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Abstract

The empirical evidence on the linkage of the informal economy and GDP is ambiguous. It depends on the method used to estimate the size of the informal economy. I propose a common factor of four different approximations of the size of the informal economy as an alternative. Using Spain as an example I find that GDP Granger-causes informality, but not the other way around. I also find that positive GDP shocks induce positive and statistically significant responses of the size of the informal economy.

Keywords: Informal economy, dynamic factor model
JEL: C38, O17

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1 Introduction

Informal markets exist all over the world and have motivated different studies on its size, its determinants and its effects on other relevant economic variables for developing and OECD countries.[1] One main discussion point has been the relationship between GDP and the size of the informal economy. Does a higher GDP encourage or discourage informal activities? Do larger informal markets boost or hinder growth? Using Spain as an example and the four most recent approaches to estimate the size of the informal economy, I show in a VAR-framework that the different informality estimation methods lead to contradictory evidence on the relationship between GDP and informality. I propose a common factor of the four informality estimates as an alternative.

Markets are institutionally secured arenas in which voluntary exchange takes place (Vanberg, 2001). Informal (shadow, hidden, underground, black, unofficial) markets are *illegal* institutionally secured arenas where voluntary exchange of *legal* goods and services takes place.[2] Porta and Shleifer (2008) recognize three different views on informality. First, a legal-institutional perspective (or "romantic view"), that sees informal markets as the best response to legal exclusion and unequal enforcement of property rights (De Soto, 1989, 2000). Informality is therefore a symptom of "bad" or unequal law. Second, a tax-avoidance view (or "parasite view") which considers informal firms as harmful for growth as they are small and unproductive and take an important market share away from the more productive formal firms (Farrell, 2004). Third, a "dual view", which considers formal and informal markets to be independent from each other, as their producers and consumers operate in completely different scenarios. From the dual perspective, informal markets are exchange arenas mainly for poor people and tend to disappear with economic development (Porta and Shleifer, 2008, 278).

Except for the legal-institutional perspective, the different perspectives on informality imply a specific macroeconomic relationship between GDP and informal production. The tax-evasion view implies a negative relationship. An increase in informal production, for example through informal investment

[1] See for example De Soto (2000), Schneider (2005), Schneider *et al.* (2010) and Elgin and Oztunali (2012) for a worldwide analysis, Bajada and Schneider (2005) for the Asia-Pacific, De Soto (1989) Loayza (1996) and Perry *et al.* (2007) for Latin America, Eilat and Zinnes (2002) and Feige and Urban (2008) for transition countries, and Bovi and Dell'Anno (2010) and Feld and Schneider (2010) for OECD countries.

[2] For a discussion on the most used definitions of informality in economics see Schneider and Enste (2000).

made possible by higher remittances, would have a negative effect on formal GDP, as unproductive competition increases, forgone tax revenues increase and potential government expenditure decreases. In the other direction, an increase in GDP, for example through a tax reduction, would increase the expected benefits from formality, such that participants of informal markets might decide to become formal. Informal production and income would therefore decrease. The dual view implies that GDP and informal production are completely independent, that is that one variable does not respond to shocks of the other.

If the relationship between GDP and informal production is not as assumed by each view, the effects of the policy implications might be counterproductive. The tax-evasion perspective, for example, mainly recommends a stronger enforcement of tax collection and "combating" informality more efficiently. But if formal and informal production are not negatively but positively interlinked, "combating" informality would be harmful for the formal economy. On the other hand, expansive monetary or fiscal policy aiming to impulse the production of the formal sector, would also increase informal production and thus unproductive competition. Such dilemma reflects the importance of empirical evidence on the relationship between formal and informal markets.

The empirical evidence on the relationship between GDP and informality depends heavily on the method used to estimate the size of the informal economy and is contradictory[3] and difficult to compare. The main studies examine different countries and use only one, each time different, informality estimation approach. The results do not point into the same direction. For instance, Giles (1997) and Giles *et al.* (2002) use the multiple-indicators multiple-causes (MIMIC) approach for New Zealand and Canada and suggest evidence of Granger-causality from GDP to informality and mild evidence in the opposite direction. Bovi (2004) uses official data from the Italian statistical office and claims that both variables are independent. Serrano Sanz and Gadea (2005) use the monetary approach for Spain and suggest a positive Granger-causality in both directions. In a Panel-VAR framework, Birinci (2013) uses a model approach for 12 advanced economies and reports a positive effect of the size of the informal sector on GDP growth but not the other way around. To my best knowledge, there is no work examining the relationship between GDP and the informal economy in a VAR-framework for one country

[3]See Dell'Anno (2008) for a summary of the contradictory empirical evidence on the determinants of informality.

by using different informality estimation methods.

I test the relationship between GDP growth and the first log-differences of four different informality estimations using data for Spain. The evidence is contradictory. The four informality estimations seem to capture different information, even though they aim at the same unobserved variable. Assuming that each informality time series can be expressed as the sum of the true informality size – which is a *common factor* for all estimations – and some "noise" – the proper characteristics of each series – I estimate a dynamic factor model to compute a new informality time series. I examine the relationship between the common factor and GDP growth. I find that GDP growth Granger-causes informality, but not the other way around, and that positive GDP growth shocks induce significantly positive responses in the size of the informal economy, but not vice-versa. The empirical evidence suggests that, everything else equal, expansionary policies will likely induce a higher informal income and that a bigger informal economy will not have the negative effect on GDP alleged by the tax-evasion view. Policies seeking to "combat" informality will neither dampen nor boost formal economic growth.

The reminder of the paper is organized as follows: section two describes the four most commonly used methods to estimate the informal economy. Section three examines the causal relationships between each one of the estimates of the informal economy and Spanish GDP. Section four calculates a common factor of the four informal market estimations and examines the relationship between the common factor and GDP. Section five draws conclusions regarding macroeconomic analysis based on the estimation of the size of the informal economy.

2 Measuring the informal economy

Direct and indirect methods haven been widely used to estimate the size of the informal economy.[4] The direct methods are microeconomic approaches based on surveys.[5] The indirect methods are more appropriate to examine macroeconomic relationships as the one between GDP and the informal economy, because they are available for a longer period of time and in a regular frequency. Therefore, I focus on the four most recently used methods of estimating the size of the informal economy: the currency demand

[4]See (Schneider and Bühn, 2013) and (Schneider and Enste, 2000, p. 91 - 99) for a comprehensive and critical overview of the methods for estimating the size of the informal economy.

[5]Martinez-Lopez (2012), for example, presents a recent study for Spain.

approach, the energy consumption approach, the MIMIC approach, and the model based approach.

The currency demand approach

Under this approach it is assumed that informal transactions are mainly done in cash to prevent being traced by the authorities. Using the currency method, a currency demand equation over time is estimated using conventional explanatory variables including a tax variable. Two currency demand values are estimated for each year: one assuming the tax variable is zero (no evasion is necessary) and one with the real values of the tax variable. The difference between the two estimated cash demand values is the *tax induced currency demand* and thus the *illegal money*. The informal production can be estimated assuming that the velocity of money is equal in both the formal and informal economies (Tanzi, 1983).

The currency demand approach, however, has relevant shortcomings. First, not all informal transactions are done in cash. Second, the tax burden is not the only motivation for informal activity. Third, the assumptions of equal velocity of money at the formal and informal sectors as well as the tax burden of zero at the benchmark year tend to underestimate the size of the informal sector (Schneider and Bühn, 2013, 14).

The energy consumption approach

The energy consumption method was introduced by Kaufmann and Kaliberda (1996) and Lackó (2000). Considering that energy consumption is an essential input for production, the method assumes that the elasticity of electricity consumption to GDP equals one. Under these assumptions and taking energy consumption as a proxy for the "true" national production it is possible to estimate the size of the informal economy based on an energy demand function of the households and the growth rates of official GDP.

The energy consumption approach can be criticized on different points. The intensity of electricity usage depends on the kind of activity and therefore changes in the size of the informal economy can be over or underestimated. The elasticity of electricity consumption to GDP is not necessarily equal to one and technological improvement may change the energy consumption patterns in both the formal and the informal sectors (Schneider and Bühn, 2013, 16).

The MIMIC approach

The multiple-indicators multiple-causes (MIMIC) approach considers the size of the informal economy as an unobserved (latent) variable which is related to variables that *indicate* its changes and others which reflect its *causes*. The *indicators* and *causes* are selected based on theoretical considerations and the estimation is done in a factor-analysis framework (Schneider, 2005).

The MIMIC approach is based on more than only one indicator for the estimation of the size of the informal economy. Its main weaknesses have to do with the estimated latent variable. The calculated factor can not be interpreted exclusively as the size of the informal economy and it is plausible that it includes additional components which are related to the indicators and causes but not necessarily to the informal economy (Schneider and Bühn, 2013, 24). As the estimation procedure does not provide the size of the informal sector directly but only a set of estimated coefficients, an initial value is necessary to "calibrate" the model. The calibration is mainly done by using data estimated by the currency demand method for one period, transporting its biases to the MIMIC-estimated series (Breusch, 2005).

The model based approach

The model estimation approach was introduced by Elgin and Oztunali (2012). The method relies on a two-sector dynamic general equilibrium model in which infinitely-lived representative households may choose between a formal and an informal production technology. After calibrating the model, Elgin and Oztunali (2012) estimate the size of the informal economy for 161 countries from 1950 to 2009.

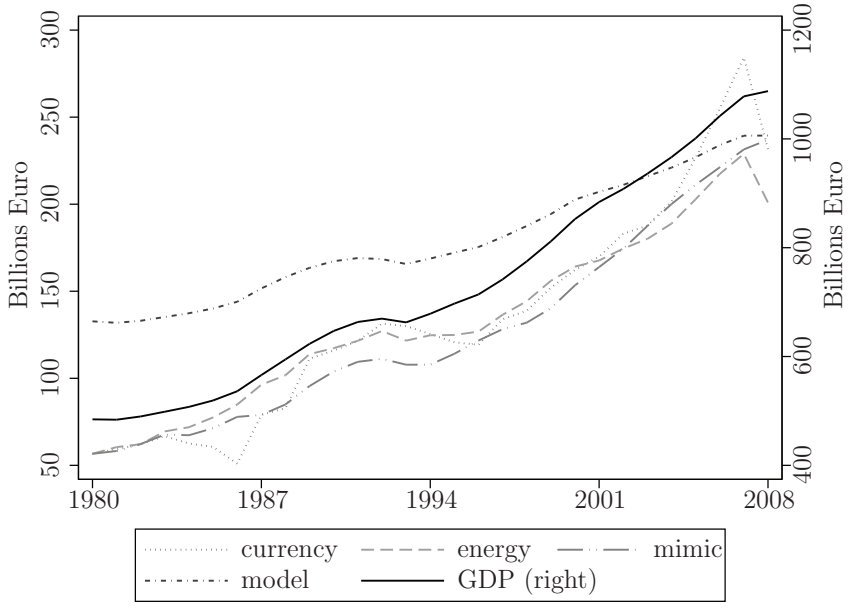
Elgin and Oztunali (2012) claim that the model approach has the advantages of being micro-founded, of not relying on ad-hoc econometric specifications and of evading statistical errors. A disadvantage is the sensibility of the computed values to the set-up of the DGE-model and to the selection of crucial parameters as the depreciation rate and the participation rates of the inputs in the assumed production technologies of the formal and the informal sectors.[6]

[6]The advantages and disadvantages of the model approach still need to be widely discussed.

3 The link between GDP and the informal economy

Figure 1 presents the annual time series of Spanish real GDP and the four estimations of the size of Spanish informal economy from 1980 to 2008 introduced above. The four series show a positive time trend and a reduction at the end. The difference between the highest and the lowest estimations reduces over time. In 1980, the size of the informal sector by the *model* approach is 27,4% of GDP and by the other three methods around 12% of GDP. In 2008 informality is 22% of GDP by the *model* approach and 18.5% by the *energy* approach.

Figure 1: Spanish Real GDP and Informal Economy



Note: The original data is provided as percentage of GDP. Source: Arrazola *et al.* (2011), Elgin and Oztunali (2012) and OECD Economic Outlook.

The estimations by the *currency*, *energy* and *MIMIC* approaches are reported by Arrazola *et al.* (2011). The estimation by the *model* method is from Elgin and Oztunali (2012). All five time series are I(1) and the null hypothesis of no-cointegration between each informality estimation and GDP can not be rejected such that there is no long-run equilibrating mechanism between each informality estimation and GDP. Therefore I use the first log-differences of each series.

I estimate four VAR models, one for each informality estimation (j):

$$y_t = A_0 + A_1 y_{t-1} + \cdots + A_p y_{t-p} + u_t$$

where y_t is a (2×1) vector containing the variables ΔGDP_t (the first log-difference of Spanish GDP) and ΔI_t^j (the first log-difference of each $j \epsilon [1, 4]$ informality estimate). A_0 is a (2×1) matrix of intercepts, A_i are (2×2) matrices of coefficients and u_t is a (2×1) matrix of error terms. I select the optimal lag order p using the standard information criteria (AIC and BIC). The structures of the estimations are stable (the roots are inside the unit circle) and after testing the residuals for autocorrelation and normality, the models are well specified.

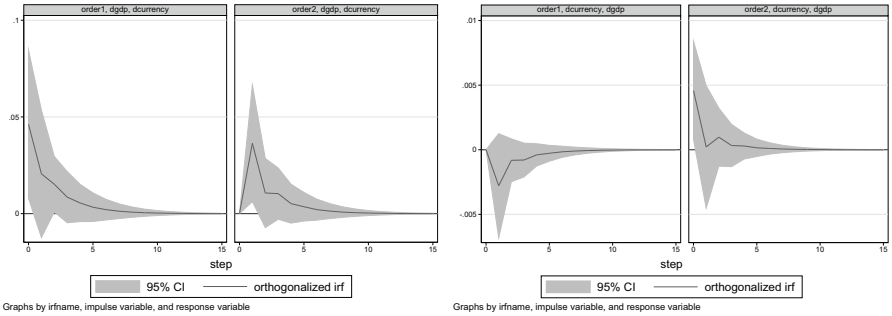
Table 1: Granger-Causality test: X does not Granger-cause Y (Wald-Test P-Values)

		Y				
		ΔGDP	**Δcurrency**	**Δenergy**	**ΔMIMIC**	**Δmodel**
X	**ΔGDP**		0.17	0.87	0.87	0.00
	Δcurrency	0.01				
	Δenergy	0.70				
	ΔMIMIC	0.00				
	Δmodel	0.00				

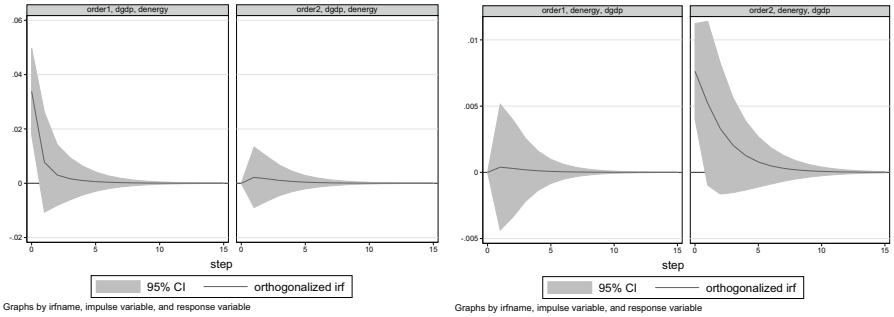
Table 1 shows the results of a Granger-causality test between GDP and informality in both directions. GDP improves the predictions of the size of the informal sector, only if it is estimated by the *model* method (first row, last column), but not if it is estimated by the *energy*, the *MIMIC* and the *currency* methods. In the opposite direction, the null hypothesis that informality does not Granger-cause GDP can be rejected with the *currency*, the *MIMIC* and the *model* methods but not with the *energy* method. Summing up, by the *currency* and the *MIMIC* methods, informality Granger-causes GDP, but not the other way around. Using the *energy* method, the variables are independent and the *model* approach suggests Granger-causality in both directions.

The impulse response functions in Figure 2 also show ambiguous evidence on the relationship between GDP and the size of the informal sector. The reactions to the shocks depend in most of the cases on the Cholesky ordering and their sign and statistical significance vary with the method used to estimate the size of the informal sector. With the *currency* (panel a) and *MIMIC* (panel c) methods, a positive GDP shock induces positive and (weak) statistically

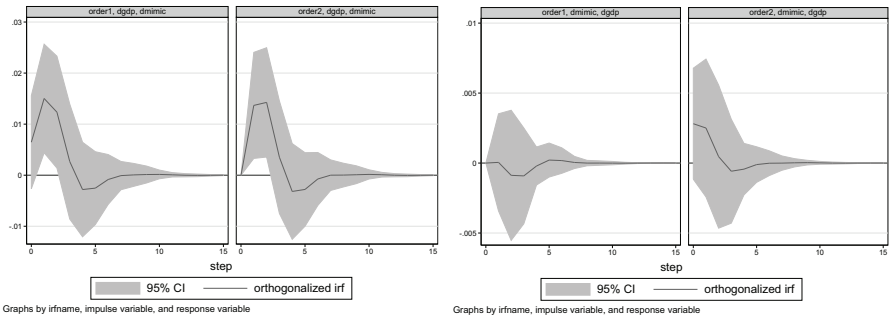
Figure 2: Impulse Response Functions: Spanish Real GDP and Informal Economy



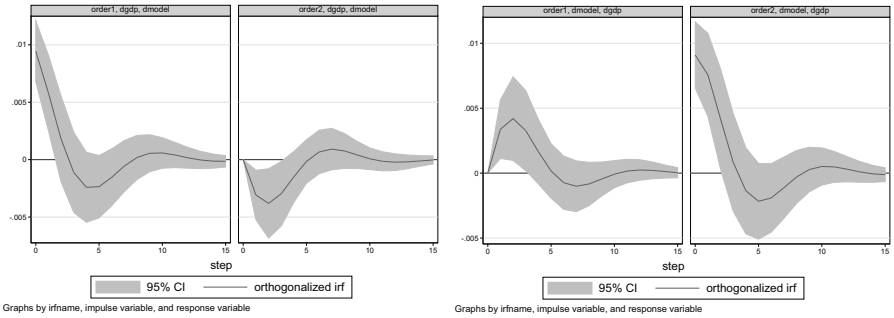
(a) Currency



(b) Energy



(c) MIMIC



(d) Model

Note: Order 1 and Order 2 are the alternative Cholesky orderings. The independet variable is GDP in Order 1 and each informality measure in Order 2.

significant responses of informality. A positive informality shock does not induce a statistically significant response of GDP. By the *energy* method (panel b), the variables' responses are positive and statistically significant if the impulse variable is first in the Cholesky ordering. By the *model* method (panel d), the reaction of GDP to an informality shock is positive and statistically significant if GDP is first in the Cholesky ordering and negative and (weak) statistically significant if informality is first in the Cholesky ordering. The reaction of informality to a GDP shock is positive and statistically significant irrespective of the Cholesky ordering.

The fact that the informality estimations reflect a different Granger-causality relationship to GDP and that the variables respond differently to the shocks shows that the information captured by each estimation method is substantially different, and that it has a decisive influence on the conclusions drawn from such tests.

4 The informality common factor

Despite the contradictory results, all four informality estimations intend to approximate the same unobserved variable. Said differently, each informality estimation can be expressed as the sum of two components: the "true" unobserved variable f_t, which is common for all four estimations and an *idiosyncratic* component u_t, which stores the specific characteristics of each series. Such expression is the starting point of factor analysis models. In general, the model can be written as:

$$Z_t = \mathbf{L}f_t + u_t, \tag{1}$$

where Z_t is a $(K \times 1)$ vector of variables, f_t a $(N \times 1)$ vector of common factors and $\mathbf{L}$ a $(K \times N)$ vector of *factor loadings* with $N < K$. In this case, Z_t includes the four log-first-differences of the informality estimations ΔI_t^j $(K = 4)$. $N = 1$, as I only estimate one common factor. Dynamic factor models (DFM), in contrast to strict factor models, allow for autocorrelation of the factors and the idiosyncratic components (Breitung and Eickmeier, 2006), such that the equations for the common factor f_t and the idiosyncratic component u_t can be specified as

$$f_t = A_1 f_{t-1} + \cdots A_p f_{t-p} + \eta_t \tag{2}$$

and

$$u_t = C_1 u_{t-1} + \cdots C_q u_{t-q} + \varepsilon_t, \tag{3}$$

where η_t and ε_t are white noise processes. The coefficients to be estimated are the factor loadings coefficient matrix $\mathbf{L}$ and the matrices A_i and C_j for $i = 1, \ldots, p$ and $j = 1, \ldots, q$.

DFMs are usually used for Now- and Forecasting variables that are reported with a certain delay (i.e. GDP) using variables which are known at the time of the prediction and available at higher frequencies.[7] In such cases it is possible to measure the performance of the estimations by comparing them with the true variable at the time it is released. For the size of the informal sector such a measure is not possible because the variable is not observable. Even though it can not be shown that a dynamic factor model performs better than other alternatives, its theoretical structure offers a helpful tool to go one step further in the estimation of the size of the informal economy.

Stock and Watson (2010) review three generations of different DFM estimation methods. The estimation procedure here corresponds to the first generation. The estimation comprises three steps. The first one is the computation of the Gaussian Likelihood using the Kalman Filter, the second is the estimation of the parameters of the matrices $\mathbf{L}$, A_i and C_j and the last one is the utilization of the Kalman smoother to obtain estimations of the factor f_t.

Equation 1 contains the given information and is thus the observation equation. Equations 2 and 3 are the state equations. Following Stock and Watson (1991), the first step follows the prediction equations which can be written as:

$$\alpha_{t|t-1} = T_t \alpha_{t-1|t-1}, \tag{4}$$

where $\alpha_{t|\tau}$ represents the estimate of the vector of states (f_t and u_t) according to the available information of the vector Z_t until the last period τ, and

$$P_{t|t-1} = T_t P_{t-1|t-1} T' + Q, \tag{5}$$

where $P_{t|\tau} = E[(\alpha_{t|\tau} - \alpha_t)(\alpha_{t|\tau} - \alpha_t)']$ is the estimation of the covariance matrix of the state vector with the available information until the last period τ.

Given the information, the vector of indicators Z_t can be predicted at the period t according to:

$$Z_{t|t-1} = L\alpha_{t|t-1} \tag{6}$$

[7] See for example Duarte and Süssmuth (2014)

and the forecast error would be:

$$v_{t|t-1} = Z_t - L\alpha_{t|t-1}. \tag{7}$$

The covariance matrix would be given by:

$$E[v_t v_t'] = F_t = LP_{t|t-1}L'. \tag{8}$$

Equations 4 to 8 are used to obtain a priori estimates of the values for the state (α_t) given some arbitrary initial values $\alpha_{0|0}$ and $P_{0|0}$. After the a priori estimate, an a posteriori update is done using:

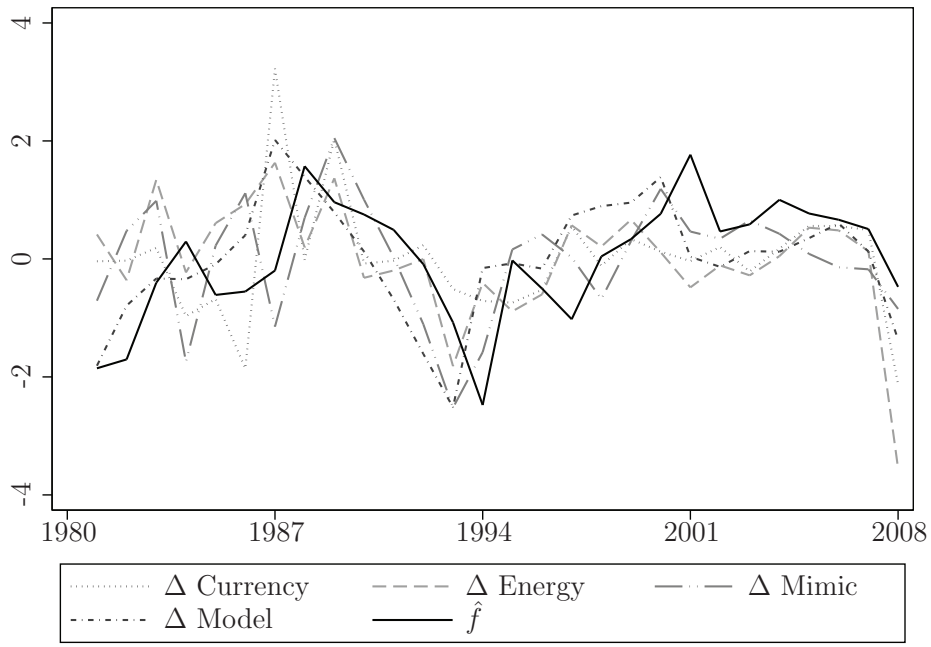
$$\alpha_{t|t} = \alpha_{t|t-1} + P_{t|t-1}L'F_t^{-1}v_t \tag{9}$$

and

$$P_{t|t} = P_{t|t-1} - P_{t|t-1}L'F_t^{-1}LP_{t|t-1}. \tag{10}$$

The same procedure is done recursively again with the updated values for α_t and P_t. Finally, the log likelihood function is computed and the function maximized to estimate the coefficients.

Figure 3: Informal Economy Common Factor: 1980 - 2008



Source: Arrazola *et al.* (2011), Elgin and Oztunali (2012) and own calculations. The graph shows the standardized variables.

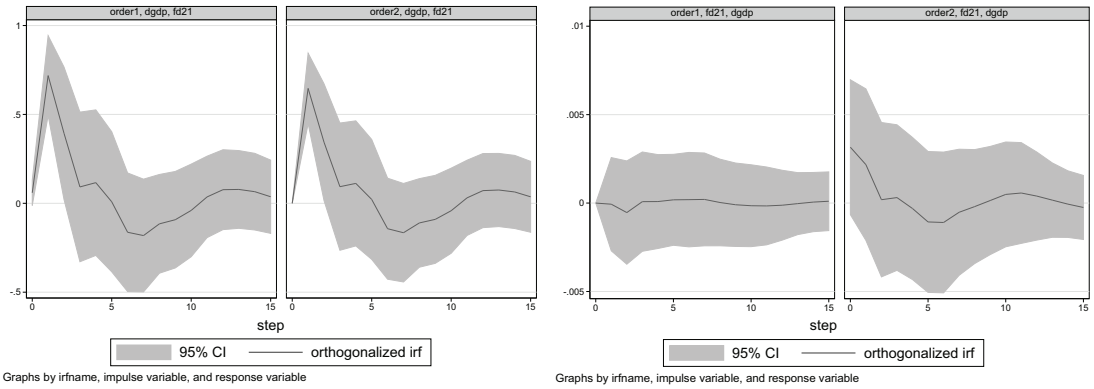
The final specification for the dynamic factor model corresponding to the lowest information criteria (AIC and BIC) is obtained at one lag for f_t ($p = 1$) and two for u_t ($q = 2$).[8] This suggests that a dynamic factor model is more accurate than a strict factor model ($p = q = 0$) for the estimation of the common factor. All factor loadings are statistically significant. Figure 3 shows the estimated factor ($\hat{f}$) and the first log-differences of the four basic informality estimations.

Table 2 shows that ΔGDP Granger-causes informality but the informality common factor ($\hat{f}_t$), does not Granger-cause ΔGDP. The impulse response functions in Figure 4 show that, irrespective of the Cholesky ordering, a positive GDP shock induces a positive significant response in the size of the Spanish informal sector. On the other hand, a positive informality shock does not provoke any significant responses in the size of the formal economy (GDP).

Table 2: Granger Causality test: X does not Granger-cause Y (Wald-Test P-Values)

		Y	
		ΔGDP	$\hat{f}$
X	$\hat{f}$	0.93	
	ΔGDP		0.00

Figure 4: Impulse Response Functions



[8]The maximum lag order was $p_{max} = q_{max} = 3$.

5 Conclusion

I examine the link between the size of GDP growth and the size of the informal economy in Spain using four different estimation procedures for the size of the informal economy. I show that the differences in the evidence found in the literature can be traced back to the methods by which the size of the informal sector is estimated. Until the estimation procedures are refined, assertions about the size of the informal economy and its relationship with GDP growth shall be considered carefully.

Assuming that all four informality estimations aim at the same unobservable variable, I calculate a common dynamic factor for the four estimations and examine the link between the common factor and GDP growth. The results show that GDP growth Granger-causes informality, but informality does not Granger-cause GDP growth. The impulse response functions show that a positive GPD growth shock induces a significant positive response of the informal economy, but not vice-versa irrespective of the Cholesky ordering.

Using the informality common factor as an alternative measure of the size of informality, the tax-evasion view does not seem to be a suitable perspective for the Spanish case. As the evidence above shows, informal markets are rather a complement than a competitor of formal markets. Therefore, "combating" informality, the policy implication of the tax-evasion view, will not have the claimed positive GDP growth effects. From the legal-institutional perspective, the complementarity of both formal and informal markets imply that structural reforms which allow for formal labor and production (such as working visas) would enlarge formal markets by enabling the complementary activities to become formal and that new formal firms will not necessarily compete against established formal firms. The fact that GDP does not react to changes in the size of the informal sector implies that formal and informal production partly take place in different scenarios and that the informal sector depends on the formal one but not vice versa.

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