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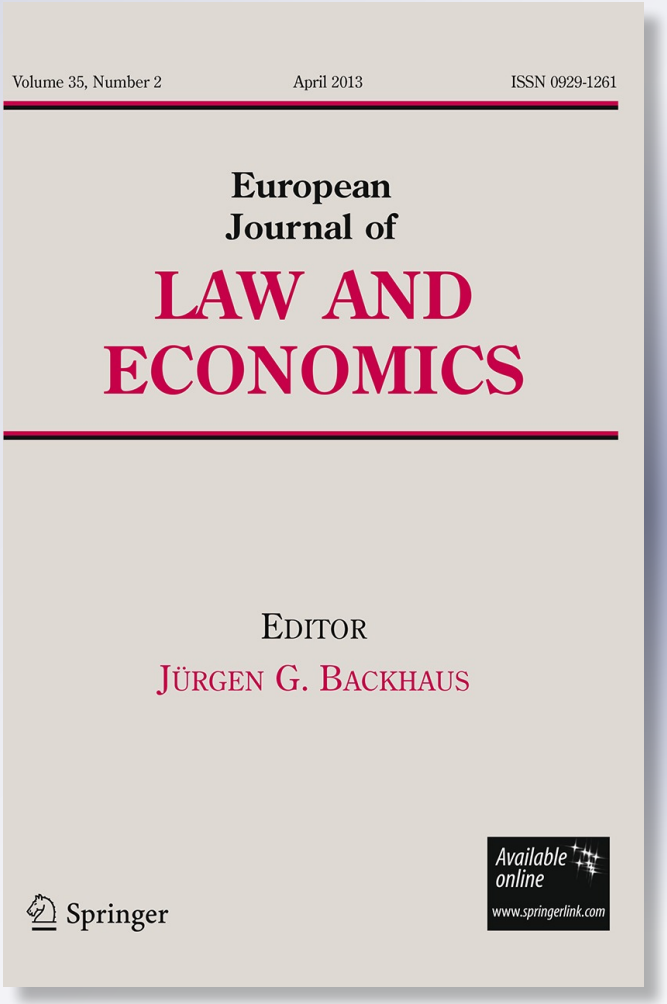

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Tax rates and tax evasion: an empirical analysis of the long-run aspects in Italy

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Abstract We use official time series of the Italian evaded VAT base (Ministry of Finance) for the period 1980:1–2006:4 to investigate empirically the long-run characteristics of tax evasion and the relationship with the tax burden. Three hitherto unexplored issues are addressed. First, using different measures of aggregate economic activity as reference variables in estimating the average tax burden, we examine the size and dynamics of the overburden traceable back to tax evasion. Second, exploiting cointegration techniques, we quantify the elasticity between tax evasion and the average tax rate in Italy. We then comment on the complex dynamic interaction between the tax burden and tax evasion to ascertain whether in the Italian experience there is evidence for any "vicious circle" between them.

Keywords Tax evasion · VAT evasion · Effective tax rate · Apparent tax rate · VECM

JEL Classification H30 · H26 · O17 · C32

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1 Introduction

The tax burden is viewed, in both empirical and theoretical studies, as the main determinant of tax evasion and the shadow economy. "Cheating the government" is a thriving practice in most countries, and in particular in Italy where latest official estimates indicate a figure of about 200 billion euro for the value added generated by the underground economy (ISTAT 2008).

Although the determinants of tax evasion have been extensively examined, the lack of reliable time series has prevented the long-run characteristics of this phenomenon being investigated. In this paper, by exploiting a new yearly time series estimate of the non-reported Value Added Tax base (Marigliani and Pisani 2007), and computing a quarterly transformation of the original series, we get round this shortcoming. This estimate is extremely important not only because it provides a long enough time series of tax evasion, but also because it indicates the size of the underground production: evading VAT means under-reporting production, labour activities and revenues. Hence, the quarterly time series of the concealed VAT Base, covering the period 1980:1–2006:4, can be used as a proxy for the size of "unreported production". [1]

Looking at the available evidence for Italy, we focus on three key issues, hitherto not analyzed. First, using univariate analysis, we investigate the size and dynamics of two tax rates: the average "apparent" tax rate, where tax revenues are compared with the total GDP (reported and concealed), and the "effective" tax rate, where tax receipts are compared with the GDP net of the evaded VAT base. The difference between the two tax rates is a rough measure of the overburden gap for compliant taxpayers, providing interesting insights to understand the impact of tax evasion in terms of effective fiscal pressure. Second, we investigate the long-run characteristics of tax evasion in Italy and, using multivariate cointegration models, we check for the existence of a long-run equilibrium relationship between the official average tax burden (i.e. the apparent tax rate) and the estimated tax evasion. This allows us to get a measure of the long-run elasticity of tax evasion to official tax rates and vice versa[2]. Third, taking into account the equilibrium relationship, we quantify the sign and intensity of the complex dynamic interaction between taxation and tax non-compliance. This allows us to ascertain whether in the Italian experience there is evidence for any vicious circle between tax rates and tax evasion.

The paper is organized as follows. In the next section we present a brief survey of the literature as well as of the factors that cause tax evasion, emphasizing the empirical evidence available for Italy. Section 3 shows magnitudes and long-run features of the time series for tax evasion and tax rates. The univariate statistical characteristics of the series are discussed, with particular attention to the gap between the two tax rates and to the fiscal overburden. Section 4 reports on the

[1] We are aware that part of VAT evasion is generated by VAT "carousel frauds", which do not necessarily entail other forms of tax evasion, and, in particular, the under-reporting of production.

[2] Of course in discussing our results it should be borne in mind that we are dealing with: (a) estimates of unobservable data; (b) aggregate realizations rather than observable or theoretical behaviours. Spanos (1999), Lutkepohl and Kratzig (2004), amongst others, stress these aspects with relation to time series.

stationary relationship between the "hidden" variable and the average tax rate.[3] The long-run parameters are discussed, stressing the implications for the dynamic adjustment to the long-run equilibrium. The section ends with the impulse response and variance decomposition analysis of the system. Section 5 concludes the article.

2 Tax rates and tax evasion: a brief survey of the literature

A number of theoretical models have evolved to determine the relationship between tax evasion and tax rates, although such models fail to provide unanimous predictions regarding the impact of tax rates on evasion.

The seminal paper by Allingham and Sandmo (1972) provides a positive relationship between tax rates and evasion, although this depends on particular assumptions about risk aversion and the penalty for tax evasion. By contrast, some models, consistent with this portfolio approach, are able to generate unconventional wisdom such evasion being reduced by high tax rates.[4] In particular, Yitzaky (1974) shows that increases in tax rates will reduce evasion whenever the punishment for evasion is dependent on the value of taxes evaded. In general, in the Allingham and Sandmo approach, an increase in the tax rate may increase, decrease, or leave unaltered the level of evasion depending upon the degree of the absolute risk aversion (substitution and income effects), and the way the penalty is set.

Moreover, calibrating the basic Allingham and Sandmo model with reasonable values for the enforcement parameters and for risk aversion suggests that it would be a rational choice for taxpayers to evade a lot more than they appear to do. Economics scholars have devoted considerable effort to improving the basic model of tax evasion so as to reconcile evidence with theory, as well emphasized in the literature reviewed in Slemrod and Yitzhaki (2000).

The traditional economic approach needs to be enriched to take into account deterrence effects and tax morale determinants as well as their mutual interactions (see, amongst others, the surveys of Andreoni et al. (1998), Torgler (2007) and Feld and Schneider (2010)). According to Feld and Frey (2007), tax compliance is driven by a psychological tax contract that entails rights and obligations from taxpayers and citizens on the one hand, but also from the state and its tax authorities on the other. Taxpayers are more inclined to pay their taxes honestly if they get valuable public services in exchange. However, taxpayers are honest even in cases when the benefit principle of taxation does not hold, i.e. for redistributive policies, if the political decisions underlying such policies follow fair procedures. Finally, the treatment of taxpayers by the tax authority plays a role. If taxpayers are treated like partners in a (tax) contract instead of subordinates in a hierarchical relationship, taxpayers will stick to their obligations of the psychological tax contract more

[3] In this paper, in order to quantify the dimension of the hidden activities, we will use the size of the unreported VAT liabilities, as explained in Sect. 3.

[4] An analysis of the assumptions which characterize the standard model and the main criticisms may be found in Sandmo (2005).

easily. Kirchler (2007) presents further comprehensive discussion of the influence of such factors on tax compliance.

Although the traditional economic theory on tax evasion derives ambiguous predictions as to the tax rate impact on tax evasion, and despite the substantial focus on these issues in policy analyses on tax evasion, surprisingly little is known about these problems from empirical studies. However, the evidence provided in a macroeconomic setting is quite homogeneous in claiming the positive effect of the tax rate on shadow activities (Schneider 2002; Giles and Tedds 2002; Davis and Henrekson 2004). The evidence is less clear when considering tax evasion. This is due to the fact that data are not available on an international basis and are difficult to collect even for OECD countries. Collecting unobservable variables is a difficult task although in some circumstances the tax authorities, at the state level, might not be willing to reveal how intensively tax concealment is taking place. In this respect, Italy is an exception, since the large size of tax evasion and the time series evolution are witnessed by several sources of information, which will be commented upon in the next section.

In addition to the macroeconomic evidence of the tax rate-tax evasion relationship, there is some micro-founded research which emphasizes the fact that the main cause of tax evasion is the high tax burden. For instance, Fiorio and Zanardi (2006), using the results of the Survey on Household Income and Wealth (Bank of Italy), show that almost half of the respondents (46%) in 2004 claimed that tax evasion was caused by too high tax rates. Additional explanations of the non-compliance were: the misuse of tax revenues by the government (45%); a strategy of cost squeezing aimed at business preservation/survival (41%); the excessive cost of compliance (25%); the perceived low risk of detection (53%).

Finally it is worth stressing that while the microfounded approach emphasizes the tax rate-tax evasion causality (the demand for evasion), in a macroeconomic framework this relationship can also be reversed (Basile et al. 2010). For instance, according to the Italian Treasury Minister (MEF 2009), tax evasion is claimed to be a serious constraint for managing fiscal policy since this phenomenon, and its magnitude, precludes the pursuit of "optimal" tax rates on the part of government.[5] Of course, placing the tax evasion problem within a general equilibrium framework is much more useful for understanding the macroeconomic consequences of tax policy and the relationship with tax evasion. It allows joint investigation of taxes, tax evasion and other macroeconomic variables, and in particular enables labor supply and compliance-related effects of tax change to be explored (Busato and Chiarini, 2004; Papp and Takáts 2008; Busato and Chiarini 2009).

[5] Interestingly, in its annual report on tax evasion, the Italian ministry of economy (MEF 2009) claimed that the main causes of the low level of compliance in Italy were: the economic structure of the productive system, characterized by a very strong presence of small and medium sized firms and self-employed; the organization of the revenue collection system; the social pact between the tax payer and the State. One of the strategies adopted to pursue a reduction in tax evasion by small firms is investigated in Arachi and Santoro (2007), who focus on a major innovation in the field of tax auditing of self-employed workers and small firms: "*Studi di settore*" or "business sector analyses".

Overall, the above discussed evidence motivates our empirical investigation on the nexus between fiscal pressure and tax evasion, paying particular attention to the long-run equilibrium relationship and its link with the short-run dynamics.

3 Italian tax evasion and the tax burden

Several estimates of the underground economy have been carried out in Italy[6]. They should only be taken as indicative of the importance the irregular economy may assume. The elusive nature of the phenomenon and the use of very different estimation methods have provided striking variability in assessments of hidden activities[7].

The National Institute of Statistics (ISTAT 2008), consistent with international standards and, in particular, with the 1993 System of National Accounts, estimated and regularly updated a time series of the size of the underground economy from 1992 until 2006, rising from 15.8% of the total GDP in 1992 to 16.9% in 2006, with a maximum peak in 2001 of about 20%. The Italian National Accounts, and, in particular GDP and Employment statistics, address the issue of exhaustiveness, measuring productive activities that are non-observed because they are part of the underground economy. The compilation method for covering underground activities relies on a complex procedure, whose main steps can be summarized as follows: (i) the correction for underreporting by small and medium sized firms; (ii) the use of the labour input method (pioneered by ISTAT during the 1980s); (iii) the cross check of the supply and demand aggregates by branch of economic activity. Several authors have attempted conservative estimates of tax evasion based on these official estimates for the underground economy, showing that the phenomenon accounts for about 8-10 percent of GDP.[8]

3.1 Time series data: tax evasion

Data on tax evasion in Italy are currently provided by the Revenue Agency of the Ministry of Finance, which has recently estimated a yearly time series of the non-reported Value Added Tax base. This issue is crucial since, 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 1980–2006 can be used as a proxy for the size of underground production. 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 Accounts macroeconomic data. The latter aggregates are estimated by selecting the national accounts expenditure categories that comprehensively cover VAT liabilities: (i) household spending and non-profit institutions serving household final

[6] See Bovi (1999), Zizza (2002), Dell'Anno (2003), and Dell'Anno and Schneider (2003).

[7] For instance, Chiarini and Marzano (2004), Busato et al. (2005a).

[8] See for instance, Busato et al. (2005b).

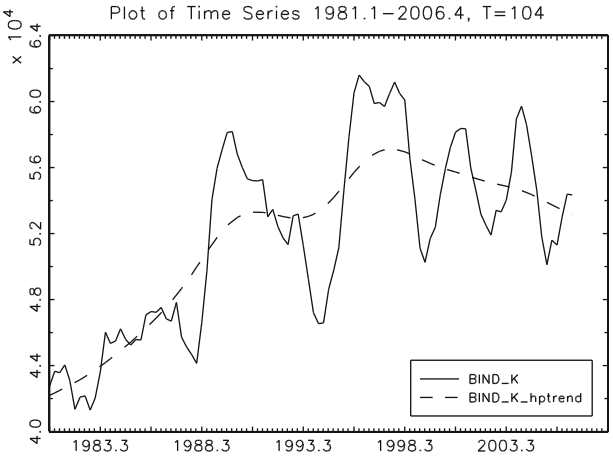

Fig. 1 Undeclared VAT base in millions of euro (constant prices): observed (*solid line*) and long-run trend (*dashed line*). Quarterly data

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.

Since we deal with aggregated data, the unreported VAT base, our proxy for concealed production, can also be considered a good approximation of aggregate unreported income. Therefore, the share of the concealed VAT base to total GDP helps to identify the size of tax evasion.

In this paper we construct a quarterly time series of tax evasion for the period 1980:1–2006:4, exploiting the yearly estimate by the Italian Revenue Agency (Marigliani and Pisani 2007). We apply the dynamic extension of the Chow and Lin (1971) temporal disaggregation procedure suggested in Proietti (2006). The method is based on the state space representation of a first order Autoregressive Distributed Lag model, which transforms the distribution problem into an unknown observation one. The Chow-Lin procedure is used by ISTAT for estimating Quarterly National Economic Accounts data, relying on related series (called indicators) in order to derive the unknown pattern of time series to be disaggregated. To disaggregate the yearly series of the total VAT base, we use the quarterly indicator of domestic resources (GDP plus net imports), whereas the quarterly indicator of net indirect taxes is used for the declared VAT base. Both indicators are from the ISTAT quarterly database and are seasonally adjusted at the source.[9]

The size of the unreported VAT base is shown in Figures 1 and 2, both in absolute terms and as a share of the total GDP. In addition, together with the estimated series we also display their long-run trends, using filter methodology suggested by Hodrick and Prescott (1997).

[9] Detailed analysis of the quarterly time series estimate for the hidden VAT base may be found in Basile et al. (2010) and is available upon request.

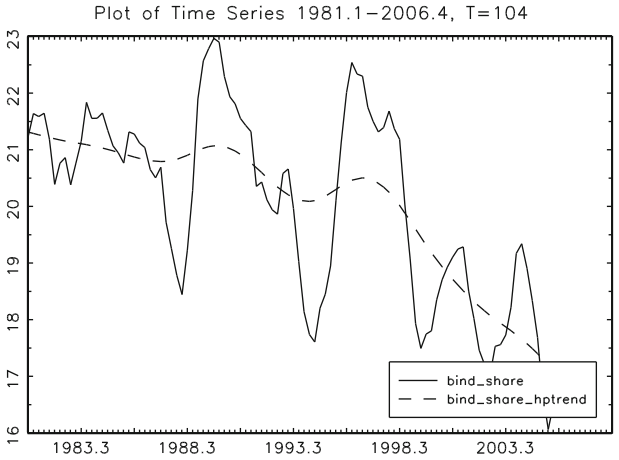

Fig. 2 Undeclared VAT base as a share of total GDP: observed (*solid line*) and long-run trend (*dashed line*). Quarterly data

The evaded VAT base ranges between 170 and 240 billion euros per year (real value), whereas concealed VAT base in percentage terms ranges from a peak of 23% in the late 1980s to a minimum of 16% ten years later. [10] The two series display considerable volatility, particularly during the second decade of the observed sample. The high volatility in this period, shown in Figs. 1 and 2, is followed by a downwards adjustment in the tax evasion share, which shifts from 20% to about 18%, with important consequences for the stationarity of the time series investigated in the Appendix.

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 and Guerra 2000).[11] The two downward peaks observed in 1994 and 1999 are affected by a process of institutional reform. In particular, during the period 1991–1993, 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 1996–1999 can be explained by structural innovations, such as the tax on line system (*fisco telematico*) and the new system for filing tax returns (*Unico*) introduced in 1998, together with Sector Studies (*Studi di Settore*), procedures midway between audit selection mechanisms and methods of presumptive (normal) taxation (see Santoro 2008). These two interventions, together with a reorganization

[10] More than 80% of tax evasion is generated by the service sectors (trade and services to households and firms). Typically these sectors consist of small firms which are most likely to evade and are subject to a presumptive taxation mechanism: in Italy about 96% of all firms employ 1–9 workers, about 60% of which are individual firms. See Pisani and Polito (2006) and Convenevole (2006).

[11] More insights about the reform may be found in the special issue of Politica Economica (2002).

process of the fiscal authority started in 1997, contributed to improve the efficiency of tax administration, indirectly increasing the effectiveness of auditing. The new recovery in VAT evasion 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. What is more interesting is the different long-run pattern of the two series. Although the graph in Fig. 2 shows an increasing trend for the unreported VAT base measured in millions of euro, equally clearly it appears that the share of unreported production decreases (Fig. 1), with a drop in the two decades of approximately 5% points.

As to the univariate properties of these two series, in the Appendix it is demonstrated that they are both integrated of order 1, i.e. tax evasion is a random walk, though with a deterministic trend. [12]

Given the nature of the concealed VAT base, which can be considered as a measure of underground production, we are able to provide an estimate of regular production. Actually, the Italian national accounts accomplish the requirement of exhaustiveness, as stated by the OECD and Eurostat, including the value added generated in the underground economy. Therefore, subtracting estimated unreported VAT base from the official GDP (national accounts), we get the regular production. This way of dealing with the aggregate market 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 by using the official data available, and, without "heroic assumptions" [13], 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 VAT evasion may be considered an important device that helps to conceal the tax base of other taxes and hence shadow activities. This is a necessary step for our analysis. 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[14].

3.2 Time series data: the tax burden

The tax burden is one of the most commonly cited determinants of tax evasion and, in general, of the underground economy. [15] The overall tax burden is a key feature

[12] It is essential to identify the non-stationary nature of our series in order to avoid problems of spurious regressions when calculating the elasticity of tax evasion to fiscal pressure.

[13] See, for instance, the Economic Journal symposium on the Hidden Economy and Schneider and Enste (2002).

[14] Marigliani and Pisani (2007) compare their estimate of tax evasion (here exploited) with the ISTAT estimate of the underground economy for the years in common, i.e. 1992–2004, finding no large differences.

[15] See, amongst others, Tanzi (1982), Feige (1989), Thomas (1992), Lippert and Walzer (1997), Schneider and Enste (2002).

for working and producing in the hidden sector and for concealing income and wealth. To assess an empirical relationship with the hidden phenomenon under investigation, we first analyse the univariate characteristics of the series. This is done by constructing two average aggregate tax rates, defined, respectively, as the ratio of total tax revenues to *total GDP* and to a proxy for the *regular GDP*. The latter is produced by subtracting from the time series of GDP the size of the evaded VAT base, as discussed in the previous subsection. Since tax revenues do not include, by definition, tax evasion, whereas total GDP comprehends the underground economy, the first indicator of the tax burden, routinely used in fiscal policy analysis, provides only a partial view about the true fiscal pressure for compliant taxpayers. By contrast, a reliable information is provided, using the regular GDP, by the second indicator. Therefore, we label these tax rates, respectively, as the "apparent" tax rate and "effective" tax rate.[16] Although we cannot deliver a statistical analysis based on a unique source for the output components, some core problems in discussing the dynamics of tax evasion can be usefully pointed out. Moreover, it is worth recalling that the Ministry of Finance's estimates originate from national accounts.

The apparent and effective tax rates are depicted in the left-hand panel of Fig. 2, whereas the right-hand panel displays the difference between the two tax rates.

The apparent tax rate is the one usually considered when examining average fiscal pressure. However, this measure is downward biased in countries with a considerable underground economy: by definition, the effective tax rate is always higher than the apparent one. If we adopt a simplifying assumption, that is, some taxpayers do not comply with their tax duties whereas others cannot escape their tax liabilities, then the difference between the two tax rates can be considered an overburden for compliant taxpayers caused by tax evaders.[17] Obviously, in the absence of evasion, all the citizens would contribute to financing the public sector, thereby lowering the average fiscal burden.

With reference to Fig. 3 three important characteristics should be stressed. First, a steep increasing trend may be observed for both tax rates during the period 1980–1997, followed, in more recent years, by a slightly declining pattern, more accentuated for the effective tax rate. Second, the peaks in the path of the two tax rates show the increases in tax revenues due to fiscal amnesties granted in 1982 and 1991, whereas the amnesties granted in 1994 and 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, respectively connected to the so-called tax for Europe (1997) and to asset and buildings taxation (1993). Together with the persistence of the overburden gap, the above observations

[16] In order to analyze the tax burden we use the average fiscal pressure and not marginal tax rates. In any case, the closest definition to a legal tax rate is, in this paper, our measure for the effective tax rate, that is the ratio between total tax revenues and the production in the regular economy.

[17] However, a different point of view would suggest that each taxpayer acts as a moonlighter, deciding how much to comply/declare according to the utility maximization process. In this case the higher tax rate depicted in Fig. 3 would represent the *statutory* tax rate, whereas the share of tax revenues to total GDP is the *smoothed* tax rate resulting from optimal evasion choice.

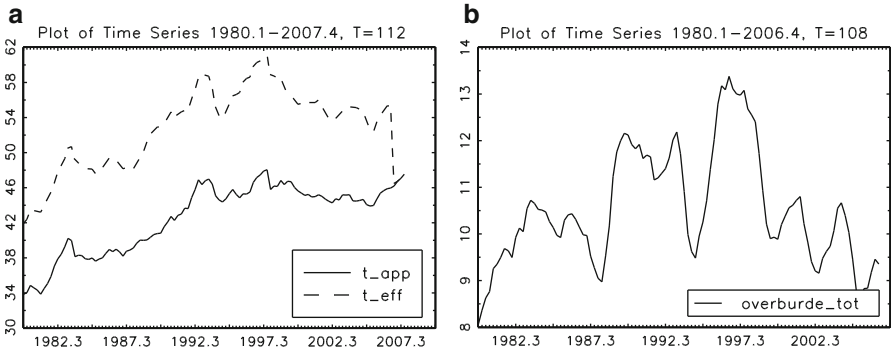

Fig. 3 Average tax rates in Italy. Quarterly data. **a** Apparent and effective tax rates, **b** The overburden for compliant tax payers

confirm that amnesties have, at best, a short-run effect, but cannot be used as policy instruments for reducing work and income "under the ground".[18]

Finally, the considerable magnitude of the apparent fiscal pressure, rising from 31 to 43% during the period examined, is appreciably lower than the effective one, with a gap oscillating around 10–11% points, clearly indicating the huge burden that taxpayers have undergone due to the existence of underground activity and tax evasion. This overburden gap seems to be invariant over the decades, generations and governments. To better appreciate this issue, in the right-hand panel of Fig. 3 the gap between the two tax rates is displayed. The overburden gap presents marked oscillations during the observed sample, though in recent years there is evidence of lower volatility.

4 Assessment of the tax burden effect on tax evasion

The evidence available for Italy tells a story of increasing fiscal pressure, though with a declining pattern in recent years, and high volatility of tax base concealment. What is remarkable in this time-varying framework is the stable gap between the apparent and the effective tax rates, suggesting that taxpayers suffer a stable overburden of fiscal pressure because of tax evasion. Moreover, the absence of a stochastic trend also signals that there might be a long-run strategy linking tax evasion to fiscal pressure, and the intensity of this interaction is certainly worth quantifying.

A second economic issue not fully clear from the univariate evidence is the perverse interaction between tax evasion and tax rates, through tax base erosion.[19] This worrying issue is considerably more marked in a situation of high public debt and deficit spending, as it was in pre-EMU Italy. However, at first glance, the

[18] See Bernasconi and Lapecorella (2007).

[19] This is related to the Laffer Curve as modified by Gutmann (1981) to account for shadow economy activities.

stability of the overburden gap may be considered a signal of the absence of such a vicious circle.

Yet to further investigate the interaction between tax evasion and the tax rate, it is important to find empirical support for the two claims above. To this end we will refer to the apparent tax rate, since this measure is the one usually considered in fiscal policy analysis.[20]

4.1 The statistical model

Since we are dealing with two non-stationary variables, the tax rate and tax evasion, we use the Johansen technique to test for the cointegration rank. Our estimation procedure is the following: after setting the appropriate lag-length of the VAR model, we determine whether the system is conditional on some dummy variables for controlling structural breaks. Then we test for the existence of a cointegration vector, and finally for weak exogeneity of the tax variable. All the variables (except deterministic variables) are in log.

Estimated equations are derived by a two-variable system with one cointegrating equation and a lag structure including five lags in the VAR model. Consider the following VAR model, written in the usual notation:[21]

$$\Delta y_t = \Pi y_{t-1} + \sum_{i=1}^{p-1} \Gamma \Delta y_{t-i} + B z_t + \varepsilon_t \tag{1}$$

where $\Pi = \sum_{i=1}^{p} A_i - I; \qquad \Gamma_i = -\sum_{j=i+1}^{p} A_j$

In our case, y is a vector containing two I(1) non-stationary variables, z is a vector of deterministic variables and ε_t is a vector of innovation. It is well known that if the coefficient of the matrix Π has a reduced rank ($r < k = 2$ the number of cointegrating relations in our case) there exist two (2×1) matrices α and β such that $\Pi = \alpha\beta'$ where β is a cointegrating vector.

In the VAR specified in Eq. 1, we use as a normalized variable the unreported VAT base as a percentage of total GDP (VAT_E/Y_T), our proxy for tax evasion.[22]

4.2 To what extent is the tax burden a determinant of tax evasion?

We have seen that our series are characterized, other than by stochastic trends, by non-zero means and deterministic trends. Similarly, the stationary relations may call

[20] The econometric analysis is carried out only for the apparent tax rate (the tax burden is compared with the total GDP), since when controlling for the effective tax rate the estimated residuals display too large a correlation with the size of tax evasion, weakening the interpretation of the statistical model.

[21] See, for instance, Johansen (1995).

[22] In the Appendix we show the time series graph for a further measure of tax evasion, the ratio of uncollected VAT revenues -calculated by multiplying the unreported VAT base by the marginal VAT rate- to total GDP. The graph clearly shows that there is only a difference in the scale of measurement between VAT evasion and the proxy of tax evasion used in the VECM. The results of a different model, using as endogenous variables VAT evasion and VAT tax burden (measured as the ratio of VAT revenues to total GDP), though qualitatively similar to those displayed in the text, cannot be trusted, since the correlations between the estimated residuals are too large.

for intercepts and trends. For the evasion model we cannot rule out the following assumption (the level data and the cointegrating equation have linear trends): [23]

$$H(r) : \Pi y_{t-1} + Bz_t = \alpha(\beta' y_{t-1} + \mu_0 + \mu_1 t) + \alpha\perp(\gamma_0) \tag{2}$$

4.2.1 The long-run equilibrium and error correction adjustment

A major feature of the data is the presence of two breaks in the last quarter of 1983 (subsequent to the amnesty granted in 1982) and in the first quarter of 1998 (after the tax for Europe), i.e. the two peaks in tax rates already commented upon in Sect. 3.2.[24] Conditioning the model on two dummy variables for taking such breaks into account, and estimating the stationary model using total GDP as scale variable for the tax burden (the apparent tax rate τ), produces the following cointegrating relation and loading factors (estimated standard errors in parentheses):

$$\frac{VAT_E}{Y_T} = \underset{(0.19)}{0.73}.\,\tau - \underset{(0.001)}{0.003}\,t + \underset{(0.72)}{0.38} \qquad \alpha_E = \underset{(0.04)}{-0.14}; \alpha_\tau = \underset{(0.02)}{0.1} \tag{3}$$

The cointegrating vector and the variable residuals seem statistically satisfactory. Trace test indicates one stationary relation at the 0.03 level.[25] The VEC residual serial correlation LM test shows that the Null of no serial correlation up to lag 5 is not rejected. The negative sign of the trend variable, required by the stationary relation, is consistent with the hypothesis of a gradual reduction in tax evasion as share of total GDP.[26]

4.2.2 Long-run elasticities

The model displays a long-run elasticity of tax evasion to the apparent tax rate below unity (0.73) but quite a high speed of adjustment when a disturbance in the equilibrium relation occurs. On inverting the cointegrating relationship (3), we find that the long-run tax rate elasticity to a change in tax evasion is 1.36. Below we show that this estimate may be misleading. Indeed, such "elasticities" are only indicative: stationary relationships must be interpreted cautiously because their coefficients cannot be interpreted as elasticities as in the usual sense, when all the other dynamic relations between the variables specified in the VAR model are ignored. The analysis requires that short-term dynamics and intertemporal

[23] As in Johansen (1995), $\alpha\perp$ is orthogonal to α and serves to define and distinguish the (unrelated) constants from the cointegration space and the constants from the data.

[24] Introducing dummies eliminates outliers and induces residuals to be normal, providing more Gaussian-like residuals. See Juselius (2006) amongst others.

[25] The critical values provided by Johansen and Osterwald-Lenum (1992) are known to be only indicative in such a situation (small sample, dummy variables and trends). We also perform unit root tests on the cointegrating residuals.

[26] Cointegrating tests indicates the existence of one stationary equation. With regard to the VEC residual tests: the LM-test does not reject the Null of no serial correlation (lag 5 prob 0.72) and the Jarque–Bera tests applied to the individual residual series do not reject the Null hypothesis of normality (prob. 0.89 and 0.44), and a similar test result (joint test statistic 2.37 and p-value 0.67) is provided by the multivariate test proposed by Doornik and Hansen (1994).

adjustment processes generated by equilibrium errors are taken into account.[27] Impulse response analysis, taking into account the full system may provide a more reliable conclusion.

4.2.3 Adjustment coefficients and dynamics

Thus the reactions of tax evasion to the tax rate cannot be motivated without considering the adjustment to disequilibrium which takes place through the error correction coefficient. Note that α_E is -0.14: the evaders are ready to keep in perfect step to eradicate the past disequilibrium: about 60% of the disequilibrium is removed in 1 year.

This is a major aspect of the model and of the Italian tax rate-tax evasion relationship. Consider the tax evasion adjustment coefficient when the cointegrating vector is normalized on tax evasion (VAT_E/Y_T), as it is in Eq. 3. Consider the lagged equilibrium as specified in the cointegrating vector (2). Suppose that the perspective of time is t. Thus if the ECM component in (2) is different from zero, as in (4), this means that the economy was not in equilibrium at time $(t-1)$. Hence tax evasion and/or the tax rate have to change:

$$\left(\frac{VAT_E}{Y_T}\right)_{t-1} > 0.38 + 0.73\tau_{t-1} - 0.003t \tag{4}$$

The disequilibrium (4) implies that to stay on target, tax evasion must be reduced and/or the apparent fiscal pressure must be increased. The estimated Eq. 3 shows a positive but small ECM adjustment coefficient for the tax rate. Therefore, the tax burden increases, albeit slowly to restore the equilibrium (i.e. $0.73 \times 0.1 = 0.07$). On the contrary, the tax evasion adjustment coefficient is negative and quite large over the year, indicating that under the disequilibrium depicted in (4), tax evasion almost immediately decreases to restore the equilibrium: a result perfectly consistent with the *zig–zag* behaviour around the tax evasion trend depicted in Figs. 1 and 2. Of course, the opposite picture is obtained with a disequilibrium characterized by the share of concealed tax base lower than the equilibrium level implied in Eq. 4.

The slow adjustment of the tax rate and the quick reaction of tax evasion to long-run disequilibrium support the idea that the evaders operate in a context which allows them to fix a target for the share of revenues exposed to tax authorities, feeling almost free to react to any changes in the tax burden.[28]

[27] Lutkepohl (1991, 1994), among others, emphasizes this issue.

[28] This aspect is not investigated in this paper and it has much to do with the audit selection mechanisms purported to detect firms which are most likely to evade, i.e. *Studi di Settore* (see Convenevole et al. 2007). This instrument is far from reflecting the theory of optimal auditing for several reasons. In particular *Studi di Settore* (roughly, "Sector Studies") focus on reported turnover rather than reported profits (turnover minus costs), but the real problem is that firm representatives are deeply involved in all the phases of construction of the *Studi di Settore*. As stressed by many (see, for instance, Santoro 2007, 2008), this presumed level reflects a political compromise between the government (or the Tax Agency) and these unions. Thus, the level of deterrence of the *Studi di Settore* is directly related to this political compromise rather than the probability of being audited.

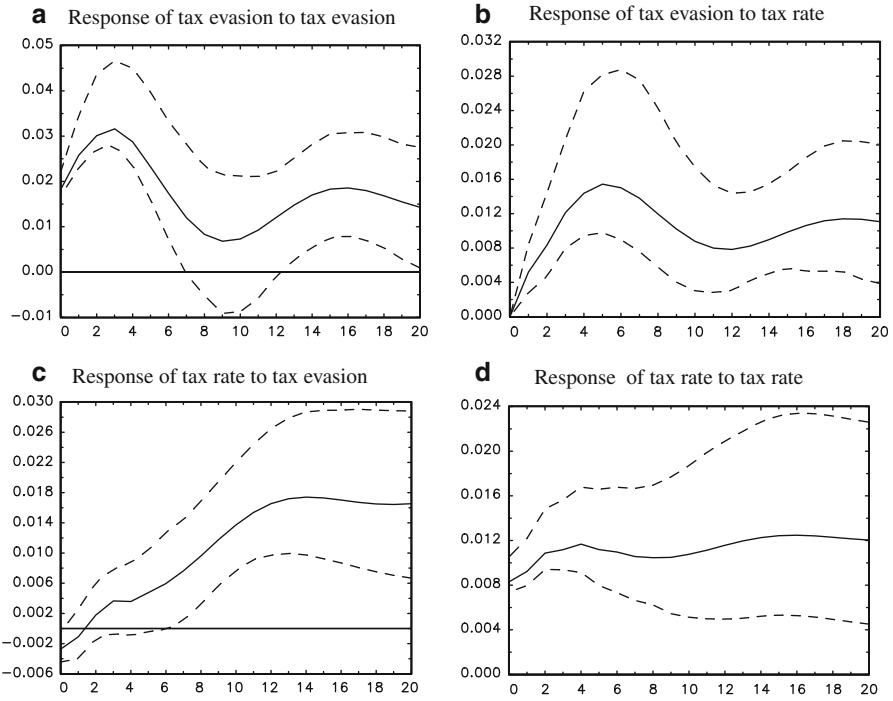

Fig. 4 Impulse response (Cholesky one standard innovation) with 95% Hall bootstrap confidence intervals. **a** Response of tax evasion to tax evasion, **b** Response of tax evasion to tax rate, **c** Response of tax rate to tax evasion, **d** Response of tax rate to tax rate

4.2.4 Impulse response analysis

Impulse response analysis (IR) amounts to dynamic simulation of the whole system (long-run parameters, short-run and adjustment effects) when a shock at $t = 0$ in a single variable occurs.[29] The unit at the vertical axes measures the time profile of the reaction of each variable to (one standard deviation) impulse in the shocked variable. In the upper plots of Fig. 4 we report the response of tax evasion to a shock in tax evasion (left side) and in the apparent tax rate (right side). Similarly, the bottom plots in the same figure show the reaction of the apparent tax rate subsequent to an impulse in tax evasion (left side) and in the apparent tax rate (right side).[30]

From the impulse responses plotted in Fig. 4, four main facts emerge. First, tax evasion and tax rates Granger-cause each other: tax dodging legitimates high tax rates and the latter push up tax evasion. Second, both the tax rate and the tax evasion display a persistent response to each other impulse. However, while tax evasion immediately reacts positively to changes in the tax rate, this latter responds slowly to shocks to tax evasion and the reaction is significantly negative on the impact. The results depicted in the figure stress the absence of any vicious circle between tax

[29] See, for instance, Lutkepohl (1991).

[30] The residuals' correlation is 0.25.

evasion and the apparent tax rate. Actually, though the two variables positively affect each other (both in the short and long run), there is strong evidence that they converge to a new long-run equilibrium. Third, an impulse in tax rate leads to a permanent increase in the level of the tax rate whereas an innovation in tax evasion generates its own time path that dies away quite rapidly, converging to the previous equilibrium.

Finally, as described above, the IR analysis provides more reliable estimates of the cross elasticities compared to the coefficients of the estimated stationary long-run relation (3). The responses of (VAT_E/Y_T) to one-Standard Deviation (SD) shock (which amounts to an increase of 0.9%) to the tax rate is 0.4% on impact and about 1.3% after 1 year, though it quickly reaches a new stable equilibrium. The response of tax rate τ to an increase in tax evasion of 2% (one-SD) is negative on impact (−0.2%), but rises to +0.4% after 1 year and after 3 years it is still close to 1.6%.[31] These results also emphasize the potential error of uncritical long-run tax rate-tax evasion elasticities provided by simple static (stationary) regressions.

4.2.5 The evader equilibrium: an assessment

The tax evader equilibrium characterizes the long-run relationship between tax evasion and the tax rate, and is defined by our VAR-ECM model. Whenever the tax rate increases (for instance, for financing new public spending), those who evade taxes wish to nullify this disequilibrium (avoiding the tax increase), and the adjustment coefficient in Eq. 3 indicates how quickly this disequilibrium will be removed. Thus the equilibrium is quickly restored (the adjustment coefficient is almost 0.6 in 1 year), as is the gap between the apparent and effective tax rates. Actually, a simple definition of our variables used in the construction of Fig. 3 shows the relationships identified and quantified by the statistical model. The apparent tax rate τ is defined as the ratio between total revenues REV and total GDP, whereas the total revenues/Regular GDP ratio defines the effective tax rate $\widehat{\tau}$:

$$\tau = \frac{REV}{Y_T}; \qquad \widehat{\tau} = \frac{REV}{Y_T - VAT_{EVAsion}} = \frac{REV}{Y_R} \tag{5}$$

Whenever τ increases, impulse response analysis makes it clear that the share of tax liabilities concealed, in order to keep the evasion target, reacts positively and quickly to restore the equilibrium. Implicitly, this produces a higher effective tax rate, $\widehat{\tau}$.

Tax dodging reflects a behaviour aiming at a sort of "apparent tax cut": given the long-run relationship linking tax evasion and fiscal pressure, the size of evasion is adapted in order to pursue the target, entailing a change in the effective tax rate.

[31] These elasticities are computed from the numerical impulse responses depicted in the plots and the estimated standard error of the VECM regression. Lutkepohl (1991) discusses the caveats of impulse response analyses. Using absolute values, we find that a one percentage point shock to the tax rate provides, on impact, a positive tax evasion reaction of 0.22% points, peaking to 0.67 points after 2 years and, finally, approaching an equilibrium level of 0.43 points after 4 years. Conversely, a shock of one percentage point to tax evasion produces an immediate decline in fiscal pressure of 0.127 percentage points, followed by a gradual increase up to 2 percentage points in the long run.

Note that both the tax rate and tax evasion are driven by the long-run elasticities to converge to a higher equilibrium. This means that both the effective and apparent tax rate change over time but the gap still remains constant.

The evidence we are discussing refers to macroeconomic aggregates, which are undoubtedly the result of individual actions. The micro-founded rationale of this macroeconomic evidence is related to the individual decision process and especially to risk aversion considerations.

4.2.6 Variance decomposition analysis

Variance decomposition analysis (Table 1) of the model provides further interesting information on the short- and long-run tax rate-tax evasion relationship in Italy. This analysis separates the variance of the forecast error of a variable k distinguishing the contribution of variable j. Table 1 reports the results of the variance decomposition analysis for tax evasion and the apparent fiscal pressure.

The table shows that after 1 year the importance of an apparent tax rate innovation in affecting the share of unreported production in the model is close to zero (0.05). At the end of the second year decomposition shows that about 84% of the variance of the evasion is due to its own innovation and about 16% to tax rate innovation. Interestingly enough, after twenty quarters the fiscal policy component of the tax evasion's variance decomposition is about 22%. Conversely, with regard to the decomposition of the variance of τ, it is immediately, though scarcely, affected by the VAT evasion innovation (6% of the total variance after 1 year). In the long run, after 20 quarters, the two components of the tax rate's variance decomposition show a dominance of tax evasion in affecting the pattern of the tax rate (52% and 48%, respectively for tax evasion and tax rate).

As expected, in the short run each time series explains the preponderance of its own past values. Interestingly, after twenty quarters, the apparent fiscal pressure

Table 1 Variance decomposition

	Variance of VAT evasion attributed to:		Variance of tax rate attributed to:	
Quarters	Tax evasion	Tax rate	Tax evasion	Tax rate
1	1.00	0	0.06	0.94
2	0.99	0.01	0.03	0.97
3	0.97	0.03	0.03	0.97
4	0.95	0.05	0.06	0.94
5	0.92	0.08	0.08	0.92
6	0.89	0.11	0.10	0.90
7	0.86	0.14	0.13	0.87
8	0.84	0.16	0.17	0.83
9	0.83	0.17	0.22	0.78
10	0.82	0.18	0.28	0.72
20	0.78	0.22	0.52	0.48

explains 22% of forecast error variance of tax evasion, whereas tax evasion explains 52% of forecast error variance of the average tax rate. This asymmetry is explained by the institutional nature of the tax rate, a policy variable mainly driven by public balance management. This evidence is also consistent with the small adjustment coefficient found for the tax rate in the model estimation (3).

The dynamics yielded by the variance decomposition show that evaders do not act in a capricious fashion but they pursue a coherent strategy. Their behaviour is strongly influenced, in their decision to cheat the fiscal authorities, by tax policy: they learn and are willing to change. However, over time, evasion becomes a substantial and non-negligible determinant of tax policy.

5 Concluding remarks

Tax evasion is part of a set of events linked to tax policy which includes taxation systems complexity, enforcement and attitudes to the state. Underreporting income, overstating deductions and failing to pay obligations are the main sources of a phenomenon called "tax cheating". Failure to pay what the tax law requires in Italy reaches such a magnitude that the budget imbalance over the last 20 years could have been considerably cut.[32]

In this paper we use official time series of the Italian Revenues Agency on the evaded VAT base to assess some statistical characteristics of tax evasion in Italy. We think that combined with detailed evidence (official audit, private enquiry, and indirect inference) and analytical frameworks, empirical aggregate analysis and its implications can be useful as a guide to policy. The main results of our analysis can be listed as follows.

First, distinguishing the apparent tax burden (revenue-GDP ratio) from the effective tax burden (revenue-regular GDP ratio) we find that the two tax rates show, during the period examined, a permanent gap, with the effective tax rate permanently higher than the apparent tax rate. The statistical properties of this gap clarify that it fluctuates around a fixed value of about 10–11%. This might suggest that taxpayers adopt a strategy of tax base concealment that aims to maintain this equilibrium gap, whose size might be related to risk aversion issues, a strategy supported by our estimated model elasticities and dynamic coefficients.

Second, the estimated model provides quantitative results about the cross-elasticity between tax evasion and average fiscal pressure. In equilibrium, an increase of 1% point in the share of unreported tax liabilites brings the apparent tax rate up by 2% points whereas the latter raises the long-run tax evasion share by 0.44% points: each variable, dangerously, Granger-causes the other. Moreover, the estimated long-run parameters imply a quick adjustment to equilibrium. This again suggests the existence of a long-run strategy by taxpayers. Whenever a new reform or a tool comes into the system and generates disequilibrium, this is rapidly learned by the evaders and removed. This result confirms that there is an underlying process

[32] See the conservative estimate of Alesina and Marè (1996) and Basile et al. (2010).

(behaviour) explaining tax evasion in Italy, which is invariant through decades, generations and governments.

Finally, despite the fact that tax evasion lies at the core of the Italian economy, there is no evidence of any vicious circle with fiscal pressure, since the dynamic interaction between these two variables always converges to a stable equilibrium.

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Appendix

Here we show the results of stationary tests for the two tax rates and their difference, and the ratio of the unreported VAT base to total GDP. It is essential to identify the non-stationary nature of our series and avoid problems of spurious regressions. Statistical inference about a stochastic trend is often combined with a deterministic trend, and distinguishing between them when several breaks are present in the variables is not straightforward. Furthermore, the analysis is complicated by the weakness of the unit root tests when small samples are used (See Table 2).

Note that as the calculated ADF *statistics* for tax rates and VAT evasion exceed the critical values when considering the first differences, we reject the null (variables have a unit root) at conventional test sizes for the differenced variables. The tests confirm that we are dealing with non-stationary series (Fig. 5).

Table 2 Stationarity test: ADF (The Null Hypothesis of Unit Root)

Variable	Deterministic term	Test-statistic ADF
Unreported VAT base (millions): level	$g + t$	−2.69
Unreported VAT base (millions): 1st diff.	g	−5.53***
Unreported VAT base (%): level	$g + t$	−2.85
Unreported VAT base (%): 1st diff.	g	−6.05***
Effective tax rate: level	$g + t$	−1.17
Effective tax rate: 1st diff	g	−5.28***
Apparent tax rate: level	$g + t$	−1.93
Apparent tax rate: 1st diff	g	−5.13***

Critical values for the ADF test with constant and trend are: −3.96 (1%) and −3.41 (5%). Critical values for the ADF test with constant are: −3.43 (1%) and −2.86 (5%)

g is a constant term, t is a deterministic linear trend

*** p-value < 0.01

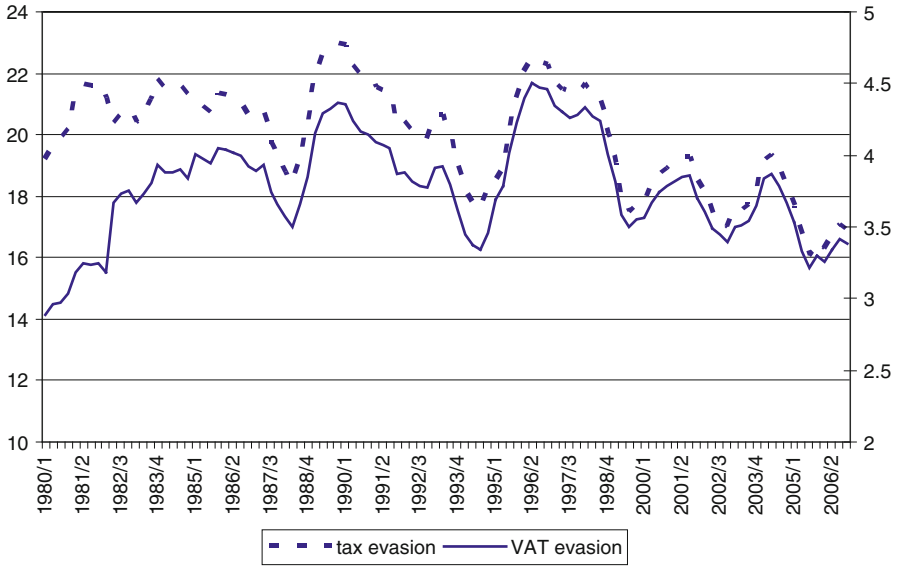

Fig. 5 Tax evasion (*left axes*) and VAT evasion (*right axes*), percentage, quarterly data. *Tax Evasion* is defined as the ratio of concealed VAT base to total GDP, whereas *VAT Evasion* is defined as the ratio of uncollected VAT revenues—calculated by multiplying the unreported VAT base by the marginal VAT rate- to total GDP

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