} = \frac{-0.30 + 0.42}{0.88} = 0.1363$$

The test clearly suggests to accept the $H_0$ hypothesis of $\beta_1 = -\phi^*\beta_0$ even at the 0.99 per cent of confidence. In the case of employees over self-employed, estimation results yield the following $t$ statistics:

$$t_{(25-6)} = \frac{-3.43 + 2.46}{2.136} = 0.454$$

The test confirms the null hypothesis at 0.99 per cent of confidence as well and we can still consider the Chow-Lin as the proper model instead of the broader Adl specification.

According to the rolling experiment, Chow-Lin estimates still out-perform the ones deriving from the Adl and the Fernández model, as shown in Table A.5, and therefore estimation results lead us to choice estimates obtained with the Chow-Lin model.
Tab A.6 Declared VAT base, revision histories using two indicators

<table>
<thead>
<tr>
<th></th>
<th>1Q</th>
<th>2Q</th>
<th>3Q</th>
<th>4Q</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean percentage revision error</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Adl</td>
<td>0.55</td>
<td>0.82</td>
<td>1.93</td>
<td>1.14</td>
</tr>
<tr>
<td>Cl</td>
<td>0.42</td>
<td>0.65</td>
<td>0.85</td>
<td>0.52</td>
</tr>
<tr>
<td>Fe</td>
<td>0.11</td>
<td>0.12</td>
<td>0.24</td>
<td>0.33</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Mean revision Error</th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Adl</td>
<td>23</td>
<td>982</td>
<td>1673</td>
<td>863</td>
</tr>
<tr>
<td>Cl</td>
<td>315</td>
<td>786</td>
<td>927</td>
<td>580</td>
</tr>
<tr>
<td>Fe</td>
<td>93</td>
<td>107</td>
<td>245</td>
<td>329</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Mean absolute revision error</th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Adl</td>
<td>3500</td>
<td>3705</td>
<td>4782</td>
<td>5262</td>
</tr>
<tr>
<td>Cl</td>
<td>3574</td>
<td>1853</td>
<td>2865</td>
<td>3254</td>
</tr>
<tr>
<td>Fe</td>
<td>1876</td>
<td>2783</td>
<td>3323</td>
<td>3624</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Mean root square revision error</th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Adl</td>
<td>781.552</td>
<td>522.211</td>
<td>643.600</td>
<td>757.973</td>
</tr>
<tr>
<td>Cl</td>
<td>489.083</td>
<td>276.940</td>
<td>355.843</td>
<td>416.536</td>
</tr>
<tr>
<td>Fe</td>
<td>250.581</td>
<td>375.165</td>
<td>447.452</td>
<td>482.490</td>
</tr>
</tbody>
</table>

The comparison of estimates obtained with the Chow-Lin method using one indicator and the new ones based on two indicators (net indirect taxes and employees over self-employed ratio), however, clearly shows that no significant differences emerge between the two time series, as shown in panel a of Figure A.3.

Figure A.3 Declared VAT base, comparison

Panel a

Panel b
Panel b shows log-differences between the two series, represented by the solid line. No systematic difference emerges between the two series (the mean is zero) and also differences vary within a very small range: from a minimum value of about -0.01 per cent to +0.01 per cent.

In Figure A.3 we also plotted the estimates obtained by using the Fernández method with two indicators and found that major differences occur at the end of the estimation sample. The series named “log_diff_cl_fe” in panel b shows log-differences between Cl estimates based on one indicator and Fe estimates based on two indicators. Also in this case no systematic difference emerges, even if differences show a slightly higher variation range, from -0.04 to 0.02 per cent.

As a final result, we do not expect the use of estimates based on two indicators for Declared VAT base could make relevant differences in the analysis therefore, as already stated, we consider estimates obtained with the Chow-Lin method and one indicator as the correct for constructing the declared VAT base.
Appendix B: Quarterly fiscal data

Since the introduction of the System of National Accounts, the *accrual principle* for measuring fiscal quantities has been favoured by National Statistic Institutes belonging to ONU. The International Monetary Fund and the EUROSTAT consider the accrual principle as the proper one in handling fiscal variables, because committed expenditures and assessed revenues might have a major effects on the behaviour of economic agents than receipts and payments.

Moreover, models with rational agents show that the private sector behaviour is not only influenced by cash-basis government finances, but also by expenses and revenues that will be paid or cashed in the future, throughout the anticipation of their effects. Also, recent empirical literature on macroeconomic effects of fiscal policy pointed out how the reliability of results is strongly affected by the use of proper fiscal policy indicators, suggesting the use of long-lasting quarterly national account data for the general government sector. Coherently to this orientation, and due to the shortage of genuine quarterly national account government data in many countries, most of literature on macroeconomic effects of fiscal policy has extensively focused on the United States and, in a lesser extent, to the United Kingdom, Canada, West Germany and Australia.

The issue is important for Italy, as well as in many other countries, where an informative gap seems to emerge both at yearly and quarterly frequency. Yearly general government national account data based on the European System of Accounts (henceforth ESA95) are issued by ISTAT in the *Conto Economico Consolidato delle Amministrazioni Pubbliche* (henceforth CECAP), but only since 1980. Quarterly general government data based on ESA95 are published in the *Conto Economico Trimestrale delle Amministrazioni Pubbliche* (henceforth CETAP), however, these fiscal time series are only available since the first quarter of 1999.

Six variables, referring to direct and indirect taxes, social contributions and social payments are, instead, published by EUROSTAT from the first quarter of 1991 and can be, therefore, found in the EUROSTAT NEW-CHRONOS database, which actually extends public finance information from the CETAP account. At a second-level classification, neither ISTAT or EUROSTAT provide quarterly national account data for current taxes on household (direct taxes on labour) and on corporate income (direct taxes on profits).

Thus, an empirical analysis relying on official quarterly general government data, compiled on a national accounts basis, would be feasible only if considering few budgetary items, referring to the non-market sector for the spending side and the revenue item of VAT and other taxes on import. These time series are available back to 1980:I. As a consequence of this information gap, empirical applications for Italy have been relying on either OECD quarterly general government data or

---

35 The items refer to: Current taxes on income and wealth, Taxes on production and imports, Value added type taxes, Capital taxes receivable, Actual social contributions receivable (excluding imputed social contributions) and Social payments (social benefits other than social transfers in kind).
quarterly cash-basis data. Two kinds of problems arise, however, when using these figures. On the one hand, OECD quarterly government time series are interpolated without a guide; on the other hand, cash principle does not seem to be considered as the proper one according to recent international opinion on government accountancy.

The first issue, regarding OECD high frequency data, deals with temporal disaggregation methods. It seems to exist a quite large consensus about the recent critics affirming that OECD quarterly data are not more informative than the annual one. When no official long-run high frequency data are available by the national source, OECD computes quarterly estimates by interpolating yearly data without any guide, as in the case of Italian quarterly government account. The model used to perform the temporal disaggregation is exclusively based on a mathematical criteria aimed at avoiding unrealistic jumps when passing from a year to another.

With regard to cash-basis data, according to many authors, these kind of data should be considered an incomplete guide for the measurement of counter-cyclical activity effects of the government sector on the private one. Other stream of literature, instead, emphasizes that payments would produce major effects on private consumption than spending commitments. A recent study of Bank of Italy (Giordano et al 2007) relies on quarterly cash-basis data of the public sector. Data for the consolidated public sector been based on genuine cash observations referring to the State sector, local governments, health sector and social security institutions published by the Italian Ministry of Economic and Finance. For the period 1982-1993, authors performed data consolidation for the public sector, consolidating intergovernmental flows when possible. On the spending side, only government consumption spending is considered.

As explained in Section 2 of the paper, one of the novelties of this study refers to the use of fiscal policy variables based on national account definitions. The estimation of the VECM model relies upon quarterly general government (henceforth government) national account estimates, namely government direct spending and net revenues. The two series are taken from a broader set of quarterly government estimates which has been recently constructed for Italy over the period 1980:1-2007:4. The quarterly database has the aim to fill the aforementioned information gap and provides fiscal policy data fully comparable with the major industrialized countries statistics for their institutional coverage and accountancy basis.

In the following we briefly report the main characteristics of the temporal disaggregation methodology used to obtain quarterly estimates for government primary spending and net revenues. The quarterly time series have been estimated starting from yearly observations of the CECAP account, which

---

36 See, for instance, Perotti (2004).
38 Auerbach, William (2009).
39 For more details about the construction of the quarterly dataset see Basile (2009) and Basile, De Arcangelis and Proietti (2010).
represents the informative base for the calculation of the net lending requirement defined by the Maastricht Treaty, over the period 1980:1 – 2007:4. The temporal disaggregation method used consists in the dynamic extension of the Chow-Lin procedure suggested in Proietti (2006). The procedure relies on the estimation of a first order Autoregressive Distributed Lag model (Adl), described in detail in the Appendix A, which embeds the three univariate models constituting the Chow-Lin classic approach, namely the Chow-Lin, the Fernàndez and the Litterman models. The fiscal variables we selected are widely used in empirical literature on discretionary/non-systematic fiscal policy. On the spending side, we focus on direct public spending on goods and services. Public transfers are, however, considered for the definition of net revenues.

The source of quarterly proxy indicators used to derive the unknown pattern of government primary spending and net revenues is the CON-ISTAT quarterly conjunctural database, containing data from Quarterly National Accounts. For each yearly series it has been selected one related time series, by taking into consideration SEC definitions: quarterly indicators of the expenditure side are supposed to include the unknown government quarterly time series, whereas the quarterly indicators of the revenues side are supposed to replicate the unknown pattern of corresponding taxation base.

Table B.1 provides an insight on the input data considered.

<table>
<thead>
<tr>
<th>YEARLY SERIES</th>
<th>QUARTERLY INDICATORS¹</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gov. consumption expenditure</td>
<td>Consumption expenditure of non-market sector</td>
</tr>
<tr>
<td>Gov. fixed capital formation (gross of divestments)</td>
<td>Fixed capital formation of total economy</td>
</tr>
<tr>
<td>Current taxes on income and wealth</td>
<td>The sum of estimates for the items of Current taxes on corporate income and Current taxes on household income</td>
</tr>
<tr>
<td>Social contributions receivable</td>
<td>Compensations of employees less gross wages and salaries of total economy</td>
</tr>
<tr>
<td>Taxes on production and imports</td>
<td>VAT and other taxes on imports</td>
</tr>
<tr>
<td>Total revenues net of transfers to households and firms</td>
<td>The sum of estimates for the items of Current tax on income and wealth, Social contributions and Taxes on production and imports</td>
</tr>
</tbody>
</table>

¹) Seasonally-adjusted with trading day correction at the source.
**Government spending**

Quarterly estimates for government direct spending are found as the sum of quarterly estimates for public consumption spending and gross investments.

As shown in Table B.1, the disaggregation of government consumption was based on the quarterly series of non-market consumption spending.\(^{40}\) Obviously, government consumption spending includes wages and non-wages current purchases of goods and services.

Regarding to public investments, we consider the series of government gross investments not inclusive of earning from real estate divestments in order to avoid irregular jumps due to divestments in real estate. According to public accountancy rules, indeed, divestments earnings in real-estate enter the budget into the item of government fixed capital formation with the sign minus, determining a strong volatility in both official yearly CECAP figures and quarterly CETAP estimates provided by ISTAT. As explained in Basile (2009), the inclusion of such extraordinary events into the yearly series seems to be misleading for research purpose, and for the economic meaning of the fiscal variable itself. The literature focuses on public investments, which are mostly determined by long-term funding programmes not by contingent events. The revised definition of the yearly series brings to a significant gain in term of precision of estimates referring to public investments and allows to use also this information in the analysis of fiscal policy. Gross investments excluding divestments in real-estates are disaggregated on the base of total gross fixed capital formation of the whole economy.\(^{41}\)

**Net revenues**

Net revenues, are defined as total revenues less monetary social benefits (including pensions and other assistance monetary transfers), “other current expenditure” (including production subsides), and “other capital expenditure” (including investment subsides).\(^{42}\) The variable is widely used in fiscal policy VAR models and in macroeconomic models with credit constraints where fiscal policy is supposed to produce economic effects via the demand-side channels.\(^{43}\)

The disaggregation of the net revenues was based on a two-step approach. In the first step, we estimated quarterly series for direct taxes, social contributions and indirect taxes. Subsequently, these

---

\(^{40}\) According to ESA95 accounting system, the non-market sector includes both public and private producers whose market revenues are less than half of production costs. Hence, the series represents a very good proxy for the government series.

\(^{41}\) The choice of an indicator for government investments is not easy and, at present, it appears to be controversial. The use of an indicator referring to a part of aggregated demand might produce some bias when using government investment estimates to assess their impact of GDP. We thank Sandro Momigliano for some discussion on this issue.

\(^{42}\) Interest payments were excluded from the definition of net revenues. See De Castro (2004) amongst others.

\(^{43}\) See, for example, Blanchard and Perotti (2002).
estimates were used to proxy the unknown pattern of the whole amount of net revenues. The quarterly indicator used in the disaggregation is, indeed, found as the sum of the quarterly estimates for current taxes on income and wealth, taxes on production and imports, and social contributions.

The quarterly government estimates used in this analysis benefit from the following main characteristics: i) they are time-consistent with the corresponding official yearly data from ISTAT in the sense that the sum of quarterly data is equal to the corresponding year observation, ii) they are coherent with the economic accrual principle set by ESA95 as both yearly observations and quarterly indicators are complied according to the economic accrual principle, iii) they are fully comparable with official quarterly national account data issued by National Statistic Institution of the other industrialized countries.

\footnote{For more details about disaggregation results and a comparison of estimates with official quarterly estimates issued by EUROSTAT and ISTAT see Basile (2009) and Basile, De Arcangelis, Proietti (2010), which also provide a robustness proof of the methodology for the USA case.}
Appendix C: The regular GDP model

In this Appendix we first report the statistical characteristics of the time series used in the models and, successively, the cointegration analysis and the complete set of the impulse response analysis obtained for the regular GDP model.

Section C1. Unit Root Tests

Table C.3: Augmented Dickey Fuller Test for unit root. Null Hypothesis: unit root

<table>
<thead>
<tr>
<th></th>
<th>Level</th>
<th>First Difference</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Test statistic</td>
<td>Deterministic (lags)</td>
</tr>
<tr>
<td>Government Primary Spending</td>
<td>-2.11</td>
<td>intercept, time trend (3)</td>
</tr>
<tr>
<td>Net tax revenues/GDP</td>
<td>-2.04</td>
<td>intercept, time trend (2)</td>
</tr>
<tr>
<td>VAT Evasion^</td>
<td>-3.36*</td>
<td>intercept, time trend (4)</td>
</tr>
<tr>
<td>VAT Evasion</td>
<td>-3.16*</td>
<td>intercept, time trend (1)</td>
</tr>
<tr>
<td>Total GDP</td>
<td>-1.79</td>
<td>intercept, time trend (4)</td>
</tr>
<tr>
<td>Private GDP</td>
<td>-1.46</td>
<td>intercept, time trend (4)</td>
</tr>
<tr>
<td>Regular GDP</td>
<td>-2.63</td>
<td>intercept, time trend (6)</td>
</tr>
</tbody>
</table>

Thresholds (constant and trend): 1% (-3.96) 5% (-3.41) 10% (-3.13).
Thresholds (constant): 1% (-3.43) 5% (-2.86) 10% (-2.57).

^KPSS test reject the null of trend stationarity for the undeclared VAT base at the significance level of 1%.

Section C2. Cointegration analysis

The deterministic variables included in the Johansen test are:

- one mean-shift dummy describing a regime shift starting in 1992:3. This dummy is restricted to lie in the cointegration space.
- 1 dummy describing a transitory shock: 2003:3-4.
- Constant (restricted)

Table C2: Johansen Trace Test for private GDP, tax evasion, public spending, net tax rate

<table>
<thead>
<tr>
<th>R0</th>
<th>LR</th>
<th>Pi value</th>
<th>90%</th>
<th>95%</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>94.84</td>
<td>0.0000</td>
<td>56.61</td>
<td>59.10</td>
</tr>
<tr>
<td>1</td>
<td>39.48</td>
<td>0.0524</td>
<td>37.46</td>
<td>39.61</td>
</tr>
<tr>
<td>2</td>
<td>16.61</td>
<td>0.4809</td>
<td>22.21</td>
<td>24.07</td>
</tr>
</tbody>
</table>

Optimal endogenous lags from information Criteria: 5 (AIC; Final Prediction Error); 2 (Hannan Quinn C.; Schwartz C.)
Table C3: Johansen Trace Test for Regular GDP, tax evasion, public spending, net tax rate

<table>
<thead>
<tr>
<th>R0</th>
<th>LR</th>
<th>Pi value</th>
<th>90%</th>
<th>95%</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>95.19</td>
<td>0.0000</td>
<td>56.61</td>
<td>59.10</td>
</tr>
<tr>
<td>1</td>
<td>39.40</td>
<td>0.0537</td>
<td>37.46</td>
<td>39.61</td>
</tr>
<tr>
<td>2</td>
<td>16.82</td>
<td>0.4609</td>
<td>22.21</td>
<td>24.07</td>
</tr>
</tbody>
</table>

Optimal endogenous lags from information Criteria: 5 (AIC; Final Prediction Error); 2 (Hannan Quinn C.; Schwartz C.)

Section C3. The VECM analysis

We briefly describe the main diagnostic tests for Model 2 (Regular GDP, Tax Evasion; Public Spending; Net Tax Rate), for which we also plot the complete Impulse Responses. Further elaboration are available upon request.

The order selection criteria suggest to use four lags, hence the model is based on a sample period going from 1982:2 to 2006:4 (99 observations). We use a two stages estimation procedure: in the first stage the cointegration matrix has to be estimated by the S2S method explained in Lutkepohl (2004). Once an identified form of the estimated cointegration matrix is available, it can be used in the second stage of the estimation procedure. In the second stage, structural and subset restrictions as well as exogenous variables can be accounted for.

The deterministic variables included in the VECM specifications are:

- one mean-shift dummy describing a regime shift starting in 1992:3. This dummy is restricted to lie in the cointegration space. Its difference should be included as an unrestricted permanent impulse dummy in the VAR equations, i.e. two unrestricted permanent impulses for the observations 1992:3 and 1992:4.


- 3 impulse dummies (describing a permanent intervention/shock) for the observations: 1982:2; 1983:4; 1998:1. A shift in the levels of a variable becomes an impulse dummy in the differenced variable.

- constant
Table C5: residual autocorrelation tests for VEC Model 2

<table>
<thead>
<tr>
<th>Test</th>
<th>$Q_{16}$</th>
<th>$Q^*_{16}$</th>
<th>LM$_5$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Test statistic</td>
<td>176.77</td>
<td>194.21</td>
<td>79.93</td>
</tr>
<tr>
<td>p-value</td>
<td>0.99</td>
<td>0.91</td>
<td>0.48</td>
</tr>
</tbody>
</table>

Table C6: residual non-normality tests for VEC Model 2

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>joint</td>
<td>skewness</td>
<td>kurtosis</td>
</tr>
<tr>
<td>joint skewness kurtosis</td>
<td>7.34</td>
<td>4.54</td>
<td>2.79</td>
</tr>
<tr>
<td>p-value</td>
<td>0.50</td>
<td>0.34</td>
<td>0.59</td>
</tr>
</tbody>
</table>

Table C6: residual non-normality tests for VEC Model 2 (follows)

<table>
<thead>
<tr>
<th>Test</th>
<th>Jarque Bera</th>
<th>ARCH-LM TEST</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>$u_1$</td>
<td>$u_2$</td>
</tr>
<tr>
<td>Test statistic</td>
<td>2.96</td>
<td>0.76</td>
</tr>
<tr>
<td>p-value</td>
<td>0.23</td>
<td>0.68</td>
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</table>

Table C7: VEC residuals’ correlation, Model 2

<table>
<thead>
<tr>
<th>Private GDP</th>
<th>Tax Evasion</th>
<th>Public Spending</th>
<th>Tax rate</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.000000e+00</td>
<td>-3.069994e-01</td>
<td>-3.460676e-01</td>
<td>-8.059666e-03</td>
</tr>
<tr>
<td>-3.069994e-01</td>
<td>1.000000e+00</td>
<td>9.251888e-02</td>
<td>-3.007224e-01</td>
</tr>
<tr>
<td>-3.460676e-01</td>
<td>9.251888e-02</td>
<td>1.000000e+00</td>
<td>-4.732756e-02</td>
</tr>
<tr>
<td>-8.059666e-03</td>
<td>-3.007224e-01</td>
<td>-4.732756e-02</td>
<td>1.000000e+00</td>
</tr>
</tbody>
</table>
Section C3.1 The Impulse Response analysis

Column 1: effects of one s.d. shock to GDP on GDP, Tax Evasion, Gov. Spending, Tax rate.
Column 2: effects of one s.d. shock to Tax Evasion on GDP, Tax Evasion, Gov. Spending, Tax rate.
Column 4: effects of one s.d. shock to Tax Rate on GDP, Tax Evasion, Gov. Spending, Tax rate.

<table>
<thead>
<tr>
<th>GDP regular</th>
<th>Tax Evasion</th>
<th>Gov. Spending</th>
<th>Tax Rate</th>
</tr>
</thead>
<tbody>
<tr>
<td><img src="image1.png" alt="Graph 1" /></td>
<td><img src="image2.png" alt="Graph 2" /></td>
<td><img src="image3.png" alt="Graph 3" /></td>
<td><img src="image4.png" alt="Graph 4" /></td>
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<tr>
<td><img src="image5.png" alt="Graph 5" /></td>
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<td><img src="image7.png" alt="Graph 7" /></td>
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<tr>
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<td><img src="image14.png" alt="Graph 14" /></td>
<td><img src="image15.png" alt="Graph 15" /></td>
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<tr>
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<td><img src="image18.png" alt="Graph 18" /></td>
<td><img src="image19.png" alt="Graph 19" /></td>
<td><img src="image20.png" alt="Graph 20" /></td>
</tr>
</tbody>
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References


- ISAE (2006), Rapporto, October, Rome.


-Schneider F. and Buehn A. (2009), Shadow economies and corruption all over the World: Revised estimates for 120 countries, Economics Journal, October 27, pp. 1-53.

-Torgler B. (2007), Tax Compliance and Tax Morale, Edward Elgar Publishing


