The Unofficial Economy and the Business Cycle: A test for theories

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Abstract

The shadow economy is a substancial and increasing phenomenon worldwide. It poses several questions, the consequences on fluctuations in economic activity being among the major ones. Based on official data, this paper attempts to establish a set of features of the business cycle from the perspective of cross-country variation in the size of the unofficial sector. Through comparisons with the existing literature on macroeconomic fluctuations in economies featuring underground activities, the obtained stylized facts are used to test the relevance of theoretical predictions on the influence of the shadow economy. This procedure allows to confirm that the evidence is not entirely of the sort suggested in business cycle models. In particular, some important macro aggregates and cyclical properties have been neglected in the analysis altogether. One could conclude that much more needs to be done in order to obtain a thorough understanding of the nature of informal sector and its implications on macroeconomic performance as a whole.

JEL codes: E26, E32, O17, C82, C52

1 Introduction

The informal, underground, shadow, irregular or unofficial economy comprises all otherwise value-added creating activities that are unregistered and unlicensed. As described in Fortin *et al.* (1997, p. 294), firms in this type of an economy do not pay taxes such as corporate income taxes and social security contributions; they do not pay registration fees, nor are they subject to state regulations (including labor and environmental legislation). Moreover, informal sector workers do not pay income taxes on their informal wage income.[1] This is a substantial and increasing phenomenon worldwide, but especially in developing and transition economies. Indeed, Schneider (2005) reports that it represents an average size of 41% of GDP in developing countries, of 38% in transition economies, and of 17% in OECD nations.

The existence and increase of an underground economy pose several questions, the consequences on macroeconomic and fiscal performance being among the major ones. Given the difficulty to observe and measure, the shadow sector may introduce inaccuracies in the evaluation of the economic and social conditions of individuals, households, and countries (Frey & Schneider, 2004). Thus, for example, that the system of national income accounting does not include the proceeds of unofficial activities may lead to mismeasurement of domestic output, as generally pointed out in economics textbooks. Likewise, if one relies on the official statistics, the unemployment rate may hide that an (unknown) number of apparently idle persons actually work and receive wage income. Because policy makers conceive and implement economic measures based on essentially biased estimations, macroeconomic and social policies tend to be inappropriate or not well tuned.

Furthermore, that underground activities escape taxation has a number of consequences both for a government and for informal firms. Diversion of resources into the shadow sector creates a fiscal problem as it erodes the tax base. But, to the extent that unofficial firms avoid tax payments and do not comply with labor regulations, their access to basic public goods and credit markets is restricted. This translates into small scale, labor-intensive activities, which in turn results in lower productivity as compared to firms in the formal economy.[2] By and large, this points to a basic tradeoff faced by

[1] As such, this definition excludes unpaid private household production, voluntary non-profit (social) services and criminal activities.

[2] Transactions in the underground economy are typically undertaken in the form of cash payments, so as to leave no traces for the authorities. This is especially the case in developing countries where, as Gordon and Li (2009) emphasize, informal firms do not make use of the financial sector and thus

firms, namely, taxes and regulatory burden vs. public goods and finance.[3]

A substantial body of literature has documented a wide range of empirical regularities in business cycles across countries. This literature has usually distinguished between developed and developing countries, with studies comparing the patterns observed in the two types of economies (see Rand & Tarp, 2002, and Agénor *et al.*, 2000), in the understanding that differences in standards of living reflect in the features of fluctuations in economic activity. As regards the unofficial sector, several methods have been used in an attempt to estimate time series of output and ascertain their comovements and symmetry with the official economy. While this line of research has focused on the interactions between both sectors, it does not shed too much light on the cyclical behavior of the labor market and fiscal variables.

The present paper deals with the cyclical properties of macroeconomic aggregates as seen through the lens of cross-country variation in the size of the unofficial sector. That way, it recognizes informal activities are common to both industrialized and non-industrialized countries, despite the apparent presence of sizeable shadow economies in the latter ones. In this sense, it is regarded that an approach solely focusing on poor countries, and thereby ignoring the underground sector in rich ones, could be neglecting important elements in the characterization of interactions between unrecorded activities and macroeconomic fluctuations. Moreover, as this study is based on official data, it shall be deemed as an endeavor in the pursuit of establishing a set of features of the business cycle essentially different from those computing time series on informal output.

Through comparisons with the existing literature on business cycles in economies featuring an underground sector, the obtained 'stylized facts' are in turn used to test the successfulness of current theories in predicting the influence of unofficial activities on macroeconomic performance. These comparisons encompass the main aggregates involved in the definition of informality (i.e. fiscal and labor market variables) as well as other variables that could be affected over the business cycle by the existence of

lack access to capital markets for financial, insurance, and corporative purposes. Although disintermediation has the advantage of activity concealment, it does so at the expense of preventing firms from achieving efficient economies of scale and operating with the appropriate capital-labor combination (Loayza, 1996).

[3]Yet, depending on the nature of the public goods, informal agents may be incompletely excluded from their use as they have an incentive to free ride, i.e. use them at least partly while not participating in their financing. Moreover, Straub (2005) highlights the existence of informal substitutes for some government-provided goods and the specific markets they give access to. These substitutes are either produced by the agents themselves (e.g. reputation in the case of contracting) or by specific institutions (Mafia protection, informal credit by money lenders, etc.).

unregistered economic activities and their underlying characteristics (e.g. output and its components, money stock). While this preliminary exercise may serve to discriminate among alternative approaches, it can also be seen as an empirical basis for formulating theoretical models accounting for the shadow economy.

The following section makes a distinction between the empirical (i.e. time series on underground output) and the theoretical contributions addressing the relation between the official and the unofficial sector from a business cycle perspective, and describes the main strands of literature in this regard. Along with the methodological notes, preliminary comparisons and analysis on the consistency of current models with the empirical patterns found in this study are presented in the third section. Lastly, some general conclusions and further comments are provided, with a reference to possible avenues for future research.

2 A review of the literature

Few studies have tackled the relation between the unofficial and the official sector from a business cycle perspective. Among these studies, there is one empirical approach focusing on the estimation of time series of informal output and attempting to ascertain their comovements and symmetry with formal GDP. This empirical, a-theoretical aproach contrasts with business cycle models featuring underground activities. Despite the lack of uniformity in the way how these models address the existence of a shadow economy, some common characteristics and clear tendencies can be identified as follows.

2.1 The unofficial business cycle approach

This approach involves the estimation of time series of underground output using either indirect methods (e.g., currency demand, electricity use) or modeling techniques (e.g., Multiple Inputs, Multiple Indicators). Based on the estimated series, the comovements between the unrecorded and the measured economy are ascertained, as well as some evidence regarding asymmetry issues.

Among the studies using this approach, Bajada (2003) and Giles (1997) provide evidence of a procyclical relationship between the two sectors in Australia during 1967-95 and New Zealand in 1968-94, respectively, in what seems to indicate the prevalence of an income effect over a substitution effect. In contrast, Russo (2008) shows that the cyclical component of the US GDP is negatively correlated with the cyclical component

of the hidden output over the period 1960-2003, suggesting the existence of a 'double business cycle' in which peaks of the official sector coincide with troughs of the unofficial sector and vice versa.

Another subject of interest in the study of the relation between the measured and the unrecorded business cycles deals with timing patterns.[4] Again, Giles (1997) and Bajada (2003) find in this regard that the cycle of the official economy 'leads' that of the shadow economy. This result apparently poses a dilemma for policy-makers as, according to Tedds & Giles (2000), it would imply that attempts to stimulate the (official) economy also promote underground activities.

Finally, not one study provides evidence of asymmetry in the unofficial business cycle. Giles (1997) finds no indication of significant 'deepness' or 'steepness' in any of the cycles for New Zealand.[5] Similarly, neither Bajada (2003) nor Eng & Wong (2008) detect signs of asymmetry in the underground business cycles for Australia and South-east Asia, respectively. No asymmetries would mean, in Giles' (1999) view, that fiscal and monetary policy changes that respond to the observed business cycle are likely to have consistent effects on the underground cycle. Bajada (2003), nevertheless, ascertains using threshold models that the shadow economy is more responsive to negative shocks in legitimate activity than to positive shocks, and so the hidden sector deepens economic downturns and increases the volatility of the overall business cycle (i.e. the composite of both the formal and the informal cycles) in the Australian economy.

This line of research has been the subject of some criticism due to the empirical relevance of estimates of the underground economy. In this regard, Tanzi (1999) and Thomas (1999) both argue the existence of underground activities does not prove that official output estimates may not be correct. While Tanzi's (1999) skepticism partly rests on the vast discrepancies in quantitative magnitudes obtained using different methodologies, Thomas (1999) claims that the various approaches to the estimation of the size of the unofficial economy rely on heroic assumptions to justify the manipulation of certain figures rather than on any economic theory.

In addition to this criticism, it is worth noting that the approach described in this section does not cast too much light on the behavior of important variables, such as those related to the labor market and fiscal performance, over the business cycle.

[4]Some authors address the very same issue by conducting Granger causality tests. See, for example, the application for Canada and New Zealand conducted by Tedds & Giles (2000).

[5]A series exhibits deepness if it is negatively skewed relative to its trend. Likewise, a series displays steepness if its first-differences are negatively skewed, which means that contractions in the cycle are sharper than are expansions.

Though Eng & Wong (2008) suggest that the existence of a significant underground sector offers an interpretation for why fiscal policy is generally procyclical in developing countries,[6] not one study has tackled the influence of the unofficial economy on the cyclical properties of fiscal policy and thereby attempted to explain such puzzling feature.[7] Overall, these criticisms point out the need for an alternative empirical approach to examine the implications of the shadow economy on macroeconomic fluctuations.

2.2 Business cycle models with an unofficial sector

More grounded on economic theory, this section deals with business cycle models taking account of hidden activities. Although these models generally involve two sectors (official and unofficial), their differences could be said to have given rise to three strands of literature. The first strand shares some features in common with the household production literature (see Benhabib *et al.*, 1991), but differs from it by considering commodities produced in both sectors as perfect substitutes that are tradeable in the market. While the second line of analysis addresses dual labor market developing economies, it does not exhibit a clear-cut theoretical approach. The third approach, rather, takes a stand on search models and reflects a nuanced view of labor market adjustment.

As regards the household production-related models, Conesa *et al.* (2002) develop a real business cycle (RBC) model with an underground sector and indivisible official labor in order to address the observed negative relationship between the ratio of employment to population, which they coin the market participation rate, and the standard deviation of (log of) GDP. In this model, workers can only take part in one of the production sectors, so they face two labor decisions in two stages: First, individuals decide whether or not to participate in the formal sector; then, those who engage in shadow activities choose how many hours to dedicate to these. This setup allows for workers switching sectors in response to aggregate productivity shocks, amplifying the

[6] Talvi & Végh (2005) state that "a procyclical fiscal policy with respect to taxes is defined as increases in tax rates during recessions and reductions in tax rates during expansions (i.e., a negative correlation of tax rates with the business cycle). This definition stresses the notion that movements in tax rates tend to reinforce the business cycle. In the same vein, procyclical government consumption will be defined as government consumption increasing in good times and decreasing in bad times (i.e., a positive correlation of government consumption with the business cycle)" (p. 157, footnote 2)

[7] The common wisdom on this issue places its source on the fact that countries may be cut off from international credit markets during recessions. In addition to showing that procyclical fiscal policy is quite a pervasive phenomenon in the world economy, Talvi & Végh (2005) contend that governments may find it optimal to deviate from a full tax-smoothing rule as an indirect way of resisting political pressures to increase spending.

response of registered output. In addition to a closed-economy model, the authors introduce a similar framework in a standard international RBC model with two large open economies (US, EU) characterized by differing participation rates (see Conesa Roca *et al.*, 2001). Both models predict that the level of participation in registered activities, as an (inverse) expression of the size of the underground economy, has a negative effect on the degree of fluctuation of investment and registered GDP when different economies face the same technological shocks. The models are calibrated to the US economy, providing a better account of its business cycles facts. Thus, the authors conclude that hidden activities rationalize the negative relationship between participation rates and fluctuations in official output.

Within the same theoretical approach, there is though an alternative tack based on the arguable finding that business cycles in the formal and informal sector are negatively correlated. Busato & Chiarini (2004) pioneered this approach by devising an economy with one good and two technologies where, unlike the two previous models, the decision to work in the official or the unofficial sector is not mutually excludable.[8] Also, government levies taxes to finance its expenditures. Furthermore, firms face a probability of being discovered producing in the informal economy, convicted of tax evasion and subject to a penalty surcharge. The model is calibrated to the Italian economy, and the simulations show a reallocation of labor and production between the official and the underground sectors taking place over the business cycle. According to the authors, this inter-sectoral reallocation can resolve some heretofore unsatisfactory results concerning the labor market in the RBC literature such as the employment variability puzzle.[9] Moreover, this process of resource reallocation underlies the claim that the underground sector allows for consumption and income smoothing by providing insurance or risk sharing opportunities.

Russo (2008), in the same vein, develops a dynamic stochastic general equilibrium model wherein the government supplies a revenue enhancing and perfectly excludable public good to formal businesses. Further, agents exhibit stochastic preferences for hidden goods. The model is calibrated to the US economy, providing explanation for the negative correlation between the unofficial and the official sectors in terms

[8]One could imagine a firm producing for the formal economy in the day, and for the informal economy by night. Consequently, employees work a certain amount of hours under a regular contract during the day and additional hours and extra-hours are worked without any legal agreement by night.

[9]The employment variability puzzle refers to the fact that employment (or total hours worked) is almost as variable as output, and strictly procyclical, something difficult to replicate in a standard neoclassical model.

of a process of labor reallocation in response to idiosyncratic exogenous shocks. In addition to explaining the empirical countercyclicality of illegitimate output, the use of Bayesian Markov Chain Monte Carlo methods allows to obtain a quantitative estimate of several model parameters related to the unofficial sector. Of these estimates, a small elasticity of substitution between formal and unregistered goods is worth mentioning, as it characterizes the two types of goods as complements.

In contrast to the previous approach, which centers its attention on developed countries, the following two strands of literature focus on developing countries. Despite the common focus, these strands exhibit discrepancies as to whether or not characterizing developing country labor markets as dual. Thus, while one approach adopts a dualistic view in which the labor market is composed of a formal tradable sector and an informal non-tradable sector, the other reflects a nuanced approach of labor market adjustment. Another source of discrepancy lies on the use of a consistent theoretical framework, as papers in one stream display a common analytical framework whereas this is absent in the other stream.

Concerning the dual labor market models, Fiess *et al.* (2010) conceive a Rogoff-Obstfeld small economy wherein informality is also a self-employment sector facing liquidity constraints to entry. This framework allows to derive a set of hypothesis about the comovement of relative sector sizes and earnings in response to different types of shocks in contexts with and without wage rigidities. Then, the authors test for cointegrating relationships corresponding to the conjectured patterns of comovement using time series data from Argentina, Brazil, Colombia and Mexico. They identify, among others, expansionary episodes driven by relative demand or supply shocks to the non-tradable sector that suggest a 'procyclical' behavior of informal employment.

Using a substantially different setup, Cook & Nosaka (2005) develop a dynamic general equilibrium model of a small open economy in which there is no unemployment. Rather, the key element in this model economy is the existence of search frictions in finding positions in formal firms. The model is calibrated to the East Asian pre-crisis economy and the responses both to an interest rate shock and to permanent shocks to technology in the tradable and the non-tradeable sectors are examined. An external financial shock leads to a reallocation of labor from the productive formal sector to the less productive informal one, and thus results in a decline in output. On the other hand, a shock to technology in the tradable sector leads to migration of workers across sectors, increasing overall productivity and output over time. This contrasts with the effects of a positive shock to the non-tradable technology, which leads to a shift of the

workforce from the informal non-tradeable sector to the formal sector that increases the production of tradeable goods at the expense of non-tradeable goods, and hence reduces output, consumption and investment.

As seen, the latter paper shares some features with the search literature, which is the third strand described in this review. There is, in this regard, two recent studies attempting to disentangle the flows in and out of unemployment in economies with sizeable unregulated sectors. The first study, an empirical one, uses a search theoretic framework to analyze the cyclical properties of worker flows in Brazil and Mexico. Among other findings, Bosch & Maloney (2008) report both the unemployment (employment) rate and the share of formal (informal) employment are strongly countercyclical (procyclical) in these two countries. In contrast to the evidence for the US, they further encounter that separations from both formal and informal jobs are countercyclical and very volatile. Notwithstanding, the authors find largely procyclical flows among employment states, including transitions between the formal and the informal sector, which seem to be analogous to the US literature. In their concept, these findings provide a view of labor market adjustment in LDCs across the business cycle that has elements of the conventional notion of informality expanding across downturns, but without a connotation of overall inferiority of the unofficial economy.

Based on the findings reported in the previous paper, Bosch & Esteban-Pretel (2009) build a search and matching labor market model. In this economy, firms have the choice of hiring workers legally or illegally, so substitutability between formal and informal contracts within similar job types is present. The authors calibrate the model to match some facts of the Brazilian economy. They also conduct simulations which, overall, show the model does a good job at reproducing the observed correlations mentioned above, yet a different parameterization is needed to generate sufficient volatility. Furthermore, the simulations show the existence of two reinforcing effects: a meeting effect, whereby positive productivity shocks foster vacancy creation, and an offer effect, by which firms expand formal contracting to take advantage of the increase in productivity. Hence, more job creation and less job destruction explain the countercyclicality of the unemployment rate.

It can be inferred from these streams of literature a strong concern for understanding the performance of consumption and investment expenditures over the business cycle, as well as the behavior of the labor market. Yet some important variables and cyclical properties are neglected in the analysis altogether, such as the volatility of unemployment and the cyclicality of the labor income share as a whole (i.e. relative standard

deviation and correlation with GDP). Moreover, an overwhelming silence regarding the cyclical behavior of fiscal variables is observed. This is a serious shortcoming since most of the described models depart from definitions of informality that highlight lack of compliance with tax laws, and hence it is to be expected that these yield inferences on fiscal grounds along with predictions on the cyclical properties of labor market variables.

In addition to the criticism underlined above, it is worth noting that none of the summarized studies features monetary and nominal variables, and so nothing can be inferred from them as to the relation between the shadow economy and monetary policy and/or the pattern of inflation. Then, it can be inferred that the relation between underground activities and macroeconomic fluctuations, although somewhat addressed, has not been comprehensively examined so as to provide relevant enough insight into the nature of this sector and its overall influence on business cycles. The comparisons proposed in the following section shed further light on this issue.

3 Towards testing theories...

In an attempt to examine the appropriateness of the mentioned business cycle models, this section takes account of a set of characteristics of macroeconomic fluctuations that can be used for comparisons with the statements and predictions described above. While the exercise conducted here is very preliminary, it shall be deemed as an endeavor in the pursuit of establishing a set of business cycle properties in economies with an important component of unrecorded activities. Moreover, it shall be seen as a test for the relevance of the existing models of the business cycle with shadow activities and to identify how these can be improved to better account for these activities.

3.1 In the quest for some stylized facts

The approach proposed in this paper encompasses the estimation of moments (i.e. means, standard deviations and correlations) of official macroeconomic variables for a number of developed and developing countries. Once the moments are obtained for each country, correlations between each moment and the size of the shadow economy are computed on a cross-country basis. Further, an indication of the significance of each correlation is obtained in the form of probability values.[10]

[10] Alternatively, one could estimate cross-country regressions of each moment on the size of unofficial economy and then figure out the significance of each regression by computing the standard deviation

Since the sampled countries differ in the importance of their underground sectors, point estimates shall be taken to account for the size of the shadow economy. In this regard, Schneider (2005) presents econometric estimations using the dynamic multiple input multiple indicator (DYMIMIC) approach for 110 countries. While these estimates are obtained for periods of approximately three to five years, they are not meant to configure time series of the unofficial economy and hence might be to some extent exempt from the criticism described in past section. I use averages of these estimations for 17 developing countries and 23 OECD countries, including two East European transition economies.

As for the estimated moments, these are based on annual data on national accounts, monetary aggregates and fiscal and labor market variables obtained through the online databases of World Development Indicators, International Financial Statistics, OECD Factbook 2008 and International Economic Database. For further details on the data sources, see Appendix A.

Unless the variable is a share, each series is transformed into logarithms. These are detrended using the Hodrick-Prescott filter with a smoothing parameter of 100. Once separated the permanent and the transitory component of each series, the moments are computed on the transitory ones. It must be noted that, because the moments estimators require the time series involved have the same length, the time span considered for each series in each country corresponds to the length of the shortest series available. Alongside the inconvenience of HP filtering short series, this circumstance explains why second moments for most of the young transition countries cannot be obtained. The estimated moments are shown in Appendix B.

As this approach relies on quite standard procedures for the estimation of the features of the business cycle, it can be said to be an attempt to ascertain some 'stylized facts' in regard to the unofficial sector. In such a sense, this attempt is of an entirely different nature from that displayed in the underground time series approach. Furthermore, it is only slightly similar to the works of Backus & Kehoe (1992) and Fiorito & Kollintzas (1994) for highly industrialized countries, and of Agénor *et al.* (2000) and Rand & Tarp (2002) for developing economies. The estimates obtained using this methodology, likewise, may serve as a basis for comparisons involving selected countries. Also, more extended estimations could be of help in the conduct of cross-country studies implementing other statistical tools (see, for instance, Ferreira-Tiryaki, 2008).

of the R-square using either a bootstrap approach or jackknife procedures. I conduct this approach through bootstrap methods, providing the results upon request.

3.2 Preliminary results and some analysis

The following tables display the main results of the exercise suggested above. These tables present the correlation of each moment with the size of the unofficial sector, the probability value of this correlation as an indicator of its significance, an average estimate of each moment and the number of countries used for the computations (i.e. those countries for which available relevant data were found). Because the moments estimated for one single variable comprise the observations in one sample, all of the observations and samples are shown in Appendix B. Also, the sample was splitted into OECD countries and developing countries when possible in order to allow for some comparisons and further analysis.

As regards the comovements over the business cycle, it shall be borne in mind that many of the results discussed below are based on unconditional correlations between different variables. The degree of comovement of each series with real output is measured by the correlation coefficient of the cyclical deviations of the variable in question with those of GDP. A coefficient close to one indicates that a series is highly *procyclical*, whereas a coefficient close to one but of the opposite sign indicates that a series is *countercyclical*. A coefficient close to zero means that a series does not vary contemporaneously with the cycle in any systematic way, in which case the series is said to be *acyclical*. In addition to the correlations with deviations from trend GDP, the correlations of the cyclical components of productivity and real wages with total hours are estimated with the aim to deriving informative comovements pertaining to the labor market. The cross-correlations indicating the phase-shift of each series are not estimated.

3.2.1 Two important means

Before considering the moments specifically related to the business cycle, let us first consider the correlation of the size of the underground sector with two important means: GDP per capita and average inflation rate. As can be seen in Table 1, while GDP per capita is strongly negatively correlated with the extent of informal activities, the average inflation rate exhibits a positive correlation. Moreover, the same table shows that these estimations are significant. This means as a whole that countries with a large unofficial economy tend to display higher inflation rates and lower standards of living compared to countries in which this type of an economy is small. Though correlation is not causation, these results deserve further research as to the underlying mechanisms and

Table 1. Correlations with the size of unofficial activity

	GDP per capita (USD 2005)	Average inflation rate (%)
$\rho(size, moment)$	-0.7555	0.3190
p-value	0.000	0.048
Average moment	15636.98	48.42
No. of obs.	39	39

Source: Own calculations based on WDI (see Appendix A).

the policy implications.

3.2.2 Expenditure and fiscal components

Except for output, for which the standard deviation is presented as is, Table 2.a shows the relative standard deviations of each variable with respect to GDP. A significantly positive correlation between the size of the shadow economy and the volatility of GDP and its components can be inferred from this table, meaning that countries with a sizeable unofficial sector exhibit higher variability in output, consumption and investment. This finding confirms the predictions of the household production-related literature associating a large underground sector with higher fluctuations of registered output, consumption and investment over the business cycle. However, these results seem to be less robust for OECD countries, apparently the main focus of that line of analysis, as Table 3.a shows that only the correlation involving the standard deviation of consumption is significant for that subsample. Even so, the findings also confirm those of Ferreira-Tiryaki (2008), who uses a Generalized Method of Moments approach to demonstrate that the size of the informal sector is not only statistically significant, but also economically relevant in determining business cycle volatility.

The relative standard deviation of government expenditures is significantly correlated with the size of the informal economy. A positive correlation, in this case, implies that countries with little shadow activities tend to exhibit less fluctuations in public consumption. Since none of the models described above has a say on the volatility of government expenses, no comparisons can be made on these grounds. Nonetheless, it is noteworthy that the obtained estimates are consistent with the literature on stylized facts of the business cycle in both developed and developing countries (see Backus & Kehoe, 1992; Rand & Tarp, 2002) in that public expenditures are generally more

variable than output, as can be seen in Table 3.a.

In an attempt to measure tax revenues, this exercise deals with the tax burden. One common measure of the tax burden is the tax ratio, which is the percentage of a country's annual production (i.e. GDP) levied in taxes.[11] Using the approach suggested in this section, it can be inferred that the volatility of the cyclical component of the tax ratio is not significantly correlated with the size of the irregular economy. As neither the models described in the previous section conjecture on the behavior of the tax burden, nor the existing literature on business cycles stylized facts reports on the volatility of government revenues, the finding presented here deserves further research.

As for the comovements, Table 2.b shows the correlations between the cyclical elements of the expenditure components and GDP are not correlated with the size of the unofficial economy, nor is this the case for the tax burden. Regarding consumption and investment, the correlations displayed on this table are slightly negative, which suggests that countries with a small underground sector tend to exhibit higher procyclicality in these two variables. The associated probability values, however, point out that these estimates are not significant.

Concerning fiscal variables, neither the correlation of (the cyclical components of) government purchases with GDP nor the same type of correlation for the tax burden are significantly correlated with the size of the shadow economy. This result holds true both for the entire sample of countries (see Table 2.b) and, at least in the public expenditures dimension, for the subsamples of developing and highly industrialized countries (Table 3.b). Moreover, this finding casts doubts about the pertinence of Eng & Wong's (2008) suggestion that the underground sector may explain the procyclicality of fiscal policy in developing countries.

By looking at the sample related to government purchases (Appendix B), it can be seen that these are either acyclical or fairly procyclical regardless of the cross-country distribution of the size of shadow activities. On top of that, there is no consensus in the literature as to the cyclical properties of public expenditures in developing economies. While Rand & Tarp (2002) find a robust positive relationship between public consumption and domestic output in developing countries, with magnitudes in line with those observed in OECD nations, Agénor *et al.* (2000) provide evidence of countercyclical variation of government expenditures in the same type of countries. In regard to the industrialized world, some authors agree on the absence of a systematic cyclical tendency

[11]Since 1973, OECD has chosen to measure the tax burden as the total taxes and duties as a percentage of GDP in market prices.

Table 2. Correlations of moments with the size of unofficial activity
Expenditure and fiscal components
2.a. Relative standard deviations

	GDP	Consumption	Investment	Govt. exp.	Tax ratio
$\rho(size, moment)$	0.4506	0.2687	0.3848	0.3366	0.0421
p-value	0.004	0.094	0.014	0.036	0.856
Average moment	0.032	1.229	3.362	1.547	0.448
No. of obs.	40	40	40	39	21

2.b. Correlations with GDP

	Consumption	Investment	Govt. exp.	Tax ratio
$\rho(size, moment)$	-0.2553	-0.0861	0.1464	-0.0739
p-value	0.112	0.598	0.374	0.750
Average moment	0.686	0.751	0.247	-0.040
No. of obs.	40	40	39	21

Source: Own calculations based on several sources (see Appendix A).

(Backus & Kehoe, 1992; Talvi & Végh, 2005).

In regard to fiscal revenues, a similar lack of consensus arises. Whereas Agénor *et al.* (2000) show that government receipts is acyclical in some developing countries and significantly countercyclical in others, Talvi & Végh (2005) underscore the procyclicality of tax revenues in both developing and industrial countries. Thus, there is no clear evidence of a consistent pro- or countercyclical pattern in fiscal policy, let alone its stabilizing role on the economy.

3.2.3 Labor market

Moving on to labor market performance, the results in Table 4.a point out that informal activities are related with the volatility of both the unemployment rate and the labor's share of income. Indeed, the correlation between the size of the shadow sector and the relative standard deviation of unemployment is negative and significant at a ten percent level. This means that unemployment fluctuates less over the business cycle in countries with a large irregular economy. Though, intuitively, this finding may be explained by labor reallocation from the formal to the unofficial sector in bad times, none of the models described above predicts this sort of cyclical behavior of unemployment.

Likewise, the variability of the labor income share and the underground economy are fairly positively correlated at a five percent significance level. This implies that the

Table 3. Correlations of moments with the size of unofficial activity in subsamples
Expenditure components
3.a. Relative standard deviations

	GDP	Consumption	Investment	Govt. exp.
OECD countries				
$\rho(size, moment)$	0.1051	0.4218	-0.1477	0.0388
p-value	0.633	0.045	0.501	0.861
Average moment	0.025	1.041	3.058	1.235
No. of obs.	23	23	23	23
Developing countries				
$\rho(size, moment)$	0.2702	0.0115	0.3769	0.1921
p-value	0.294	0.965	0.136	0.476
Average moment	0.041	1.484	3.774	1.960
No. of obs.	17	17	17	16

3.b. Correlations with GDP

	Consumption	Investment	Govt. exp.
OECD countries			
$\rho(size, moment)$	-0.1331	0.0919	-0.2022
p-value	0.545	0.677	0.355
Average moment	0.719	0.785	0.188
No. of obs.	23	23	23
Developing countries			
$\rho(size, moment)$	-0.1816	0.0636	0.0010
p-value	0.486	0.809	0.997
Average moment	0.642	0.706	0.325
No. of obs.	17	17	16

Source: Own calculations based on several sources (see Appendix A).

fraction of (official) GDP earned by regular workers is more volatile in countries with sizeable unregulated sectors. Again, this suggests that people in these countries divert into unofficial activities as a buffer against fluctuations in wage income.[12] Although this argument is stated in several papers dealing with the business cycle implications of the shadow economy, especially in the double business cycle literature, no model has predicted any cyclical pattern of the labor's share of income at all.

The volatilities of wages and productivity are uncorrelated with the size of the informal economy. Indeed, the estimated correlations are close to zero and non significant. These findings are consistent with the search and matching literature, which allows for too large a variation in real wages relative to the data. However, it should be recalled in this regard that search-theoretic overpredictions of the real wage are a result of the setup of the model rather than a consequence of introducing an informal sector in such a framework.

As for labor input properly speaking, the cyclical variability of employment and total hours is uncorrelated with the extent of unofficial activities. An actual negative correlation between the relative standard deviation of these two variables and the size of informality implies that countries with a large shadow economy tend to exhibit less fluctuations in employment and hours worked. Though sensical, especially in view of a possible complementarity relationship between the formal and the informal sectors, the estimations are not significant at all. In this sense, the results do not confirm Busato & Chiarini's (2004) predictions of a meaningful relation between underground activities and the volatilities of employment and hours.

Regarding the comovements, the estimated coefficients highlight a significant rela-

[12] Another possible explanation deals with mismeasurement of the labor income share brought about by the existence of unrecorded activities. In attempting to rationalize cross-country disparities in the fuctional distribution of income, Gollin (2002) claims that the common practice of using employee compensation as a measure of labor income explicitly omits the labor income of the self-employed and other entrepreneurs. Given that almost no self-employed people is legally incorporated and that small enterprises and self-employment account for huge fractions of the workforce, particularly in developing countries, it is to be understood that the employee compensation measure fails to include the earnings of informal workers. As a consequence, the usual calculation of labor shares –i.e. employee compensation as a fraction of GDP– systematically understates labor's share of income in poor countries relative to rich countries.

Though Gollin's claim relies on a methodology for measuring the labor income share essentially different from mine, one could argue that both approaches are complementary (in that, for instance, measures of total hours worked and real wages used in the present study are based on official sources that unintentionally miscount informal activities). Hence, the unofficial sector might rationalize not only variations in the level of the labor's share of income across countries, but variations in cross-country volatilities as well.

tion between the size of the underground economy and the correlations of unemployment, employment, hours and real wages with GDP. That unemployment correlation with output is positively and significantly correlated with the extent of shadow activities implies that this variable is more countercyclical the smaller the unofficial sector is. The existence of such a significant relation is consistent with the search-theoretic literature's explanation of the countercyclicality of the unemployment rate, which lies on the fact that job separations of informal workers increase dramatically in recessions. As papers in this strand of literature focus their analysis on Brazil and Mexico, two middle-income developing countries not covered in the present study, and given that unemployment comoves negatively with output in all of the sampled economies (see Appendix B), the rationalization of the cyclicality of the unemployment rate provided by these search and matching models raises the question of whether it can be applied to both developed economies and LDCs at the same time.

That the comovements of employment and hours with output and the magnitude of shadow activities are negatively correlated implies the labor input behaves more procyclically the smaller the unofficial economy is. These results to some extent confirm the argument of the double business cycle literature that opportunities for intratemporal substitution between the legitimate and the illegitimate sectors can explain the puzzling strict procyclicality of employment and total hours worked (see Busato & Chiarini, 2004). It seems, nevertheless, that the explanation for the cyclical behavior of productivity lies in the multi-sector framework underpinning models in this strand of literature rather than on the particular features of underground activities. In fact, Tables 4.b and 4.c show that the comovements of labor productivity with GDP and hours are not significantly correlated with the extent of the unrecorded economy. To support this claim, consider for instance Cook & Nosaka's (2005) analysis of a technology shock in the tradable sector. Although the informal sector in their model economy exhibits different characteristics from the one in the double business cycle literature, the observation of a shock to technology in the formal sector leading to inter-sectoral allocation of workers and increasing overall productivity and output points to a similar conclusion.

Finally, as no study has yet directly or indirectly said anything concerning the positive correlation between the cyclical comovement of real wages and the size of informality, its meaning in terms of a tendency of labor compensation to be procyclical in countries with a large underground economy remains unrationalized. These findings, along with the estimated average acyclicality, support the contentions that the relation

Table 4. Correlations of moments with the size of unofficial activity
Labor market variables
4.a. Relative standard deviations

	Employment	Unemployment	Wages	Hours	Productivity	Labor share
$\rho(size, moment)$	-0.2060	-0.3293	-0.0254	-0.1730	-0.0057	0.4764
p-value	0.293	0.087	0.898	0.453	0.981	0.039
Average moment	0.966	8.398	3.258	1.202	0.919	0.004
No. of obs.	28	28	28	21	21	19

4.b. Correlations with GPD

	Employment	Unemployment	Wages	Hours	Productivity	Labor share
$\rho(size, moment)$	-0.4198	0.3432	0.3414	-0.4020	0.2207	0.3548
p-value	0.026	0.074	0.075	0.071	0.336	0.136
Average moment	0.553	-0.666	0.051	0.691	0.235	-0.169
No. of obs.	28	28	28	21	21	19

4.c. Correlations with hours

	Productivity	Wages
$\rho(size, moment)$	-0.0221	0.3436
p-value	0.924	0.150
Average moment	-0.456	-0.047
No. of obs.	21	19

Source: Own calculations based on several sources (see Appendix A).

between the real wage rate and output differs from country to country (Fiorito & Kollintzas, 1994), though it seems positive in developing countries (Agénor *et al.*, 2000).

3.2.4 Money and nominal variables

Regarding monetary aggregates, the results in Table 5.a confirm a considerably positive correlation between the extent of underground activities and the relative standard deviations of M1, M2 and quasi-money. These correlations are significant in all of the cases at a less than 10 percent level. However, these findings seem to be less robust for non-OECD countries, since Table 6.a shows that none of the correlations involving the standard deviation of money aggregates is significant for that subample. Even with this apparent discrepancy, nothing can be inferred from the models described in the previous section as to the relation between the shadow economy and monetary policy. Yet the averages in the mentioned tables corroborate that money stock fluctuates more

Table 5. Correlations of moments with the size of unofficial activity
Monetary and nominal aggregates
5.a. Relative standard deviations

	M1	Quasimoney	M2	Interest rate	CPI	Inflation rate
$\rho(size, moment)$	0.5069	0.3642	0.4272	0.1514	0.4732	0.4688
p-value	0.005	0.052	0.017	0.524	0.002	0.003
Average moment	5.062	5.966	4.724	0.890	3.266	2.173
No. of obs.	29	29	31	20	39	39

5.b. Correlations with GDP

	M1	Quasimoney	M2	Interest rate	CPI	Inflation rate
$\rho(size, moment)$	-0.0100	-0.0802	-0.0849	-0.1613	0.1093	-0.3868
p-value	0.959	0.679	0.650	0.497	0.508	0.015
Average moment	0.116	0.054	0.119	0.233	-0.315	0.030
No. of obs.	29	29	31	20	39	39

Source: Own calculations based on several sources (see Appendix A).

than real GDP, which is one of the stylized facts reported in the literature on business cycles (see Fiorito & Kollintzas, 1994).

The cyclical properties of the interest rate are seemingly uncorrelated with the magnitude of the shadow sector. As Tables 5.a and 6.a show, the correlation of the size of unofficial activities with neither the standard deviation nor the correlation of nominal interest rate with respect to GDP is significant. These findings, though, cannot be compared with the prescriptions in the business cycle models described above. It can be said at most that the results pertaining to the comovement with output apparently contrast Cook & Nosaka's (2005) predictions of an external financial shock leading to a decline in output (in a dual small open developing economy). However, it shall be borne in mind that these authors refer to a shock on real interest rates. Once this caveat is considered, one could say their theoretical predictions seem to match the evidence on the cyclical behavior of real interest rates in G7 countries, wherein this variable is countercyclical and more volatile than real GDP (see Fiorito & Kollintzas, 1994).

In a different vein, the relative standard deviations of consumer prices and the inflation rate are considerably positively correlated with the size of the underground economy. These observations are significant both for the entire sample of countries and at the OECD level (see Table 7.a). Despite the apparent robustness of these results, it is noteworthy that neither the papers summarized above nor the literature on the business

cycles stylized facts have a say on these particular properties of nominal variables.

Focusing on the comovements, it can be observed that the cyclicality of the money stock does not have any empirical relation with the size of the underground sector. Indeed, the correlation of each monetary aggregate with real GDP is not significantly correlated with the magnitude of the shadow economy. This finding holds both for the entire sample of countries (see Table 5.b) and for the subsample of developing nations (Table 6.b). That business cycle models with an unregistered sector say nothing on monetary performance hinders any meaningful comparison on these grounds. It is worth noting, nonetheless, that the obtained comovements between money and output do not exhibit a clear cut pattern. Although the correlations involving broad (M2) and narrow (M1) money appear to be positive, these are not very high. On the other hand, interest-bearing time deposits (quasi-money) is acyclical on average. These observations by and large confirm the facts reported in the literature in that the behavior of money varies both across countries and definitions of money stock (see Fiorito & Kollintzas, 1994, and Agénor *et al.*, 2000).

As for the cyclical movements of consumer prices, the results in Table 5.b point to a positive but non significant correlation with the extent of unofficial activities. This observation is challenged by that for the subset of OECD countries, which displays a strongly negative and significant correlation (see Table 7.b). Even with this lack of consistency, the estimated moments averages refer to countercyclical prices in the entire sample and its subsamples of developed and developing economies. This turns out to be a quite standard pattern in the literature (see Fiorito & Kollintzas, 1994; Rand & Tarp, 2002).

In contrast to the disparity observed above, the cyclical pattern of the inflation rate is significantly correlated with the size of the shadow economy both for the entire sample and the subsample of OECD countries. Indeed, the correlations in question are negative and significant at a five percent level, meaning that developed economies with a small unofficial sector tend to exhibit more procyclical inflation rates. While none of the models described in the previous section alludes to the cyclical properties of the inflation rate, and hence no comparisons can be made in this regard, the average moments seem to be in line with the facts reported in the literature, which suggest little evidence of procyclical inflation rates in developing countries (Agénor *et al.*, 2000; Rand & Tarp, 2002). The above findings add to those related to the average inflation rate to suggest that countries with extended underground activities exhibit not only higher inflation rates, but also these are more countercyclical.

Table 6. Correlations of moments with the size of unofficial activity in developing countries
Monetary aggregates
6.a. Relative standard deviations

	M1	Quasimoney	M2
$\rho(size, moment)$	0.3909	0.3333	0.3958
p-value	0.121	0.191	0.116
Average moment	6.486	6.881	5.618
No. of obs.	17	17	17

6.b. Correlations with GDP

	M1	Quasimoney	M2
$\rho(size, moment)$	-0.1631	-0.1042	-0.1857
p-value	0.532	0.691	0.475
Average moment	0.187	0.086	0.181
No. of obs.	17	17	17

Source: Own calculations based on several sources (see Appendix A).

Table 7. Correlations of moments with the size of unofficial activity in subsamples
Nominal variables

	Relative standard deviation		Correlation with GDP	
	CPI	Inflation	CPI	Inflation
OECD countries				
$\rho(size, moment)$	0.4647	0.3957	-0.6423	-0.4605
p-value	0.026	0.062	0.001	0.027
Average moment	1.732	1.153	-0.399	0.119
No. of obs.	23	23	23	23
Developing countries				
$\rho(size, moment)$	0.3006	0.2854	-0.0194	0.0169
p-value	0.258	0.284	0.943	0.951
Average moment	5.470	3.639	-0.194	-0.099
No. of obs.	16	16	16	16

Source: Own calculations based on several sources (see Appendix A).

4 Further comments and conclusions

The present paper has summarized some properties of macroeconomic data in a heterogeneous sample of countries and compared these properties with predictions and inferences taken from business cycle models accounting for underground activities. One goal of such a preliminary exercise has been to ascertain a set of stylized facts of the business cycle that, unlike studies focusing exclusively on industrialized or developing economies, takes account of the increasing pervasiveness of the unofficial economy. The other objective has been to examine the appropriateness of the mentioned models and to identify how the resulting empirical regularities can be used as a guide for future theoretical developments.

As regards the first goal, this paper contributes to the business cycle literature by providing an updated set of features of macroeconomics fluctuations.[13] Moreover, that the obtained estimates are in turn accompanied by inferences on its possible relation with the extent of shadow activities might constitute an informative procedure as long as it exploits the variety in one of the underlying sample characteristics, even though it does not include controls nor instruments, and allows for meaningful comparisons with previous empirical and theoretical results.

This heuristic procedure is of further help as to the second objective in that its use allows to confirm that unofficial activities actually exert an influence on the cyclical properties of a number of macroeconomic aggregates. Yet the evidence found is not entirely of the sort suggested in the theoretical business cycle literature. In particular, one could argue that business cycle models with an underground sector have paid too much attention to variables that turn out to be uncorrelated with the size of the shadow economy, like the comovements of productivity with GDP and hours; and have completely neglected variables and patterns that are indeed significantly affected by the existence of irregular activities such as the volatility of government expenditures, unemployment, prices and money.

Of special notice in this regard is the claim that the underground economy explains the procyclicality of fiscal policy in developing countries (see Eng & Wong, 2008). While there is no agreement on the behavior of fiscal variables over the business cycle, that government consumption is procyclical has been recognized as a widespread phenomenon even in the industrialized world (Rand & Tarp, 2002; Talvi & Végh, 2005). In such a sense, the uncorrelatedness between the magnitude of unofficial activities and

[13]The classic papers cited here provide estimates up to the late nineties.

the comovements of public purchases and tax revenues reported in the present paper does not lend much credence to the mentioned conjecture. At most one could say that the existence of a shadow sector not only rationalizes the reduced tax base typical in LDCs, but also might offer an explanation for its high volatility.

To the extent that the claim on the procyclicality of fiscal policy has not turned into a theoretical approach, it can be said that business cycle models with an underground sector are totally silent on the cyclical behavior of fiscal variables. Furthermore, none of these studies tackles the relation between the shadow economy and monetary and nominal aggregates. These are serious shortcomings so long as the described papers depart from definitions of informality that highlight lack of compliance with tax and labor laws as well as transactions realized in cash. Then, it would be expected that these papers yield inferences on fiscal and nominal grounds along with predictions pertaining to the labor market. Future models on the topic will have to address these issues.

In this sense, the very fact that transactions in the underground economy are typically undertaken in the form of cash payments stands as a possible avenue for future theoretical developments. This striking feature is especially the case in developing countries, where unofficial firms do not make use of the financial sector and thus lack access to (formal) credit markets so as to leave no traces for the authorities (Gordon & Li, 2009; Loayza, 1996).[14] Even though this particular feature is widely known, very few studies have addressed it in a business cycle context from a theoretical perspective; and the most prominent of these invoke liquidity constraints (Fiess *et al.*, 2010) or the lending channel (Ferreira-Tiryaki, 2008) as the means through which financial disintermediation exposes unregistered firms to higher fluctuations in economic activity. One can then infer that much more needs to be done in order to obtain a thorough understanding of how shadow activities affect the cyclical properties of macroeconomic aggregates. Certainly, this paper has suggested some paths that could and should be followed in this pursuit.

[14] As Straub (2005) notes, the decision of becoming formal (at least partially) and accessing the formal credit market is joint. Financial institutions require borrowers to present credible documentation relative to their physical location and pledgeable assets, and to make their operations at least partly observable through specific records (books, financial statements, banking operations, information from their suppliers and clients). In contrast, most informal producers do not register their operations in books, they do not use banking accounts or traceable means of payment, and they generally mix cash operations corresponding to their business with their personal activity. While these actions make monitoring difficult, most loans in this sector are possible only because of the strong enforcement techniques used by informal lenders such as physical threat and violent seizure of assets.

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A Data sources

The data used in the present study are based on several official sources and were taken from online databases. The time periods covered by the series may not coincide. Tables A2-A4 display the spans considered for each variable in every sample country. The following sections provide further details on how the data was obtained and describe some transformations employed in this pursuit.

A.1 Prices and GDP per capita

Data for both GDP per capita and average inflation rates were taken from the World Bank's World Development Indicators (WDI). The national accounts section in this database provides series for all of the countries on GDP per capita, expressed in dollars at constant 2000 prices. From these series, the data points corresponding to 2005 were chosen to represent real GDP per capita in every country in the sample.

As for inflation, annual figures on consumer prices percent inflation rate were compiled from the section on exchange rates and prices. Given data availability, all the sample countries were chosen to share figures from 1992 to 2007 in common. With these 15-year time series, the average inflation rates were then computed. Table A1 shows the obtained figures on GDP per capita and average inflation. Note that information regarding Taiwan is unavailable in WDI.

Except for Germany and the United States, series of consumer price index (CPI) were taken from the same section in WDI as inflation rates. These series were not subjected to any transformation, however. Whereas a CPI (2005=100) series for unified Germany was obtained from the International Economic Database (IED), estimates on Urban CPI (1982-84) were gotten from the US Bureau of Labor Statistics.

A.2 GDP and expenditure components

Series of real gross domestic product (GDP) and the expenditure components (i.e. consumption, investment, government expenditures) were mostly taken from WDI, in the section on national accounts. All of these series were chosen to be expressed in dollars at constant 2000 prices. Notwithstanding, to make use of the longer and most frequently utilized series for the US, data on real output and its components were taken from the National Income and Product Accounts calculated by the Bureau of

Economic Analysis. These series are expressed in billions of chained dollars at constant 2005 prices.

As it is not possible to obtain long enough series on the mentioned items for a number of countries in WDI, data from other sources were used. This is the case of Argentina, Nepal, Nigeria, Poland, Singapore, and Sri Lanka, for which the series were taken from the IMF's national accounts database featured in International Financial Statistics (IFS). Note that these series are mainly expressed in current prices. For this reason, it was chosen to work with series on GDP volume (base year=2000) as a proxy for real output. As for the expenditure components, all of the series were deflated using the GDP deflator (2000=100) found in the same datasource. The estimated moments are shown in Table A5.

A.3 Labor market aggregates

Data pertaining to the labor market were compiled from a variety of sources. Most of the series on both employment and unemployment were taken from the ILO's LABORSTA database. While the majority of these series are based on labor force surveys (LFS), data for some countries are based on different methods. This is the case of France, the Netherlands, Singapore and Switzerland, for which series on unemployed persons explicitly take account of registered unemployment through Employment Office Records. Series on employment in the Netherlands and unified Germany were obtained from IED, as well as data on (registered) unemployed persons in the latter country. The Portuguese unemployment series was taken from Eurostat, though it is based on LFS. Finally, a series on employment in South Africa was extracted from IFS.

Note that employment stands for the number of persons employed. The product of this series with average hours yields an estimate of total hours worked in the economy. Basically, series on average hours actually worked (hours per year per person in employment) were obtained for industrialized countries from OECD Factbook 2008. Exceptions are Germany, the Netherlands, Taiwan and United States. For Germany, Eurostat provides LFS-based figures on average number of actual weekly hours of work in main job. As for the last three countries, IED features indices of total hours in the manufacturing sector with 1996 as base year (1992 in the US). These figures and indices are considered in the present estimations.

As regards wages, data were mainly compiled from ILO's Key Indicators of the Labor Market (KILM) database. In its sixth edition, this database includes indices of real wage

in the manufacturing sector that, in the present study, were used for several OECD countries (Belgium, Canada, Chile, France, Hungary, Ireland, Korea, the Netherlands, Spain, and Sweden) and a few developing economies (Costa Rica, Singapore, Sri Lanka). Another ILO database from which a couple of series were extracted is LABORSTA. In this case, series on earnings per month of employees were downloaded for Botswana and Poland indirectly from UN data. As these series are expressed in national currency and thus refer to nominal wages, they were deflated using CPI data so as to convert them into real wage series.

While its data do not exhibit a uniform definition of wages, one important source of wages series was IED. For most countries (Denmark, Italy, New Zealand, Norway, Taiwan, UK, and USA), it was possible to get series on real wage indices. However, real wages for Japan and Australia were estimated by deflating the available data on nominal wages using CPI series. Using a different datasource, an annual index of real average wages (1995=100) was obtained for two Latin American countries, Chile and Costa Rica, through the Social Indicators and Statistics featured in ECLAC's CEPALSTAT database. A series of wages and salaries per man-hour in Germany was borrowed from IFS and then deflated with the already mentioned procedure. Lastly, an index of real wages with basis 1939 was taken from the Swiss Statistical Encyclopedia, which is published by the Swiss Federal Statistical Office.

Once data on all these variables were compiled, an estimation of labor income was proposed by multiplying real wages times total hours worked. This product was in turn divided by real GDP to compute the labor income share. Since estimates of this variable depend on the simultaneous availability of four different types of figures (employment, average hours, real wage, and GDP), the length of the resulting series is determined by the maximum of the start date and the minimum of the end date. Table A3 provides the time spans covered by each labor market series, including the periods for data on the labor share in each country. The estimated moments are displayed on Tables A6-A7.

A.4 Monetary policy aggregates

Series on monetary aggregates were taken in its vast majority from the monetary survey in IFS. The only exceptions are Germany, South Africa and Taiwan. For South Africa, these series were extracted from the monetary holdings (liabilities) subsection in turn featured in the WDI's section on financial statistics. Data on money stock in Taiwan and Germany were obtained from IED. As there are no series on quasi-money for

(unified) Germany in this database, these figures were calculated based on the other available time series by subtracting M1 from M2. Since national monetary aggregates series of the Euro area countries were discontinued beginning in January 1999, no data on money stock from those countries was used in the present study.

Regarding the interest rate, the most important data source is IED. As this database displays a number of definitions and series on nominal interest rates, those more closely related to the ones actually set by central banks when making monetary policy (e.g. discount rate, money market rate, interbank overnight rate) were chosen for the present estimations. Only series for the Philippines and USA were taken from a different source. The money market rate, obtained from IFS, was used in the case of Philippines. For the US, series of the Federal Funds rate were retrieved from the Federal Reserve Bank. Table A8 features the estimated moments of the monetary policy variables discussed in the present paper.

A.5 Tax revenues

The present exercise deals with the percentage of GDP levied in total tax revenue, which is known as tax ratio. Note that the tax ratio actually measures the tax burden rather than tax revenues. Except for US, data is obtained from OECD Factbook 2008. Since 1973, OECD has chosen to measure the tax burden as the total taxes and duties as a percentage of GDP in market prices.

In the same spirit, the percentage of GDP's total tax receipts (including social insurance and retirement receipts) was taken to measure the tax ratio in the US. This measure is provided by Tax Policy Center, which in turn is based on Historical Tables of the Office of Management and Budget. As this series displays figures on a fiscal year basis, quarterly GDP was used to obtain data on real output that could be employed consistently in estimating the moments.[15] These are shown on Table A7.

B Estimated moments

[15]This approach yielded similar estimates to those obtained using the OECD series.

Table A1. Means

Country	Size (% of GDP)	GDP per capita (USD 2005)	Average inflation rate (%)
Bolivia	61.0	1115.98	6.18
Panama	57.9	4440.48	1.36
Zimbabwe	53.4	450.35	1690.10
Peru	53.1	2350.66	12.81
Nigeria	52.0	437.92	24.08
Thailand	47.7	2386.58	3.62
Sri Lanka	40.3	1008.68	10.01
Philippines	40.2	1105.55	6.17
Nepal	35.1	238.76	6.86
Botswana	30.6	4335.84	9.46
Cameroon	29.1	679.21	4.51
Greece	27.6	14002.10	6.09
Italy	26.1	19548.56	2.94
South Africa	24.9	3425.54	6.60
Korea	24.9	13801.83	3.95
Poland	24.4	5229.63	14.05
Costa Rica	24.1	4502.40	13.03
Argentina	24.1	8094.17	7.16
Hungary	23.5	5853.79	13.11
Spain	21.5	15712.54	3.46
Belgium	21.5	23944.58	1.97
Portugal	21.4	11153.47	3.71
Sweden	18.7	30873.19	1.56
Norway	18.2	40617.84	1.99
Denmark	16.7	31463.69	2.03
Chile	16.6	5671.35	5.90
Canada	15.2	25437.10	1.88
Ireland	15.0	30286.04	3.22
Germany	14.9	23707.43	1.99
France	13.9	23693.48	1.66
Australia	13.3	23181.00	2.50
Netherlands	13.0	25061.98	2.28
United Kingdom	12.1	27200.33	2.77
Taiwan	11.9	N/A	N/A
New Zealand	11.7	14839.79	2.07
Singapore	11.4	26885.84	1.26
Japan	10.6	38971.84	0.20
Austria	9.3	25299.16	2.10
USA	8.4	37050.22	2.66
Switzerland	8.4	35783.33	1.23
Average	25.1	15636.98	48.42

Table A2. Time spans for prices, output and expenditure components

Country	GDP	CPI	Consumption	Investment	Govt. exp.
Bolivia	1960 - 2007	1960 - 2007	1970 - 2007	1970 - 2007	1970 - 2007
Panama	1960 - 2007	1960 - 2007	1980 - 2007	1980 - 2007	1980 - 2007
Zimbabwe	1960 - 2005	1964 - 2005	1965 - 2005	1968 - 2005	1965 - 2005
Peru	1960 - 2008	1960 - 2007	1960 - 2007	1960 - 2008	1960 - 2008
Nigeria	1973 - 2003	1973 - 2003	1973 - 2003	1973 - 2003	1973 - 2003
Thailand	1960 - 2008	1960 - 2008	1960 - 2007	1960 - 2007	1960 - 2007
Sri Lanka	1965 - 2007	1965 - 2007	1965 - 2007	1965 - 2007	1965 - 2007
Philippines	1960 - 2008	1960 - 2008	1960 - 2008	1960 - 2008	1960 - 2008
Nepal	1960 - 2004	1964 - 2004	1975 - 2004	1975 - 2004	1975 - 2004
Botswana	1960 - 1967	1974 - 2007	1975 - 2007	1974 - 2007	1975 - 2007
Cameroon	1960 - 2007	1968 - 2007	1960 - 2007	1975 - 2007	1960 - 2007
Greece	1960 - 2007	1960 - 2007	1960 - 2007	1960 - 2007	1960 - 2007
Italy	1960 - 2008	1960 - 2008	1960 - 2007	1960 - 2007	1960 - 2007
South Africa	1960 - 2008	1960 - 2008	1960 - 2008	1960 - 2008	1960 - 2008
Korea	1960 - 2008	1966 - 2008	1960 - 2008	1960 - 2008	1960 - 2008
Poland	1980 - 2007	1980 - 2007	1980 - 2007	1980 - 2007	1980 - 2007
Costa Rica	1960 - 2008	1960 - 2007	1960 - 2008	1960 - 2008	1960 - 2008
Argentina	1950 - 2008	1960 - 2007	1975 - 2007	1975 - 2007	N/A
Hungary	1960 - 2007	1972 - 2007	1965 - 2007	1960 - 2007	1965 - 2007
Spain	1960 - 2008	1960 - 2008	1960 - 2007	1970 - 2007	1960 - 2007
Belgium	1960 - 2008	1960 - 2008	1960 - 2007	1970 - 2007	1960 - 2007
Portugal	1960 - 2008	1960 - 2008	1960 - 2007	1970 - 2007	1960 - 2007
Sweden	1960 - 2008	1960 - 2008	1960 - 2007	1960 - 2007	1960 - 2007
Norway	1960 - 2008	1960 - 2008	1960 - 2007	1960 - 2007	1960 - 2007
Denmark	1960 - 2008	1960 - 2008	1960 - 2007	1966 - 2007	1960 - 2007
Chile	1960 - 2008	1960 - 2008	1960 - 2008	1960 - 2008	1960 - 2007
Canada	1960 - 2008	1960 - 2008	1960 - 2006	1960 - 2006	1960 - 2006
Ireland	1960 - 2008	1960 - 2008	1960 - 2006	1970 - 2006	1960 - 2006
Germany	1970 - 2008	1970 - 2008	1970 - 2007	1970 - 2007	1970 - 2007
France	1960 - 2008	1960 - 2008	1960 - 2007	1970 - 2007	1960 - 2007
Australia	1965 - 2008	1965 - 2008	1965 - 2008	1965 - 2008	1965 - 2008
Netherlands	1960 - 2008	1960 - 2008	1960 - 2007	1970 - 2007	1960 - 2007
United Kingdom	1960 - 2008	1960 - 2008	1960 - 2007	1970 - 2007	1960 - 2007
Taiwan	1961 - 2008	N/A	1961 - 2008	1961 - 2008	1961 - 2008
New Zealand	1960 - 2008	1960 - 2008	1960 - 2006	1970 - 2006	1960 - 2006
Singapore	1960 - 2007	1960 - 2007	1960 - 2007	1960 - 2007	1960 - 2007
Japan	1960 - 2007	1960 - 2007	1960 - 2006	1960 - 2006	1960 - 2006
Austria	1960 - 2008	1960 - 2008	1960 - 2007	1970 - 2007	1960 - 2007
USA	1929 - 2008	1929 - 2007	1929 - 2008	1929 - 2008	1929 - 2008
Switzerland	1960 - 2008	1960 - 2008	1960 - 2006	1960 - 2006	1960 - 2006

Table A3. Time spans for labor market variables and tax ratio

Country	Employed	Unemploy	Real wage	Hours	Labor share	Tax ratio
Panama	1982 - 2007	N/A	N/A	N/A	N/A	N/A
Peru	N/A	N/A	1980 - 2001	N/A	N/A	N/A
Thailand	1971 - 2008	1971 - 2008	N/A	N/A	N/A	N/A
Sri Lanka	N/A	N/A	1980 - 2007	N/A	N/A	N/A
Philippines	1970 - 2008	1971 - 2008	N/A	N/A	N/A	N/A
Botswana	N/A	N/A	1980 - 2003	N/A	N/A	N/A
Greece	1981 - 2007	1981 - 2007	N/A	1983 - 2006	N/A	1965 - 2006
Italy	1970 - 2008	1970 - 2008	1982 - 2007	1970 - 2006	1982 - 2006	1965 - 2005
South Africa	1967 - 2007	N/A	N/A	N/A	N/A	N/A
Korea	1969 - 2008	1969 - 2008	1980 - 2007	1980 - 2006	1980 - 2006	1972 - 2006
Poland	N/A	N/A	1980 - 2004	N/A	N/A	N/A
Costa Rica	1976 - 2008	1976 - 2008	1980 - 2001	N/A	N/A	N/A
Argentina	N/A	1970 - 2007	1980 - 2001	N/A	N/A	N/A
Hungary	N/A	N/A	1980 - 2007	N/A	N/A	N/A
Spain	1969 - 2008	1973 - 2008	1980 - 2007	1977 - 2006	1980 - 2006	1965 - 2006
Belgium	1983 - 2008	1983 - 2008	1980 - 2006	1983 - 2006	1983 - 2006	1965 - 2006
Portugal	1974 - 2008	1986 - 2008	N/A	1986 - 2006	N/A	1965 - 2006
Sweden	1969 - 2008	1969 - 2008	1980 - 2007	1969 - 2006	1980 - 2006	1965 - 2006
Norway	1972 - 2008	1972 - 2008	1960 - 2007	1972 - 2006	1972 - 2006	1965 - 2006
Denmark	1983 - 2008	1983 - 2008	1960 - 2007	1983 - 2006	1983 - 2006	1965 - 2006
Chile	1975 - 2008	1975 - 2008	1980 - 2005	N/A	N/A	N/A
Canada	1985 - 2008	1984 - 2008	1983 - 2007	1985 - 2006	1985 - 2006	1965 - 2006
Ireland	1983 - 2008	1983 - 2008	1980 - 2006	1983 - 2006	1983 - 2006	1965 - 2006
Germany	1970 - 2007	1970 - 2008	1970 - 2007	1983 - 2007	1983 - 2007	1970 - 2006
France	1969 - 2007	1969 - 2007	1980 - 2005	1970 - 2006	1980 - 2005	1969 - 2006
Australia	1978 - 2008	1969 - 2008	1982 - 2008	1978 - 2006	1982 - 2006	1965 - 2005
Netherlands	1970 - 2004	1969 - 2008	1980 - 2005	1960 - 2007	1980 - 2005	1965 - 2006
UK	1987 - 2008	1987 - 2008	1963 - 2008	1987 - 2006	1987 - 2006	1965 - 2006
Taiwan	1961 - 2008	1961 - 2008	1973 - 2007	1973 - 2007	1973 - 2007	N/A
New Zealand	1986 - 2008	1986 - 2008	1987 - 2008	1986 - 2006	1987 - 2006	1965 - 2006
Singapore	N/A	1969 - 2008	1986 - 2007	N/A	N/A	N/A
Japan	1969 - 2007	1969 - 2007	1963 - 2007	1970 - 2006	1970 - 2006	1965 - 2005
Austria	1970 - 2008	1981 - 2008	N/A	N/A	N/A	1965 - 2006
USA	1948 - 2008	1948 - 2008	1960 - 2006	1960 - 2006	1960 - 2006	1948 - 2007
Switzerland	1969 - 2008	1969 - 2008	1960 - 2008	1970 - 2006	1970 - 2006	1965 - 2006

Table A4. Time spans for monetary policy variables

Country	M1	Quasi-money	M2	Interest rate
Bolivia	1960 - 2007	1960 - 2007	1960 - 2007	N/A
Panama	1960 - 2007	1960 - 2007	1960 - 2007	N/A
Zimbabwe	1975 - 2005	1979 - 2005	1979 - 2005	N/A
Peru	1960 - 2007	1960 - 2007	1960 - 2007	N/A
Nigeria	1973 - 2003	1973 - 2003	1973 - 2003	N/A
Thailand	1960 - 2007	1960 - 2007	1960 - 2007	N/A
Sri Lanka	1965 - 2007	1965 - 2007	1965 - 2007	1965 - 2007
Philippines	1960 - 2007	1960 - 2007	1960 - 2007	1977 - 2007
Nepal	1960 - 2004	1960 - 2004	1960 - 2004	N/A
Botswana	1976 - 2007	1972 - 2007	1976 - 2007	N/A
Cameroon	1960 - 2007	1960 - 2007	1960 - 2007	N/A
Italy	N/A	N/A	N/A	1981 - 2008
South Africa	1965 - 2007	1965 - 2007	1965 - 2007	1960 - 2008
Korea	1960 - 2006	1960 - 2006	1960 - 2006	N/A
Poland	1980 - 2007	1980 - 2007	1980 - 2007	1983 - 2007
Costa Rica	1960 - 2007	1960 - 2007	1960 - 2007	N/A
Argentina	1960 - 2007	1960 - 2007	1960 - 2007	N/A
Hungary	1982 - 2007	1982 - 2007	1982 - 2007	N/A
Spain	N/A	N/A	N/A	1977 - 2008
Portugal	N/A	N/A	N/A	1967 - 2008
Sweden	N/A	N/A	1960 - 2008	1982 - 2008
Norway	1960 - 2003	1960 - 2003	1960 - 2003	1964 - 2008
Denmark	1960 - 2008	1960 - 2008	1960 - 2008	1960 - 2008
Chile	1961 - 2007	1961 - 2007	1961 - 2007	N/A
Canada	1960 - 2008	1960 - 2008	1960 - 2008	N/A
Germany	1970 - 2008	1970 - 2008	1970 - 2008	1970 - 2008
France	N/A	N/A	N/A	1960 - 2006
Australia	1965 - 2008	1965 - 2008	1965 - 2008	1970 - 2008
Netherlands	N/A	N/A	N/A	1960 - 2008
United Kingdom	N/A	N/A	1960 - 2008	1978 - 2008
Taiwan	1961 - 2008	1964 - 2008	1961 - 2008	1962 - 2008
New Zealand	1960 - 2008	1960 - 2008	1960 - 2008	1964 - 2008
Singapore	1963 - 2007	1963 - 2007	1963 - 2007	1986 - 2007
Japan	1960 - 2007	1960 - 2007	1960 - 2007	1960 - 2007
USA	1948 - 2007	1948 - 2007	1948 - 2007	1955 - 2008
Switzerland	1960 - 2007	1960 - 2007	1960 - 2007	N/A

Table A5. Second moments of prices, output and expenditure components

Country	$\sigma(Y)$	$\sigma(P)/\sigma(Y)$	$\sigma(\pi)/\sigma(Y)$	$\sigma(C)/\sigma(Y)$	$\sigma(I)/\sigma(Y)$	$\sigma(G)/\sigma(Y)$	$\rho(P,Y)$	$\rho(\pi,Y)$	$\rho(C,Y)$	$\rho(I,Y)$	$\rho(G,Y)$
Bolivia	0.041166	22.70311	15.00830	0.71380	3.63379	1.59530	-0.4210	-0.1925	0.7264	0.7052	0.7107
Panama	0.042147	0.68290	0.48690	1.19920	5.95345	1.19533	0.1847	0.0997	0.5840	0.8901	0.4419
Zimbabwe	0.065514	4.94114	1.84068	1.65220	2.75073	2.12585	-0.4133	-0.3270	0.4448	0.3966	-0.0821
Peru	0.051818	18.13827	11.16347	0.96113	3.16622	1.32712	-0.6795	-0.3823	0.8854	0.7333	0.5877
Nigeria	0.051071	3.24244	2.27183	2.16234	4.90919	4.14929	0.0807	-0.0151	0.1832	0.6865	-0.0795
Thailand	0.047803	1.10344	0.84139	1.02084	3.62824	1.08067	-0.1068	0.2082	0.9350	0.9576	0.3202
Sri Lanka	0.022389	2.08839	1.80069	4.39686	7.33985	6.12190	0.3184	0.1169	0.1573	0.6851	0.1809
Philippines	0.021846	1.85915	1.86340	0.55034	4.03925	1.63990	-0.5504	-0.0712	0.8869	0.8692	0.6434
Nepal	0.019716	2.11386	2.40679	1.17477	3.16446	3.69907	0.1329	-0.0202	0.5140	0.1819	0.1360
Botswana	0.055427	0.71756	0.48426	2.25330	3.88147	1.38592	-0.6039	0.0513	0.4341	0.7306	0.1991
Cameroon	0.054783	1.07640	0.89677	1.29082	2.30177	1.47324	0.5103	-0.1271	0.7901	0.8141	0.4567
Greece	0.023758	1.72231	1.24289	1.00674	3.50285	1.26594	-0.6720	0.0202	0.6835	0.8055	-0.0895
Italy	0.015556	2.65314	1.34724	1.19166	1.19166	1.06253	-0.4215	0.1626	0.7818	0.8377	0.2160
South Africa	0.018845	1.23296	0.92033	1.32300	3.92838	1.33901	-0.2709	0.0498	0.6864	0.6605	0.1089
Korea	0.025926	1.88667	1.36304	1.26036	3.75758	1.04275	-0.5188	-0.0658	0.8259	0.6907	0.4475
Poland	0.065082	7.12461	4.93409	0.85549	2.35329	3.51522	-0.7248	-0.0786	0.4885	0.8142	0.0979
Costa Rica	0.033159	3.03150	2.45989	1.35705	3.56204	0.89396	-0.7092	-0.3772	0.7478	0.8203	0.6586
Argentina	0.051298	13.75673	9.74616	1.33551	2.92547	N/A	-0.2712	-0.4987	0.7825	0.9135	N/A
Hungary	0.043531	1.92661	0.92564	0.92482	1.75524	1.27281	-0.6502	-0.3200	0.4486	0.5819	-0.1578
Spain	0.022684	1.79876	0.91979	1.11863	2.97564	1.11741	-0.5229	0.3036	0.9375	0.9371	0.5940
Belgium	0.014618	1.61546	1.03702	1.08283	4.03146	0.96408	-0.4386	0.2469	0.7519	0.8016	0.1221
Portugal	0.029121	1.47607	0.93899	1.37098	2.68574	1.10663	-0.5760	-0.0141	0.5458	0.8875	0.3537
Sweden	0.018717	1.24646	0.88583	1.26503	3.50715	0.74457	-0.6567	0.1341	0.7441	0.8626	-0.0826
Norway	0.019236	1.14491	0.95146	1.31760	4.42065	0.88656	-0.3087	-0.0511	0.7713	0.5989	-0.1043
Denmark	0.018001	1.13789	0.78041	1.38452	4.40109	0.95739	-0.4346	-0.3076	0.6962	0.8899	0.2898
Chile	0.047702	9.86876	5.22849	1.96795	2.89367	0.74664	-0.3976	-0.4279	0.8627	0.8686	0.5204
Canada	0.019223	1.12688	0.68070	1.06083	2.72584	1.11667	-0.3952	0.2345	0.8041	0.7885	-0.1072
Ireland	0.026573	1.68709	1.56241	1.08328	3.30352	1.53726	-0.0108	0.1328	0.6344	0.7613	0.5256
Germany	0.016630	1.05636	0.66552	1.06462	2.66793	1.02208	-0.2078	0.3960	0.7963	0.8406	0.2200
France	0.013906	1.78086	0.95440	0.89253	3.04599	0.74312	-0.4774	0.2180	0.8414	0.9211	0.0307
Australia	0.017378	1.94573	1.03907	0.64258	2.95249	1.06245	-0.3961	0.2794	0.5313	0.7007	0.2202
Netherlands	0.017521	1.66796	1.66325	1.31697	2.76247	0.97383	-0.2190	0.0799	0.7414	0.7236	0.2053
UK	0.018758	2.14216	1.26255	1.24832	2.65625	0.77751	-0.5228	0.0684	0.8461	0.8596	-0.1403
Taiwan	0.024013	N/A	N/A	0.99174	3.00771	1.43785	N/A	N/A	0.7486	0.4997	0.3154
New Zealand	0.030662	0.65848	0.65848	0.97640	3.13128	0.80762	-0.2764	0.1024	0.8090	0.9275	0.3847
Singapore	0.042713	0.96376	0.80263	0.86959	3.06600	1.70378	0.0992	0.3216	0.5435	0.5881	0.1926
Japan	0.025237	1.33669	0.88807	0.67397	2.35026	0.57331	-0.5824	0.0662	0.8939	0.9658	-0.0367
Austria	0.014641	1.21055	0.76680	0.99447	2.87195	0.80639	-0.2195	0.3530	0.6193	0.8184	0.1147
USA	0.058382	0.56424	0.42327	0.52319	4.70696	3.78716	0.2377	0.1200	0.4467	0.1357	0.7479
Switzerland	0.024681	0.93854	0.63674	0.67983	2.58375	1.26182	-0.1849	0.6649	0.8999	0.8968	0.4792
Average	0.031781	3.26587	2.17307	1.22890	3.36232	1.54667	-0.3148	0.0296	0.6863	0.7512	0.2472

Table A6. Second moments of employment, unemployment and real wages

Country	$\sigma(E)/\sigma(Y)$	$\sigma(U)/\sigma(Y)$	$\sigma(W)/\sigma(Y)$	$\rho(E,Y)$	$\rho(U,Y)$	$\rho(W,Y)$
Panama	0.40976	N/A	N/A	0.5331	N/A	N/A
Peru	N/A	N/A	2.33124	N/A	N/A	0.7598
Thailand	0.72823	7.69199	N/A	0.2154	-0.6948	N/A
Sri Lanka	N/A	N/A	2.27853	N/A	N/A	-0.2932
Philippines	0.71203	3.61135	N/A	0.1107	-0.2189	N/A
Botswana	N/A	N/A	1.70294	N/A	N/A	0.1669
Greece	0.52079	7.80515	N/A	0.0762	-0.5232	N/A
Italy	0.82386	4.01198	1.81674	0.4101	-0.1272	0.0646
South Africa	2.30366	N/A	N/A	0.3188	N/A	N/A
Korea	0.65771	6.56105	2.96146	0.8005	-0.8216	0.4193
Poland	N/A	N/A	20.39931	N/A	N/A	0.6928
Costa Rica	0.71415	4.98407	2.18201	0.1267	-0.6201	-0.0204
Argentina	N/A	4.02890	1.61379	N/A	-0.2987	0.3573
Hungary	N/A	N/A	0.88888	N/A	N/A	0.7294
Spain	1.09924	6.63763	1.06548	0.8749	-0.8166	0.0538
Belgium	0.99921	9.69040	1.32702	0.4983	-0.7581	0.0499
Portugal	0.82782	7.10113	N/A	0.4273	-0.8767	N/A
Sweden	1.00473	13.94259	1.53705	0.6514	-0.7865	0.3846
Norway	1.11461	10.85005	1.79452	0.7066	-0.7777	0.0137
Denmark	1.00809	8.63757	1.58562	0.6520	-0.8866	-0.5361
Chile	0.67755	3.55912	2.93352	0.5287	-0.4357	-0.4546
Canada	0.69531	4.79605	0.45012	0.8370	-0.8926	-0.6875
Ireland	0.70289	4.76658	1.07567	0.7982	-0.8393	-0.2360
Germany	2.37713	11.30851	1.15358	0.6585	-0.4990	0.3782
France	0.68547	4.97138	1.36180	0.8186	-0.6338	0.0255
Australia	1.04194	7.74469	0.84826	0.7533	-0.7453	-0.2335
Netherlands	0.97947	14.86609	1.21069	0.7372	-0.7148	0.3462
United Kingdom	1.03083	8.21420	1.95012	0.639	-0.7818	-0.3859
Taiwan	2.41519	7.84961	32.77189	0.1351	-0.6393	-0.3370
New Zealand	0.95585	6.19642	0.69749	0.8348	-0.9168	-0.7488
Singapore	N/A	11.49532	0.98939	N/A	-0.4785	0.5872
Japan	0.34868	4.55649	0.62836	0.5985	-0.7498	0.6360
Austria	0.82884	10.76063	N/A	0.1791	-0.3696	N/A
USA	0.55224	7.97637	1.25200	0.7776	-0.8781	-0.5334
Switzerland	0.83964	30.53808	0.43124	0.7886	-0.8579	0.2235
Average	0.96625	8.39834	3.25853	0.5531	-0.6657	0.0508

Table A7. Second moments of hours, productivity, labor share and tax ratio

Country	$\sigma(tr)/\sigma(Y)$	$\sigma(H)/\sigma(Y)$	$\sigma(Y/H)/\sigma(Y)$	$\sigma(ls)/\sigma(Y)$	$\rho(tr,Y)$	$\rho(H,Y)$	$\rho(Y/H,Y)$	$\rho(ls,Y)$	$\rho(Y/H,H)$	$\rho(H,W)$
Greece	0.45320	0.91428	1.33777	N/A	-0.3567	0.0253	0.7302	N/A	-0.6645	N/A
Italy	0.61755	0.99019	1.05835	0.00006	-0.3166	0.4345	0.5384	-0.0144	-0.5251	0.2535
Korea	0.20684	0.87927	0.52166	0.03311	0.1464	0.8535	0.4783	0.3103	-0.0493	0.1295
Spain	0.29650	1.55205	0.67018	0.00673	0.1834	0.9535	-0.7160	0.3815	-0.8931	0.1612
Belgium	0.54603	1.16543	1.24932	0.00615	-0.6701	0.3551	0.4639	-0.4282	-0.6634	-0.0223
Portugal	0.22882	1.10150	0.57801	N/A	-0.1769	0.8530	0.1045	N/A	-0.4299	N/A
Sweden	0.79137	0.95818	0.60839	0.00520	0.3609	0.8078	0.3715	0.3689	-0.2472	0.3952
Norway	0.44340	1.01682	0.74656	0.00003	0.4672	0.7261	0.3506	-0.2817	-0.3895	0.1361
Denmark	0.74566	1.23571	0.90232	0.00005	0.5461	0.6930	0.1591	-0.4109	-0.6014	-0.0200
Canada	0.37939	0.87101	0.45289	0.00263	-0.1140	0.8918	0.4929	-0.8056	0.0459	-0.7180
Ireland	0.43162	0.66508	0.72437	0.00499	-0.5400	0.6899	0.7471	-0.6337	0.0342	-0.3557
Germany	0.35621	3.18671	2.61203	0.00021	0.4436	0.6798	-0.4465	0.3860	-0.9598	0.3682
France	0.43336	0.73937	0.57793	0.00389	-0.5460	0.8201	0.6812	-0.1097	0.1397	0.0134
Australia	0.41059	1.19987	0.75889	0.00035	0.3440	0.7767	0.0898	-0.3045	-0.5577	-0.2731
Netherlands	0.53143	1.11441	1.03125	0.00000	-0.1075	0.5287	0.3983	0.2043	-0.5679	0.6703
UK	0.66770	1.40855	0.95809	0.00005	-0.2433	0.7334	-0.0344	-0.3209	-0.7047	0.0182
Taiwan	N/A	1.63802	1.26373	0.00014	N/A	0.6368	-0.0341	-0.2851	-0.7923	-0.6150
New Zealand	0.42089	1.20563	0.49389	0.00004	0.0055	0.9164	-0.2122	-0.6233	-0.5857	-0.8103
Japan	0.23892	0.55612	0.81645	0.00011	0.1825	0.5778	0.8312	-0.2712	0.0266	0.1620
Austria	0.46418	N/A	N/A	N/A	-0.3274	N/A	N/A	N/A	N/A	N/A
USA	0.42118	1.92521	1.20065	0.00012	0.3550	0.8479	-0.5268	-0.0488	-0.8973	-0.5127
Switzerland	0.32194	0.92873	0.73482	0.00764	-0.4843	0.7120	0.4609	-0.3306	-0.2949	0.1299
Average	0.44794	1.20248	0.91893	0.00376	-0.0404	0.6911	0.2347	-0.1693	-0.4561	-0.0468

Table A8. Second moments of monetary policy variables

Country	$\sigma(M1)/\sigma(Y)$	$\sigma(Q)/\sigma(Y)$	$\sigma(M2)/\sigma(Y)$	$\sigma(i)/\sigma(Y)$	$\rho(M1,Y)$	$\rho(Q,Y)$	$\rho(M2,Y)$	$\rho(i,Y)$
Bolivia	18.95362	20.88660	19.85776	N/A	-0.3866	-0.3424	-0.3760	N/A
Panama	2.82464	3.09311	2.90292	N/A	0.8216	0.7467	0.8110	N/A
Zimbabwe	17.82424	8.76249	8.13878	N/A	-0.2274	-0.3704	-0.4160	N/A
Peru	15.06301	16.80891	15.58229	N/A	-0.6206	-0.6571	-0.6477	N/A
Nigeria	3.96769	2.60570	3.28936	N/A	0.5731	0.2277	0.4935	N/A
Thailand	1.65001	1.15791	0.96148	N/A	0.4804	0.1021	0.2957	N/A
Sri Lanka	2.78829	7.06026	4.32667	0.75283	0.0658	0.6580	0.5684	0.2206
Philippines	2.01249	2.91066	2.14764	0.72875	0.3910	0.1793	0.2379	0.1105
Nepal	3.53441	6.35171	2.51103	N/A	0.0421	0.0257	0.1912	N/A
Botswana	2.61936	5.43364	4.15136	N/A	0.6501	0.4043	0.5231	N/A
Cameroon	1.96719	2.85876	1.86328	N/A	0.6260	0.3905	0.6105	N/A
Italy	N/A	N/A	N/A	0.76426	N/A	N/A	N/A	0.3657
South Africa	6.53142	4.17859	2.41404	1.35402	0.3921	0.1452	0.4903	0.4638
Korea	3.12744	5.33296	3.87734	N/A	0.4937	-0.0063	0.1988	N/A
Poland	6.02822	6.15413	5.96580	2.64417	-0.5797	-0.4547	-0.5076	0.1001
Costa Rica	3.58897	9.40900	3.81028	N/A	-0.2968	-0.0444	-0.1894	N/A
Argentina	13.10648	11.45326	11.64195	N/A	-0.2249	-0.1141	-0.1711	N/A
Hungary	1.63333	2.91941	2.01163	N/A	-0.5674	-0.7755	-0.8100	N/A
Spain	N/A	N/A	N/A	0.76753	N/A	N/A	N/A	0.3304
Portugal	N/A	N/A	N/A	0.63873	N/A	N/A	N/A	-0.3635
Sweden	N/A	N/A	1.81121	0.68347	N/A	N/A	-0.0272	0.0696
Norway	4.05995	3.56167	1.82808	0.67194	-0.3591	0.4062	-0.0413	0.1885
Denmark	2.62873	4.83798	3.12853	0.62254	0.1669	0.1333	0.1850	-0.0824
Chile	8.20148	10.11413	8.67754	N/A	-0.2080	-0.2578	-0.2447	N/A
Canada	4.20925	7.36261	6.17483	N/A	0.3393	0.0463	0.0899	N/A
Germany	2.63405	10.91151	5.25884	1.12057	0.5531	0.0449	0.1357	0.5545
France	N/A	N/A	N/A	1.14917	N/A	N/A	N/A	0.2939
Australia	2.80106	4.32154	3.20147	1.12342	-0.2674	0.1050	0.0550	0.6772
Netherlands	N/A	N/A	N/A	0.90444	N/A	N/A	N/A	0.3868
United Kingdom	N/A	N/A	6.97935	0.84262	N/A	N/A	0.6140	0.2165
Taiwan	4.13877	1.90102	1.70498	0.48501	0.5032	-0.0622	0.3425	-0.0564
New Zealand	2.75734	5.01107	3.88257	0.95638	0.2840	-0.0806	-0.0127	0.1846
Singapore	1.49459	1.98756	1.51830	0.28523	0.6022	0.4219	0.5516	0.4682
Japan	2.57699	3.52483	2.82858	0.42029	-0.0462	0.1886	0.1791	0.3101
USA	1.67433	4.57396	2.04978	0.87735	0.2119	0.2327	0.3524	0.2238
Switzerland	2.39639	2.48522	1.95181	N/A	-0.0495	0.2750	0.2214	N/A
Average	5.06185	6.13690	4.72418	0.88964	0.1160	0.0541	0.1195	0.2331