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Fiscal Multipliers and Informality

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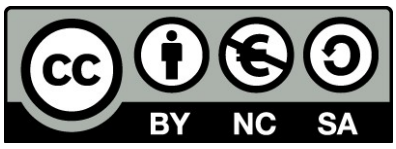

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Fiscal Multipliers and Informality*

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Abstract

This paper investigates the role of informality in affecting the magnitude of the fiscal multiplier in a panel of 141 countries, using the local projections method. We find a strong negative relationship between the degree of informality and the size of the fiscal multiplier. This result holds irrespective of the levels of economic development and institutional quality and is robust to additional country characteristics such as trade, financial openness and exchange rate regime. In a two-sector new-Keynesian model, we rationalize this result by showing that fiscal shocks raise the relative price of official goods, shifting demand towards the informal sector. This reallocation effect increases with the level of informality, because a larger informal sector is associated with a stronger appreciation of relative prices in response to fiscal shocks. Thus, informality raises the size of the unofficial multiplier. A higher degree of non-separability between public and private goods also contributes to rationalize the lower multipliers in high-informality countries.

Keywords: Fiscal multiplier; local projection methods; informality; DSGE model; TANK model.

JEL: H30; H50; E26; C32.

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1. Introduction

An empirical regularity of previous cross-country studies on the effectiveness of fiscal stabilization policy is that fiscal multipliers are smaller in developing countries (Kraay 2012; Ilzetzki, Mendoza, and Végh 2013). We show that a key driver of this result is the interaction between the strength of the public expenditure multiplier and the size of informality, that is typically larger in developing countries.

Some studies have examined the role of informality in affecting the magnitude of fiscal multipliers, both in developing and advanced economies. Lemaire (2020) investigates the effects of informality on the multipliers associated with fiscal consolidations in a group of Latin-American countries. He finds that fiscal multipliers are larger in countries with a low degree of informality, while countries with high levels of informality are characterized by a muted response of official GDP to the consolidation shock. Pappa et al. (2015) document that accounting for tax evasion, their proxy for informality, increases the estimates of fiscal multipliers in a group of OECD countries, and provide evidence that spending cuts induce a reallocation of production towards the formal sector. Dellas et al. (2017) show that the large "forecast errors" associated with the fiscal consolidation in Greece during the Euro area debt crisis is largely explained by the standard modeling practice of neglecting the informal sector, and that the fiscal consolidation introduced since the beginning of the crisis caused a substantial expansion of the Greek shadow economy. Basile et al. (2016) exploit Italian data on tax evasion and unreported income to investigate the response of the formal and informal sectors to public expenditure shocks. They find that in Italy fiscal expansions cause a reduction in the share of unreported income.

We contribute to this literature by providing the first systematic analysis of the role of informality in shaping the effectiveness of fiscal policy for a large sample of 141 developed and developing economies. Using the local projection method of Jordà (2005), we estimate the cumulative dynamic response of GDP to government spending shocks and the implied fiscal multiplier, conditional on different measures of the degree of informality. To identify fiscal shocks, we follow the approach of

Auerbach and Gorodnichenko (2013), and we use the forecast errors for the growth rate of government spending as reported in the October issue of the IMF World Economic Outlook for the same year. These forecast errors are further purged from any predictable component available at the time of the forecast, by regressing them on the lags of output and government spending and taking the residuals. As we show in the paper, the resulting shocks are exogenous with respect to the other current and lagged endogenous macroeconomic variables in the model, they are uncorrelated with other macroeconomic shocks (such as monetary policy shocks and uncertainty shocks) and represent unanticipated movements.

After having estimated the average fiscal multiplier in the overall sample, we analyze how the fiscal multiplier varies with the degree of informality, by estimating smooth-transition local projections as in Auerbach and Gorodnichenko (2012). Our results suggest that high informality is associated with a marked reduction in the size of the fiscal multiplier. This finding is fully confirmed when we control for other country characteristics that the literature has identified as key determinants of cross-country differences in the size of fiscal multipliers—such as trade openness, capital mobility, exchange rate regime, debt-to-GDP ratio, economic development.[6] Importantly, we find that irrespective of the level of development (and the degree of institutional quality), economies characterized by a low degree of informality display a higher cumulative fiscal multiplier than countries with high degree of informality. Interesting, the opposite does not hold—that is, we do not find higher fiscal multipliers in developed than in developing economies when informality is high. Overall, this result confirms the important and independent role of informality in shaping the effectiveness of fiscal policy and suggests that informality is a key factor explaining why fiscal multipliers are lower in developing economies.

To rationalize these findings, we build a medium-size two-agent new-Keynesian (TANK) model which accounts for both the official and the informal economy sectors. Our main goal here is to identify

[6] See Chian and Koh, 2017, for a survey.

the propagation channels directly related to the size of informality and, at the same time, not related to countries' characteristics affecting fiscal multipliers (such as the degree of openness, economic development, institutional differences etc.). For this reason, our model abstracts from standard structural asymmetries that characterize DSGE models designed for developed/developing countries and focus exclusively on the size of informal sector. Our key assumption is the treatment of formal and informal goods as sectoral bundles that are imperfect substitutes in households' preferences, and sector-specific formal and informal firms produce such goods.[7] Our model shows that informality reduces the size of the public expenditure multiplier. The main mechanism is because high informality is associated with a stronger appreciation of the relative price of official goods that, in turn, triggers a reallocation of private spending towards unofficial goods. This ultimately weakens the official multiplier.

We extend the baseline model to incorporate non-separability between public and private consumption in households' preferences.[8] In our context, non-separability can be useful only if low (high) informality is associated to complementarity (substitutability) between public and private goods. In fact, we find that a degree of complementarity close to the value typically assumed in DSGE models of the US economy is sufficient to replicate our estimates for the low-informality case. The results show that a relatively strong degree of substitutability contributes to even lower multipliers in economies with high informality.

[7] The assumption of imperfect substitutability between formal and informal goods in household preferences is akin to Fernández and Meza (2015), but in their contribution the informal goods are produced by self-employed workers who do not use physical capital. Here, we follow La Porta and Shleifer (2008), who report that informal firms have at least two employees and use some physical capital even if they are extremely less productive than official firms. They also document that episode of firms transition out of informality are irrelevant.

[8] According to Leeper, Traum, and Walker (2017), the degree of complementarity between private and public goods is the most important parameter for determining the (relatively large) magnitude of the fiscal multiplier in the US. Cross-country studies convey a mixed picture. Nieh and Ho (2006) conclude in favor of complementarity in OECD countries, whereas substitutability is supported by Kwan (2009) for several East Asia countries, by Auteri and Costantini (2010) for a panel of 15 Western European countries, and by Dawood and Francois (2018) for a number of African countries. By contrast, Jalles and Karras (2021) find that private and government consumption are best described as complementary for a large number of heterogeneous economies over the period 1970–2016.

Our theoretical approach adds to recent developments in the literature on informal business cycle models. In this literature, much of the emphasis has been placed on how the imprecise measurement of the informal economy can explain the excess volatility of consumption growth in developing countries (Restrepo-Echavarria, 2014) and the asymmetric response of countries following financial crises (Colombo, Onnis, and Tirelli, 2016; Colombo, Menna, and Tirelli, 2019). The presence of a large informal sector also adds volatility to the labour market (Gomes et al. 2020) and to TFP growth (Leyva and Urrutia, 2020). Horvath and Yang (2022) show that the informal sector amplifies the responses of formal output, consumption, and employment to productivity and interest rate shocks. With specific reference to the role of informality in the transmission of fiscal shocks, to the best of our knowledge, ours is the first theoretical contribution that identifies the relative price of informal goods as the key transmission channel. In fact, previous contributions typically assume that firms produce homogeneous goods, and that tax and law enforcement frictions identify the fraction of production which is produced in the underground economy (Busato and Chiarini 2004; Orsi, Raggi, and Turino 2014). Existing studies of fiscal policies under informality essentially rely on this framework and emphasize the labor reallocation effects of the public expenditure shocks (Pappa et al., 2015; Dellas et al., 2017; Junior et al 2021). These contributions ultimately emphasize transmission channels that are determined by governments' ability to enforce tax collection and corruption and generally relate to institutional quality and to the level of development. By contrast, the transmission channel identified here, based upon adjustments in the relative price effect, is largely independent from the social infrastructure of the country, in line with our empirical finding that informality affects multipliers even if one accounts for measures of institutional quality and of economic development. Further, our emphasis on the different degrees of non-separability between public and private consumption does not imply any obvious mapping with institutional quality.

The remainder of the paper is structured as follows. Section 2 presents the data and the methodology used. Section 3 illustrates the empirical results. Section 4 describes the model and its implications, finally Section 5 concludes and discusses some policy implications. The Appendix contains additional empirical results and robustness checks as well as the formal derivation of the steady state of the model.

2. Data and methodology

2.1 Identification of fiscal shocks

Given the focus on large set of countries, the scarcity of publicly available official documentation prevents the use of the narrative approach (Romer and Romer 2010; Guajardo et al. 2014; Carriere-Swallow et al. 2021) to identify fiscal shocks. Further, lack of government spending data at the quarterly frequency precludes the use of SVARs. Therefore, in line with Furceri and Zdzienicka (2020), we extend the approach developed in Auerbach and Gorodnichenko (2012) and we identify unexpected fiscal policy shocks using forecast errors in government spending.[9] This is done in two steps. In the first step, we compute the t-period forecast error for public spending for country i, $FE_{i,t|t-1}$:

$$FE_{i,t|t-1} = \Delta \ln G_{i,t} - \Delta \ln G_{i,t|t-1} \quad (1)$$

where $\Delta \ln G_{i,t}$ defines the actual government spending growth rate and $\Delta \ln G_{i,t|t-1}$ is the $t-1$ IMF forecast for $\Delta \ln G_{i,t}$ made at time $t-1$. As demonstrated by An et al. (2018), WEO forecasts of fiscal variables are usually very accurate, especially when compared to those of the private sector. The most likely reason is the continuous information flow between the IMF and finance ministries of the various member countries. Therefore, it is highly unlikely that forecast errors computed according to the methodology above might be dominated by what Ricco (2015) labels "misperceptions about fiscal

[9] Consistent with OECD definitions and the previous literature on fiscal multipliers, our government spending series is the sum of real public consumption expenditure and real government gross capital formation.

changes". Moreover, using the forecast made in October of the same year further increases the chances that forecast errors capture unexpected policy changes rather than mere misperceptions. Finally, this methodology solves by construction the problem of "fiscal foresight", which arises when agents react to anticipated rather than realized shocks.[10]

We use the forecasts of government expenditures made in October of the same year to minimize the likelihood that unanticipated changes in government spending arise due to the potentially endogenous response of fiscal policy to the state of the economy.[11] In fact, even if shocks are unanticipated, they may still occur in response to business cycle conditions: for example, the government may be forced to cut spending because growth turns out to be unexpectedly weak. However, to affect our estimates, such adjustments need to happen within the same quarter when news about the state of the economy is received (i.e., between October and December).[12] This is highly unlikely given implementation lags associated with the legislative process (see also Blanchard and Perotti, 2002). In the second step, the forecast error is purged from any predictable components by projecting it on lags of several macroeconomic variables (output, government spending, government revenue, real exchange rate, and inflation) and taking the residual of this projection as the fiscal shock.

Figure A1 in the Appendix reports the distributions of government spending shocks for the entire sample, as well as for advanced and developing economies. The average (median) of the shock is about -0.1 (0.02) percent, while the bulk of the shocks (between the 1st and the 99th percentile) ranges between

[10] See, for instance, Forni and Gambetti (2010), Leeper et al. (2012), Leeper et al. (2013), and Ben Zeev and Pappa (2015). Agents receiving news about future changes in government spending may alter their consumption and investment decisions well before the changes occur. An econometrician who uses the information contained in the change in actual spending would be relying on an information set other than that used by economic agents, and this may lead to biased estimates. By using forecast errors, the econometrician's information is aligned to that of economic agents.

[11] In the next section, we show that the results are robust to using the forecasts of government expenditures made in April of the same year.

[12] All fiscal and junctural information up to October of a given year is incorporated in the forecasts made in October.

-64 and 72 percent. Table A1 in the Appendix reports descriptive statistics (average, standard deviation, min and max) for each country.

Our shocks satisfy three key characteristics of exogenous shocks, according to Ramey (2016). First, they should be exogenous with respect to the other current and lagged endogenous variables in the model. To test for this feature, we follow Jordà and Taylor (2016) and regress the fiscal shocks against a set of endogenous macroeconomic variables such as lagged output gap, lagged public debt-to-GDP ratios, and contemporaneous change in revenue. The results reported in Table A2 show that none of these variables is significantly correlated with our fiscal shocks. Second, they should be uncorrelated with other exogenous shocks. To test for this possibility, we examine the correlation between the fiscal shocks and other demand shocks such as the monetary policy shocks identified by Furceri et al. (2017) and the World Uncertainty Index by Ahir, Bloom and Furceri (2022). The results reported in Table A3 show that these correlations are close to zero. Third, they should represent either unanticipated movements in exogenous variables or news about future movements in exogenous variables. This property is satisfied by construction as the fiscal shocks are identified as unexpected changes in government spending.

2.2 Shadow economy and other macroeconomic data

The GDP data used in the analysis are on yearly basis and are taken from the IMF World Economic Outlook database. To estimate the shadow economy, we use two alternative measures commonly used in the literature (Colombo et al. 2019; Ahamed et al. 2021). The first is from Medina and Schneider (2018), who use the Multiple Indicators Multiple Causes model (MIMIC). This is essentially a structural model where the shadow economy is estimated from a system of equations composed of economic and institutional variables. The second one is from a deterministic dynamic general equilibrium (DGE) model proposed by Elgin and Oztunali (2012) and updated in Elgin et al. (2019). Using a two-sector (official and the shadow economies) dynamic general equilibrium model, the authors developed an approach to

estimate the size of the shadow economy that overcomes three main issues of other existing measures: (i) it does not rely on ad-hoc econometric specifications and assumptions; (ii) it does not estimate the size of the shadow economy using statistical methods; (iii) it does not include statistical errors and, it does not lack micro-foundations.

Both approaches estimate informal output in percent of official GDP.[13] Our estimation sample covers an unbalanced panel of 141 countries over the period 1995–2015. Table A4 and A5 provide the list of countries included in the analysis as well as key descriptive statistics regarding informality.

2.3 Methodology

We start by estimating the unconditional cumulative fiscal multiplier using the local projection method as in Jordà (2005). Following Ramey and Zubairy (2018), we compute the cumulative fiscal multiplier by instrumenting government expenditures to GDP with our identified fiscal policy shocks. In particular, we estimate the following equation:

$$\sum_{j=0}^{k} y_{i,t+j} = \alpha_i^k + \gamma_t^k + m_h \sum_{j=0}^{k} g_{i,t+j} + \theta^k X_{i,t} + \omega_{i,t+k} \qquad (2)$$

using $shock_{i,t}$ as an instrument for $\sum_{j=0}^{k} g_{i,t+j}$. Here, $y_{i,t}$ is the log of GDP for country *i* in year *t;* α_i are country fixed effects, included to control for all time-invariant differences across countries (such as countries' average growth rates); γ_t are time fixed effects, included to take account for global shocks such as shifts in oil prices or the global business cycle; $shock_{i,t}$ is the government spending shock discussed above; $\sum_{j=0}^{k} y_{i,t+j}$ is the sum of the GDP variable from *t* to *t*+*k* for country *i*; $\sum_{j=0}^{k} g_{i,t+j}$ is

[13] Two alternative methods, namely the modified total electricity approach as in Colombo et al. (2016), and the currency demand approach typically require base year estimates of the shadow economy size, which are difficult to obtain.

the sum of the government spending from t to $t+k$ for country i; $X_{i,t}$ is a set of control variables including four lags of the dependent variable as well as four lags of government expenditure to GDP.[14]

Next, we analyze how the magnitude of the fiscal multiplier varies across countries depending on the level of informality. For this purpose, we follow the approach of Ramey and Zubairy (2018) and Auerbach and Gorodnichenko (2013a, 2013b) and estimate the following equation:

$$\sum_{j=0}^{k} y_{i,t+j} = \alpha_i^k + \gamma_t^k + F(z_i)[m_{hL} \sum_{j=0}^{k} g_{i,t+j}] + \big(1 - F(z_i)\big)[m_{hH} \sum_{j=0}^{k} g_{i,t+j}] + \theta^k X_{i,t} + \omega_{i,t+k} \qquad (3)$$

with $F(z_i) = \frac{exp^{-\gamma z_i}}{(1+exp^{-\gamma z_i})}$

where z_i is the indicator of shadow economy (s_i) normalized to have zero mean and a unit variance, that is, $z_i = \frac{s_i - \bar{s_i}}{sd(s_i)}$. To reduce endogeneity, due to the response of informality to fiscal shocks, we consider for each country the average size of informality over time ($s_i = \overline{s_{it}}$). The weights assigned to each regime vary between 0 and 1 according to the weighting function $F(.)$, so that $F(z_i)$ can be interpreted as the probability of country to have a given level of informality. The parameter γ controls the smoothness of the transitions from one regime to another with larger values being associated to immediate switches, while smaller ones implying a smoother transition. We follow Auerbach and Gorodnichenko (2011) and calibrate rather than estimate the parameters of the smooth transition model, for the same reasons they cite—it is difficult in practice to identify the curvature and location of the transition function in the data—and given the need for distributional assumptions on the error term when estimating by maximum likelihood. In the baseline estimate, we set γ=5 to give an intermediate degree of intensity to the regime switching, but we show that the results are robust to alternative values.

[14] A similar lag structure is used by Ilzetzki et al. (2013).

The coefficient m_{hL} is the coefficient in the case of low informality (when $z \rightarrow$-∞) and m_{hH} is the coefficient in the case of high informality (when $z \rightarrow \infty$). Finally, we use the interaction terms $[shock_{i,t} * F(z_i)]$ and $[shock_{i,t} * (1 - F(z_i))]$ as instruments for the respective interaction of cumulative government spending with the two state indicators.

This approach to model interaction is equivalent to the smooth transition model developed by Granger and Teravistra (1993). Its advantages are threefold. First, compared with a model in which each dependent variable is interacted with a measure of informality, it permits a direct test of whether the effect of fiscal policy varies across different regimes such as low and high informality. Second, compared to a linear interaction model, it allows the magnitude of fiscal multipliers to vary non-linearly as a function of informality. Third, compared with estimating structural vector autoregressions for each regime it allows the effect of fiscal policy to change smoothly between regimes by considering a continuum of states to compute the impulse response functions, thus making the response more stable and precise. In the robustness checks section, we also test for alternative specifications such as those based on linear interactions and a dummy variable approach capturing whether the share of the shadow economy is above or below the median.

3. Results

3.1 Baseline

Figure 1 shows the cumulative fiscal multiplier at each time horizon obtained using the baseline regression for the entire sample.[15] Time is on the *x*-axis; the solid line portrays the average estimated response, while the grey area the 90 percent confidence interval. In line with previous literature (i.e.,

[15] As shown in Figures A2 and A3 (for non-linear effects) results are very similar when using the forecasts of government expenditures made in April of the same year instead of those made in October.

Ramey and Zubairy 2018, Cacciatore et al. 2021), we find that expansionary fiscal policy leads to a significant increase in output over the four-year period following the shock. The implied cumulative fiscal multiplier is about 0.25 one year after the shock, and about 0.6 four years after the shock.

The estimated multipliers are well in the range of multipliers obtained using a large set of advanced, emerging and developing economies (Batini et al. 2014). Based on a survey of 41 such studies, Mineshima et al. (2014) show that first-year multipliers amount on average to 0.75 for government spending in advanced economies. For developing countries, the literature is much scarcer but studies comparing multiplies across country suggest that multipliers in developing economies are smaller than in advanced economies (Ilzetzki et al., 2013; Ilzetzki, 2011; and Kraay, 2012). Ilzetzki (2011) finds that in developing economies spending multipliers range from 0.1 to 0.3.

We then turn to our main empirical result, namely how the effect of fiscal shocks on output varies across countries depending on the level of informality (Figure 2). The results suggest that in countries characterized by very low informality (i.e., with a share of shadow economy below 17% of GDP), the output response to government spending shocks is positive and statistically significant at all horizons, with an implied cumulative medium-term fiscal multiplier of about 2. In contrast, in countries with a very high share of informal economy (i.e., with a share of shadow economy above 44% of GDP), the effect of government spending shocks is smaller and not statistically significantly different from zero. This result holds for both measures of informality. Moreover, the difference in the estimated multipliers is statistically significantly different from zero at all time horizons for the DGE measure of informality, and up to the first two horizons for the MIMIC measure (Table A6).

To check the robustness of our results we performed several exercises. First, we examined whether our baseline results for the unconditional cumulative multiplier were driven by the lag structure choice. Reassuringly, Figure A4 in the appendix shows that this is not the case: regardless of the number of the lags for the (log of) GDP and for the government expenditures to GDP ratio, the results are very

similar and broadly unchanged with respect to the baseline. Further, Figure A5 shows that the results are similar and not statistically different across alternative specification such as those obtained including: (i) only country fixed effects; (ii) country fixed effects and country-specific time trends at the same time; (iii) country-specific time trends in addition to country and time fixed effects. Next, we re-estimated our model assigning different values to the parameter γ. The results presented in Table A7 show that the effects obtained when changing γ from 3.6 to 6.5 are similar to, and not statistically different from those shown in Figure 2.

We also considered alternative ways to examine how the fiscal multipliers vary with the level of informality. First, we considered a simple linear interaction between government spending and the degree of informality:

$$\sum_{j=0}^{k} y_{i,t+j} = \alpha_i^k + \gamma_t^k + [m_h \sum_{j=0}^{k} g_{i,t+j}] + S_i[m_{hs} \sum_{j=0}^{k} g_{i,t+j}] + \theta^k X_{i,t} + \omega_{i,t+k} \quad (4)$$

Second, we re-estimated equation (3) substituting the smooth transition function with a simple dummy capturing whether the share of the shadow economy is above or below the median. Tables A8 and A9 in the appendix show that results are robust also to these specifications.

Overall, these results suggest that informality is an important factor influencing the magnitude of the fiscal multiplier. And while we acknowledge that any measure of the shadow economy is subject to measurement errors, the fact that results are robust to two measures obtained with largely different approaches and methodologies is very comforting. Moreover, a large measurement error in the degree of informality, that is not systematically correlated with country characteristics, is likely to bias our results toward finding similar effects for low and high informal economies.

3.2 Is informality a proxy for other well-established factors?

A potential concern with our result is that the level of informality may be correlated with other countries' structural features that also affect the magnitude of fiscal multipliers—such as the level of income, trade and financial openness, the type of exchange rate regime, the initial level of public debt and the quality institutions (see Ilzetzki et al. 2013; Avellan et al. 2020). To address this issue, we extend equation (3) by including as control variables the interaction of government spending with these countries' characteristics:

$$\sum_{j=0}^{k} y_{t+j} = \alpha_i^k + \gamma_t^k + F(z_{it})[m_{hL} \sum_{j=0}^{k} g_{t+j}] + \big(1 - F(z_{it})\big)[m_{hH} \sum_{j=0}^{k} g_{t+j}] + \eta^k \sum_{j=0}^{k} g_{t+j} (\bar{u}_i - \bar{u}) + \theta^k X_{i,t} + \omega_{i,t+k} \quad (5)$$

where u alternatively is an indicator of: trade and financial openness (from KOF database[16]); the exchange rate regime (from Ilzetzki et al. 2013); the debt-to-GDP ratio (from the World Economic Outlook database); the level of development (log of GDP per capita from the World Economic Outlook database); institutional quality (defined as the Law and Order component of the International Country Risk Guide – ICRG).[17] Similar to the baseline analysis, we use $shock_{i,t} * (\bar{u}_i - \bar{u})$ as instrument for the interaction term $\sum_{j=0}^{k} g_{t+j} (\bar{u}_i - \bar{u})$, where $\bar{u}_i$ and $\bar{u}$ respectively are the country average and the sample average of u. We demean each variable $\bar{u}_i$ so that the response obtained for the average country (when $\bar{u}_i - \bar{u} = 0$) is as in the baseline specification (equation (3)).[18]

[16] Gygli et al. (2019).

[17] The International Country Risk Guide (ICRG) rating comprises 22 variables in three subcategories of risk: political, financial, and economic. The "Law and Order" component assesses the strength and impartiality of the legal system (the "Law" element) as well as the popular observance of the law (the "Order" element) of a country. For more details see: https://www.prsgroup.com/explore-our-products/international-country-risk-guide.

[18] The finding that the cumulative multipliers is statistically significantly higher in countries with low informality also holds when these additional controls are not demeaned.

We estimate equation (5) separately for each indicator *u*, also including all the controls at the same time. The results shown in Table 1 and Table A10 point to very similar results to those shown in Figure 2 thus confirming informality as an independent driver of the magnitude of the fiscal multiplier.

3.3 The role of the shadow economy and level of economic development and institutional quality

The literature has shown that fiscal multipliers differ between advanced and developing countries (i.e. Ilzetzki et al. 2013) and according to their level of institutional quality (Avellan et al. 2020). At the same time, it is also well known that the level of development and the quality of the institutions are inversely related to the share of the informal economy. Therefore, to further confirm that the impact of the level of informality on fiscal policy transmission is independent from income per capita and institutional quality, we interact government spending with the smooth transition functions of informality and, alternatively, with the smooth transition functions of the level of income per capita or the institutional quality (proxied by the Law and Order component of the International Country Risk Guide); in other words, we consider triple interactions. With this approach—by looking at the differences in responses between low-informality low-income versus high-informality low-income and low-informality high-income vs. high-informality high-income—we can compute the marginal contribution of the informality for a given level of income or institutional quality (and vice versa). In particular, we estimate the following equation:

$$\sum_{j=0}^{k} y_{t+j} = \alpha_i^k + \gamma_t^k + F(x_{it})\{F(z_{it})[m_{hL}\sum_{j=0}^{k} g_{t+j} + \theta_L^k X_{i,t}] + \big(1 - F(z_{it})\big)[m_{hH}\sum_{j=0}^{k} g_{t+j} + \theta_L^k X_{i,t}] + (1 - F(x_{it}))\{F(z_{it})[m_{hL}\sum_{j=0}^{k} g_{t+j} + \theta_L^k X_{i,t}] + \big(1 - F(z_{it})\big)[m_{hH}\sum_{j=0}^{k} g_{t+j} + \theta_L^k X_{i,t}] + \omega_{i,t+k} \quad (6)$$

with $F(z_{it}) = \frac{exp^{-\gamma z_{it}}}{(1+exp^{-\gamma z_{it}})}$; $F(x_{it}) = \frac{exp^{-\gamma x_{it}}}{(1+exp^{-\gamma x_{it}})}$;

where z is an indicator of shadow economy, x is, alternatively, an indicator of level of development (the log of GDP per capita) or institutional quality, normalized to have zero mean and a unit variance.

Figures 3 and 4 report the results. Looking at Figure 3 it is clear that, irrespective of the level of development (and the specific measure of informality), economies characterized by a low degree of informality display a relatively higher cumulative fiscal multiplier. Moreover, the difference in the response between low and high informality is statistically significant at 90% level for all the periods considered in less developed countries, while it is statistically significant only in the short term for developed economies. Overall, these results confirm the important role of informality for the fiscal policy transmission, even when conditioning on the level of development. Moreover, the results in Table A11 show that the fiscal multipliers do not vary significantly between high- and low-income countries when conditioning for the level of informality, suggesting that the level of informality is a key element explaining difference in fiscal multipliers between advanced and developing economies.

We obtain very similar results when repeating the analysis for institutional quality. Regardless of the level of institutional quality, countries characterized by low informality display a larger cumulative fiscal multiplier than economies with high informality (Figure 4). In addition, when conditioning for the level of informality, the fiscal multipliers do not vary significantly between countries with different levels of institutional quality suggesting that the level of informality is also in this case a key element explaining the difference in fiscal multipliers between countries with different levels of institutional quality (Table A12).

4. The model economy

As the previous section has shown, the informal economy is a key determinant of the size of the multiplier irrespective of the level of development and of measures of institutional quality. To rationalize this result,

we develop a theoretical model to identify an amplification mechanism for fiscal shocks that is determined by the size of the informal sector but is not related to the quality of institutions or to other standard features that distinguish developing and advanced economies. For this reason, in our modelling choice we do not target a specific type of economy but build a standard two-sector DSGE model where the difference between the official and the informal sector is limited to: i) the capital intensity of informal firms, ii) the taxation of factor incomes; iii) the steady-state size of the informal sector; and iv) the sign of non-separability between private and public goods. This strategy allows us also to be more prudent in the choice of the parameters for calibration (section 4.6) as we can refer to a well-established literature.

In our model, monopolistically competitive firms produce sectoral goods in the official (o) and and in the informal (s) sectors. Our characterisation of the informal economy follows the literature and is consistent with a well-known "stylized fact": firms operating in this sector have access to a relatively more labor-intensive production technology (Amaral and Quintin 2006; Koreshkova 2006). Only factor incomes earned in the official sector are taxed. Sectoral goods are then sold to consumers and to investment goods producers. In our setting, the existence of the informal sector is justified by both consumption and investment decisions. Figure 5 offers a bird's eye view of the model structure.

Following Fernández and Meza (2015) and Restrepo-Echavarria (2014), household preferences over the goods produced in sector j, $(j = o, s)$, of the economy are defined as follows:

$$c_t = \left[(1-\alpha_c)^{\frac{1}{\varepsilon}}(c_t^o)^{\frac{\varepsilon-1}{\varepsilon}} + (\alpha_c)^{\frac{1}{\varepsilon}}(c_t^s)^{\frac{\varepsilon-1}{\varepsilon}}\right]^{\frac{\varepsilon}{\varepsilon-1}} \qquad (7)$$

and

$$P_t^C = [(1-\alpha_c)(P_t^o)^{1-\varepsilon} + \alpha_c(P_t^s)^{1-\varepsilon}]^{\frac{1}{1-\varepsilon}} \qquad (8)$$

defines the consumption price index. It follows that demand functions for the sectoral consumption bundles, o and s, are:

$$c_t^o = (1-\alpha_c)\left(\frac{P_t^o}{P_t^C}\right)^{-\varepsilon} c_t \qquad (9)$$

$$c_t^s = \alpha_c \left(\frac{P_t^s}{P_t^C}\right)^{-\varepsilon} c_t \qquad (10)$$

We exploit ε to introduce relative price effects in the demand for o and s goods and set α_c to characterize the steady-state share of the shadow economy, conditional to sectoral differences in technologies and on tax distortions. In each sector we have that:

$$c_t^j = \left(\int_0^1 c_t^j \left(z^j\right)^{\frac{\sigma^j - 1}{\sigma^j}} dz^j\right)^{\frac{\sigma^j}{\sigma^j - 1}} \qquad (11)$$

and the associated sectoral retail price index is:

$$P_t^j = \left(\int_0^1 \left(P_t^j(z)\right)^{1-\sigma^j} dz\right)^{\frac{1}{1-\sigma^j}} \qquad (12)$$

It follows that the demand functions for individual goods within each sectoral consumption bundle are:

$$c_t\left(z^j\right) = \left(\frac{P_t^j(z^j)}{P_t^C}\right)^{-\sigma^j} c_t^j \qquad (13)$$

Investment goods producers are characterized by a technology symmetrical to consumers' preferences:[19]

$$I_t = \left[(1-\alpha_I)^{\frac{1}{\varepsilon}}\left(q_t^{I,o}\right)^{\frac{\varepsilon-1}{\varepsilon}} + (\alpha_I)^{\frac{1}{\varepsilon}}\left(q_t^{I,s}\right)^{\frac{\varepsilon-1}{\varepsilon}}\right]^{\frac{\varepsilon}{\varepsilon-1}} \qquad (14)$$

where $q_t^{I,o}$ and $q_t^{I,s}$ define the quantities of official and informal goods used to produce I_t. The investment price index is

$$P_t^I = [(1-\alpha_I)(P_t^o)^{1-\varepsilon} + \alpha_I (P_t^s)^{1-\varepsilon}]^{\frac{1}{1-\varepsilon}} \qquad (15)$$

Demand functions for the sectoral consumption bundles, o and s, are:

$$q_t^{I,o} = (1-\alpha_I)\left(\frac{P_t^o}{P_t^I}\right)^{-\varepsilon} I_t \qquad (16)$$

$$q_t^{I,s} = \alpha_I \left(\frac{P_t^s}{P_t}\right)^{-\varepsilon} I_t \qquad (17)$$

[19] The idea is derived from medium-scale open economy DSGE models (Christoffel et al. 2008; Ratto et al. 2009) where investment goods, just like consumption goods, are a bundle of sectoral goods.

whereas the market clearing condition for the I-goods sector is

$$I_t = I_t^o + I_t^s \qquad (18)$$

Following Galí, López-Salido, and Vallés (2007), we incorporate Limited Asset Market Participation (LAMP). The LAMP hypothesis draws a distinction between a fraction of Ricardian households who are asset holders and smooth their consumption over the business cycle, and the remaining share of Non-Ricardian households who do not participate in financial markets and entirely consume their current disposable income in each period. LAMP allows to characterize a simple two-agent new Keynesian (TANK) model that provides a reasonable approximation to fully-fledged heterogeneous-agent (HANK) models where some households are subject to occasionally binding constraints (see Debortoli and Galí (2017)).[20]

Furthermore, we allow for non-separability between private and public goods consumption (Bouakez and Rebei, 2007). In practice, we postulate a "consumption" bundle characterized by a constant elasticity of substitution between public and private goods.

$$\tilde{C}_t^i = \left[\gamma_c^{\frac{1}{e}}\left(c_t^i\right)^{\frac{e-1}{e}} + (1-\gamma_c)^{\frac{1}{e}}(G_t)^{\frac{e-1}{e}}\right]^{\frac{e}{e-1}} \qquad (19)$$

where $(1-\gamma_c)$ represents the share of public goods in the bundle, and e is the elasticity of substitution between private and public goods ($e \to 0(\infty)$ implies perfect complementarity(substitutability)). Under (18) the marginal utility of consumption for household i is:

$$\lambda_t^i = \left[\gamma_c^{\frac{1}{e}}\left(c_t^i\right)^{\frac{e-1}{e}} + (1-\gamma_c)^{\frac{1}{e}}(G_t)^{\frac{e-1}{e}}\right]^{-1} \gamma_c^{\frac{1}{e}}\left(c_t^i\right)^{-\frac{1}{e}} \qquad (20)$$

An appropriate calibration of e is sufficient to generate a positive (negative) comovement between the fiscal shock and the marginal utility of consumption, triggering an increase (reduction) in

[20] Estimated TANK models can be found in Kollmann et al. (2016), Albonico, Paccagnini, and Tirelli (2017, 2019). See Havranek and Sokolova (2020) for an extensive review of the literature. Hagedorn, Manovskii, and Mitman (2019) discuss the size of fiscal multipliers in HANK and TANK models.

household demand for consumption goods in addition to the standard negative wealth effect caused by the increase in expected taxation.[21] In order to sharpen the intuition, we keep the rest of the model as simple as possible, neglecting labor matching frictions and non-trivial financial institutions.[22]

4.1 Households

Households' preferences are:

$$U_t = E_t \sum_{k=o}^{\infty} \beta^k \left\{ \ln\left(\tilde{C}_{t+k}^i\right) - \left(\frac{\chi\left(l_{t+k}^i\right)^{1+\phi}}{1+\phi} \right) \right\} \qquad (21)$$

In the labor market, each household *(i)* supplies a continuum of differentiated labor types, l^i. Following Leeper et al. (2017), fully competitive labor packers aggregate these labor types into the bundle l_t^d, that is then sold to firms. Their demand for the generic labor type h, $h \in [0,1]$, is:

$$l_t^{h,i} = \left(\frac{W_t^h}{W_t}\right)^{-\eta_w} l_t^d \qquad (22)$$

where $\frac{W_t^h}{W_t}$ defines the type-specific relative wage and $W_t = \left(\int_0^1 \left(W_t^h\right)^{(1-\eta_w)} dh\right)^{\frac{1}{(1-\eta_w)}}$ is the aggregate wage index. Households delegate wage-setting decisions to type-specific unions and then supply labor on demand. As in Galí, López-Salido, and Vallés (2007), we assume that the fraction of Ricardian and non-Ricardian households is uniformly distributed across unions and the aggregate demand for each labor type is uniformly distributed across households. Therefore, optimizers and rule of "thumbers" always supply the same amount of labor.

[21] Due to LAMP, non-separable preferences apparently play a limited role because non-Ricardian households are restricted in their consumption decisions. It should be noted, however, that wage-setting decisions incorporate the non-Ricardian households marginal utility from consumption and their intertemporal budget constraint (see conditions (36-37) below).

[22] Shadow-economy models in Colombo, Onnis, and Tirelli (2016) and Colombo, Menna, and Tirelli (2019) incorporate such extensions.

Ricardian households

There is a fraction $(1-\omega)$ of Ricardian households. The Ricardian household's flow budget constraint in consumption units is:

$$c_t^O + \frac{P_t^I}{P_t^C}(I_t^o + I_t^s) + \frac{B_t}{R_t P_t^C} = \frac{P_t^o}{P_t^C}\left[(1-\tau^k)\left(r_t^{k,o} - \delta\right)k_{t-1}^o + (1-\tau^w)w_t^o \frac{P_t^o}{P_t} l_t^o + \Pi_t^o - \tau_t^{LS}\right] + \frac{B_{t-1}}{P_t^C} + \frac{P_t^s}{P_t^C}\left[\left(r_t^{k.s} - \delta\right)k_{t-1}^s + w_t^s l_t^s + \Pi_t^s\right] \quad (23)$$

where k_t^s,I_t^s and k_t^o,I_t^o are the sectoral capital stock and investment, $r_t^{k,o}$ and $r_t^{k,s}$ are the sectoral rental prices of capital, δ is the capital depreciation rate, τ^k is the capital income tax rate, Π^o Π^s and τ_t^{LS} respectively define sectoral profits and real lump-sum taxes, w_t^s and w_t^o are the sectoral production wages.

The intertemporal Euler equations for government bonds and for sectoral capital stocks $(j = o, s)$ are:

$$\lambda_t^{Opt} = \beta E_t \frac{\lambda_{t+1}^{Opt}}{\pi_{t+1}} R_t \quad (24)$$

$$1 = \beta E_t \frac{\lambda_{t+1}^{Opt}}{\lambda_t^{Opt}} \frac{\left[q_{t+1}^j(1-\delta) + \frac{P_{t+1}^j}{P_{t+1}^C} r_{t+1}^{k,j}\left(1-\tau^{k,j}\right)\right]}{q_t^j} \quad (25)$$

where q_t^j is the sectoral relative price of capital, defined in terms of the consumption bundle and π_t defines the consumer price inflation rate. Accumulation of k_t^j is driven by:

$$k_t^j = (1-\delta)k_{t-1}^j + \left[1 - S\left(\frac{I_t^j}{I_{t-1}^j}\right)\right] I_t^j \quad (26)$$

where $S\left(\frac{I_t^j}{I_{t-1}^j}\right) = \frac{\gamma_I}{2}\left(\frac{I_t^j}{I_{t-1}^j} - 1\right)^2$ defines investment adjustment costs. The first order condition for sectoral investment decisions is:

$$\frac{P_t^I}{P_t^C} = q_t^j \left\{1 - \gamma_I\left(\frac{I_t^j}{I_{t-1}^j} - 1\right)\frac{I_t^j}{I_{t-1}^j} - \frac{\gamma_I}{2}\left(\frac{I_t^j}{I_{t-1}^j} - 1\right)^2\right\} + \beta \frac{\lambda_{t+1}^{Opt}}{\lambda_t^{Opt}} q_{t+1}^j \gamma_I \left(\frac{I_{t+1}^j}{I_t^j} - 1\right)\left(\frac{I_{t+1}^j}{I_t^j}\right)^2 \quad (27)$$

Non-Ricardian households

Non-Ricardian households entirely consume their current disposable income in each period[23]

$$c_t^{Rot} = \frac{P_t^o}{P_t^C} w_t^o l_t^o (1 - \tau^w) + \frac{P_t^s}{P_t} w_t^s l_t^s \qquad (28)$$

4.2 Firms

Sectoral goods producers ($j = s, o$) have access to the production technology:

$$y_t^j = A_t^j \left(k_{t-1}^j\right)^{\alpha^j} \left(l_t^j\right)^{1-\alpha^j} \qquad (29)$$

where y_t^j, k_t^j, h_t^j respectively define sector-specific output, capital and labor inputs. Firms maximize their profits subject to (13) and to a Rotemberg (1982) quadratic cost of nominal price adjustment:

$$\frac{\varphi}{2}\left(\pi_t^j - 1\right)^2$$

where $\pi_t^j = \frac{P_t^j}{P_{t-1}^j}$ denotes the sectoral gross inflation rate.

Factor demands are:

$$w_t^j = \left(1 - \alpha^j\right) mc_t^j \left(\frac{y_t^j}{l_t^j}\right) \qquad (30)$$

and

$$r_t^{k,j} = \alpha^j p_t^{I,j} mc_t^j \left(\frac{y_t^j}{k_{t-1}^j}\right), \qquad (31)$$

Where mc_t^j defines the marginal cost:

$$mc_t^j = \left(\frac{r_t^{k,j}}{\alpha^s}\right)^{\alpha^s} \left(\frac{w_t^j}{(1-\alpha^s)}\right)^{1-\alpha^s} \qquad (32)$$

In the symmetrical equilibrium, the price adjustment rule satisfies:

$$\left(\frac{(1-\sigma^j)}{\sigma^j} + mc_t^j\right)\frac{\sigma^j}{\varphi^j} + \beta \frac{\pi_{t+1}^j \lambda_{t+1}}{\pi_{t+1}\lambda_t} \frac{y_{t+1}^j}{y_t^j}\left[\left(\pi_{t+1}^j - 1\right)\left(\pi_{t+1}^j\right)\right] = \left(\pi_t^j - 1\right)\pi_t^j, \qquad (33)$$

[23] We assume that Non-Ricardian households do not pay lump-sum taxes.

and the sectoral price index is

$$P_t^j = P_{t-1}^j \pi_t^j. \qquad (34)$$

From (8) we also obtain that the inflation rate for the price index of the consumption bundle:

$$\pi_t = \frac{P_t^C}{P_{t-1}^C}. \qquad (35)$$

4.3 Labor market

The labor union h maximises

$$L^{u,h} = E_t \sum_{k=0}^{\infty} (\beta)^t \left\{(1-\omega) U^{Opt}\left(\tilde{C}_{t+k}^{Opt}\right) + \omega U^{Rot}\left(\tilde{C}_{t+k}^{Rot}\right) - U(l_{t+k})\right\}$$

subject to labor packers demand (22) and to a quadratic adjustment cost:

$$\frac{\xi_w}{2}\left(\frac{W_t^h}{W_{t-1}^h} - 1\right)^2 l_t.$$

In the symmetrical equilibrium, the wage setting equation is:

$$\frac{w_t \lambda_t}{\chi (l_t)^{\phi}} = \frac{\eta_w}{\eta_w - 1}\left\{1 - \left[\begin{array}{c} \frac{\xi_w}{\eta_w}\left(\frac{w_t}{w_{t-1}}\frac{\pi_t}{\pi_{t-1}^{\chi w}} - 1\right)\frac{w_t}{w_{t-1}}\frac{\pi_t}{\pi_{t-1}^{\chi w}} + \\ -\beta \lambda_{t+1}\frac{\xi_w}{\eta_w}\left(\frac{w_{t+1}}{w_t}\frac{\pi_{t+1}}{\pi_t^{\chi w}} - 1\right)\frac{l_{t+1}}{l_t}\frac{w_{t+1}}{w_t}\frac{\pi_{t+1}}{\pi_t^{\chi w}} \end{array}\right]\right\} \qquad (36)$$

where

$$\lambda_t = (1-\omega)\lambda_t^{Opt} + \omega \lambda_t^{Rot} \qquad (37)$$

Labor packers then supply the labor bundle to sectoral firms at the wage rate w_t. Therefore, the following sectoral conditions must hold:

$$w_t = w_t^s \frac{P_t^s}{P_t} \qquad (38)$$

$$w_t = w_t^o \frac{P_t^o}{P_t}(1 - \tau^w) \qquad (39)$$

4.4 Policy rules

A standard inflation-targeting rule drives monetary policy

$$R_t = \left[R(\pi_t^o)^{\phi_\pi}\right]. \qquad (40)$$

Public consumption is driven by

$$G_t = (1-\rho^G)G + \rho^G G_{t-1} + \varepsilon_t^G; \varepsilon_t^G \; i.i.d. \qquad (41)$$

where ε_t^G is the theoretical counterpart of our estimated policy shock.

The government budget constraint is:

$$G_t + \frac{B_{t-1}}{P_t^o} = \frac{B_t}{R_t P_t^p} + \tau^w w_t^o \frac{P_t^o}{P_t} l_t^o + \tau^k \left(r_t^{k.o} - \delta\right) k_{t-1}^o + (1-\omega)\tau_t^{LS} \qquad (42)$$

where lump-sum taxes, τ_t^{LS}, balance the intertemporal budget constraint in response to public consumption shocks.

4.5 Market clearing and aggregation

$$y_t^o = c_t^o + q_t^{I,o} + G_t + \frac{\varphi}{2} y_t^o \left(\pi_t^{R,o} - 1\right)^2 \qquad (43)$$

$$y_t^s = c_t^s + q_t^{I,s} + \frac{\varphi}{2} y_t^s (\pi_t^s - 1)^2 \qquad (44)$$

$$c_t = (1-\omega) c_t^{Opt} + \omega c_t^{Rot} \qquad (45)$$

The labor resource constraint is:

$$l_t = l_t^o + l_t^s \qquad (46)$$

4.6 Calibration

The values chosen for the household subjective discount factor, $\beta = 0.99$, and for the Frisch elasticity, $\frac{1}{\phi} = 1$, are standard. In the official sector, the price adjustment cost, $\varphi^o = 50$, is set at an intermediate level between Schmitt-Grohe and Uribe (2004) and Ozkan and Unsal (2012), The price-elasticity parameter $\sigma^o = 6$ is taken from Schmitt-Grohe and Uribe (2004). We choose an identical calibration for the labor market parameters $\eta_w = 6$, $\xi_w = 50$. Note that parameters φ^o and σ^o are crucial to characterize the slope of the Phillips curve. To the best of our knowledge, there is no evidence about price rigidities in the unofficial sector. We therefore take as benchmark the values adopted for the

nominal rigidities in the official sector and set $\varphi^s = \varphi^o$ and $\sigma^s = \sigma^o$. The degree of substitution between official and informal consumption bundles, ε, is set at 20.[24]

The official sector capital income share, $\alpha^o = 0.34$, and the capital depreciation rate, $\delta = 0.02$, follow the literature (Fernández and Meza, 2015). Turning to informal firms, to capture the relatively low capital intensity in their production function we have chosen the capital share parameter, $\alpha^s = 0.24$, as in Koreshkova (2006) . The steady-state relative capital labor ratio $\frac{k^o/l^o}{k^s/l^s}$ therefore amounts to 2.15. The parameter for investment adjustment costs γ_I is set at 4.

In the policy block, the Taylor rule parameter $\phi_\pi = 1.5$ is standard. Given the large differences observed in the sample, the choice of steady state values for fiscal variables is suggestive, but results are robust to alternative calibrations. We set a uniform tax rate on factor incomes: $\tau^k = \tau^w = 0.20$, as in Bi, Shen, and Yang (2016). The public-consumption- and public-debt-to-GDP ratios are set at the conventional 21% and 60% values. We calibrate the autoregressive parameter, $\rho^G = 0.93$, to match the persistence of the estimated public expenditure shock in the empirical analysis.

The fraction of non-Ricardian households, ω, is set at 0.25, as in Alichi, Shibata, and Tanyeri (2019).[25] We allow for both complementarity and substitutability between public and private goods, In the first case we set $\gamma_c = 0.7$, and $e = 0.4$, close to the values reported in Leeper, Walker, and Yang (2009) and Coenen, Straub, and Trabandt (2013). In the second case e is calibrated at 1.5. This latter choice is purely illustrative and identifies the degree of substitutability which is necessary to replicate the estimated effects of fiscal shocks in the high-informality scenario.

[24] Epstein and Finkelstein Shapiro (2017) set $\varepsilon = 5$. We experimented with this value, and our results were only marginally affected.

[25] This value is well below the estimates in Albonico, Paccagnini, and Tirelli (2017, 2019), and the value chosen in Shen, Yang, and Zanna (2018) to characterize a sample of least developed economies.

We calibrate α_c to set, $z = y^s/y^o$, the relative size of the informal economy in steady state. Schneider and Buehn (2007) document the large dispersion of this ratio, which is typically larger in developing countries. We calibrate z to match the levels of informality used for the empirical analysis and described in equation (3). More specifically, we choose: $[1 - F(\mathrm{z})] > 0.9, i.e. z \approx 45\%$, and $[F(\mathrm{z})] > 0.9,\ i.e. z \approx 15\%$ to characterize high(low)-informality cases discussed in section 3.4. Similarly, we set $z = 30\%, i.e.$ the average sample mean (Table A5). Finally, the parameter χ is set to obtain that $l = 1$ holds in the steady states associated to different shares of the informal sector. Table A13 reports all the parameters' values.

4.7 Theoretical multipliers

Our first simulation exercise replicates the unconditional cumulative multiplier obtained by empirical estimates (Figure 6). This result is obtained under separable preferences, and a share of the informal sector at 30%. The presence of an informal sector strongly reduces the cumulative multiplier relative to the no-informality case. Figures 7-8 report the theoretical IRFs. To begin with, consider aggregate variables (obtained by summing official and shadow economy variables) when $\mathrm{z} = 30\%$. Output and worked hours increase, whereas both investment and consumption fall. Ricardian households' consumption and saving decisions respond to the persistent real interest rate increase and to the negative wealth effect of the shock. Due to the limited number of non-Ricardian households, LAMP cannot prevent the aggregate consumption fall even if the consumption wage bill unambiguously increases.[26]

[26] Leeper et al. (2017) estimate for the US a fraction of non-Ricardian that is slightly larger than our calibrated value, but obtain that total households consumption increases on impact. This is essentially due to the presence in their model of frictions such as variable capacity utilization and consumption habits as well as to a different wage setting mechanism, where Ricardians optimally set their wage while non-Ricardians supply labor at the average wage.

Comparison with the IRFs obtained when $z = 0$ is instructive. In this case, the cumulative aggregate output multiplier is 40% larger and we observe a stronger response of labor. By contrast, both consumption and investment exhibit a more pronounced decline. All these effects occur because now the shock directly impacts on the whole economy. On the one hand, this implies a stronger fiscal demand pull. On the other hand, Ricardian households are exposed to a larger negative wealth effect that drives their consumption and investment decisions. Also note that the absence of an informal sector triggers a stronger increase in inflation and a more contractionary monetary stance. This latter effect also contributes to explain the observed transitions for consumption and investment.

Let us now turn to sectoral effects when $z = 30\%$. The informal output and labor responses are stronger than those observed in the official economy. In fact, the fiscal shock, whose direct effect only falls on official firms, causes a substantial appreciation in the relative price of official goods. This, in turn, triggers a persistent fall in the consumption of official goods, whereas informal consumption is above steady state for a prolonged period. The labor-market block (conditions 37-39) is crucial to rationalize these results. The fiscal shock raises labor demand and the consumption wage. Over the first 6 quarters, the official output response is stronger than the one observed for the shadow economy, therefore the relative marginal productivity of labor in the official sector must inevitably fall in this period. As a result, the relative price of official goods must increase to guarantee that official firms pay the market wage rate. In consequence of the demand diversion towards informal goods, we observe a substantial reduction in the cumulative multiplier computed for official output. In fact, by setting at zero the informal sector size, the theoretical model would predict a 30% increase in the multiplier!

The second set of simulations compares the high- and low-informality cases. IRFs, not shown for reasons of space, confirm the relative patterns outlined in Figure 7, when comparing the zero- and the 30%-informality cases. Official output multipliers (Figure 9) fall in the relative size of the informal sector. This happens because the larger the share of the informal sector, the stronger is the initial relative

increase in official output, and a greater relative price appreciation is therefore necessary for the labor market to be in equilibrium. Note that the ratio between the low- and the high-shadow cumulative multipliers is 1.33. By contrast, the shadow sector cumulative multiplier increases in the degree of informality. Thus, our analysis here points out that mismeasurement of the informal sector is one important reason why cross-country multipliers may differ.

In spite of the parsimonious modelling strategy we have chosen, which purposedly limits structural differences between high- and low-informality economies, and the discipline that our empirical analysis imposes on the values of z that characterize high(low) informality countries, our theoretical analysis does a good job in matching the unconditional multiplier and identifies a relative price effect that generates important differences in the multipliers predicted at the tails of the cross-country distribution of z.

Having said that, our simulations predict official output multipliers under low(high) informality that are close to the lower(higher) bound of the confidence bands obtained for the empirical multipliers (see Figure 10). For this reason, we explore the implications of non-separable preferences over public and private consumption. As pointed out in the introduction, complementarity between private and public consumption is crucial to rationalize the relatively large multiplier estimated for the US, and evidence exists in favor of complementarity in the bulk of OECD countries. It seems therefore natural to consider the role of complementarity in raising the theoretical multiplier when informality is low. By contrast, we incorporate substitutability for high informality countries, an assumption consistent with the findings in Dawood and Francois (2018) for a number of African countries. As shown in Figure 10, the predicted multipliers now match their empirical counterparts.[27]

[27] Our hypothesis that different patterns of non-separability might contribute to rationalize the strong differences in empirical fiscal multipliers at the tails of the informality distribution is consistent with the result that a model based on separable preferences can successfully replicate the unconditional empirical multiplier.

In Figures 11-12 we report the theoretical IRFs. Assuming complementarity between public and private consumption has a strong positive effect on the cumulative multiplier. This happens because complementarity triggers a surge in private consumption (both official and unofficial). Relative to the separable utility case, the surge in official consumption raises inflationary pressures and elicits a stronger increase in the real interest rate. As a result, official investment falls well below the level observed under separable preferences. Substitutability between public and private consumption completely reverses these results because consumption falls well below the level observed under separable preferences.

5. Conclusions

This paper documents the relevant role of informality in shaping the magnitude of fiscal multipliers. Our empirical estimates show that fiscal multipliers in high informality countries are significantly lower than those characterized by low degrees of informality. Most importantly, results show that the fiscal multipliers do not vary significantly between high- and low-income countries when conditioning for the level of informality, suggesting that the level of informality is a key element explaining difference in fiscal multipliers between advanced and developing economies.

We use a two-sector TANK model to rationalize the empirical results. The model highlights that the differential effect of the public expenditure shock is driven by two main factors: i) the stronger appreciation in the relative price of official goods that characterizes the high-informality countries; ii) the different patterns of complementarity (substitutability) between public and private goods in low- and high-informality countries.

We see important implications from our result that the mismeasurement of the informal sector contributes to rationalize the weak effect of public expenditure shocks in developing countries. First, the effectiveness of public expenditure as a stabilization tool in developing countries has been underestimated because of the neglected strong response of the informal sector. Second, the presence of

a large informal sector unambiguously undermines governments' ability to implement stabilization policies because the limited response of the official sector requires tighter tax policies to raise the revenues necessary to preserve fiscal solvency. Our model has also implications for tax policies. In standard models with homogeneous goods a VAT tax generally acts on the supply side by incentivizing firms to use informal production activities. In our model consumers demand is also affected, and the propagation mechanism is reinforced. A tax on the return to capital has a reallocating effect that in our case would be dampened by the fall in the relative price of formal goods. There would be an analogous albeit smaller effect following a variation in the labor income tax. Finally, to the extent that public and private consumption goods are substitutes in households' preferences, high-informality countries should tilt their stabilization policies towards increasing reliance on tax tools. We leave a comprehensive analysis of the effect of different tax policies as a task for future research.

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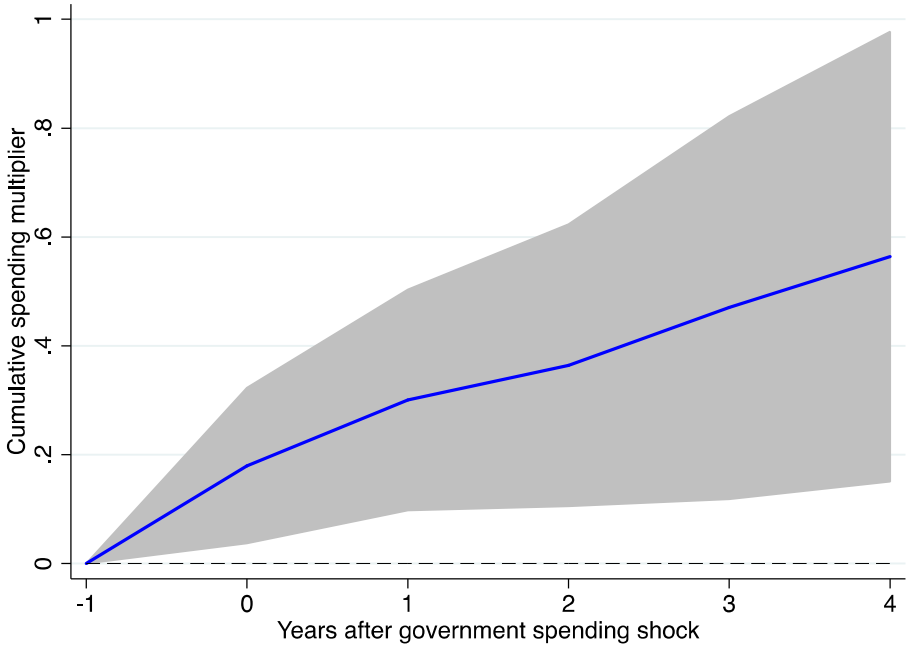
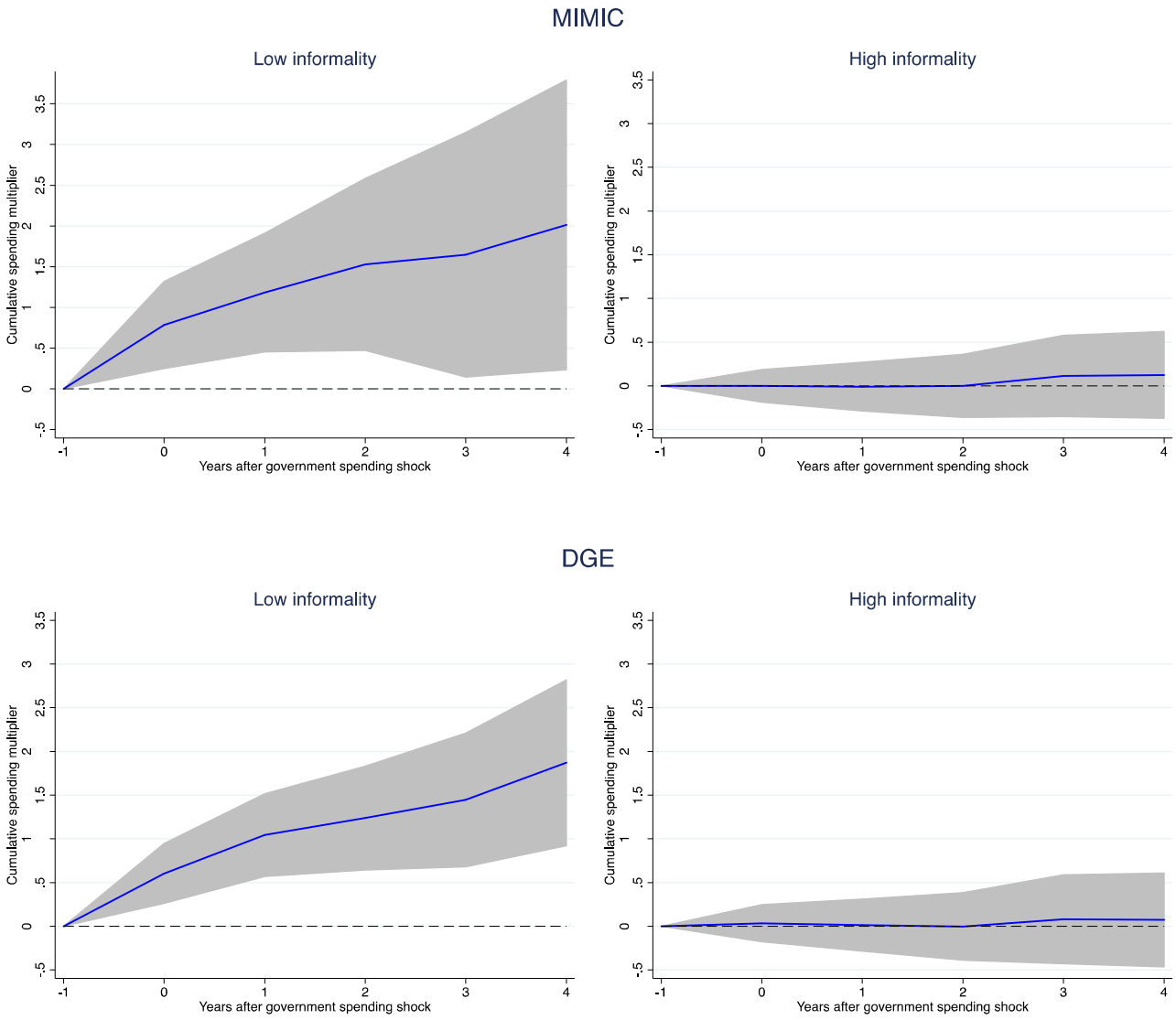
Figures

Figure 1. Cumulative fiscal multiplier – unconditional



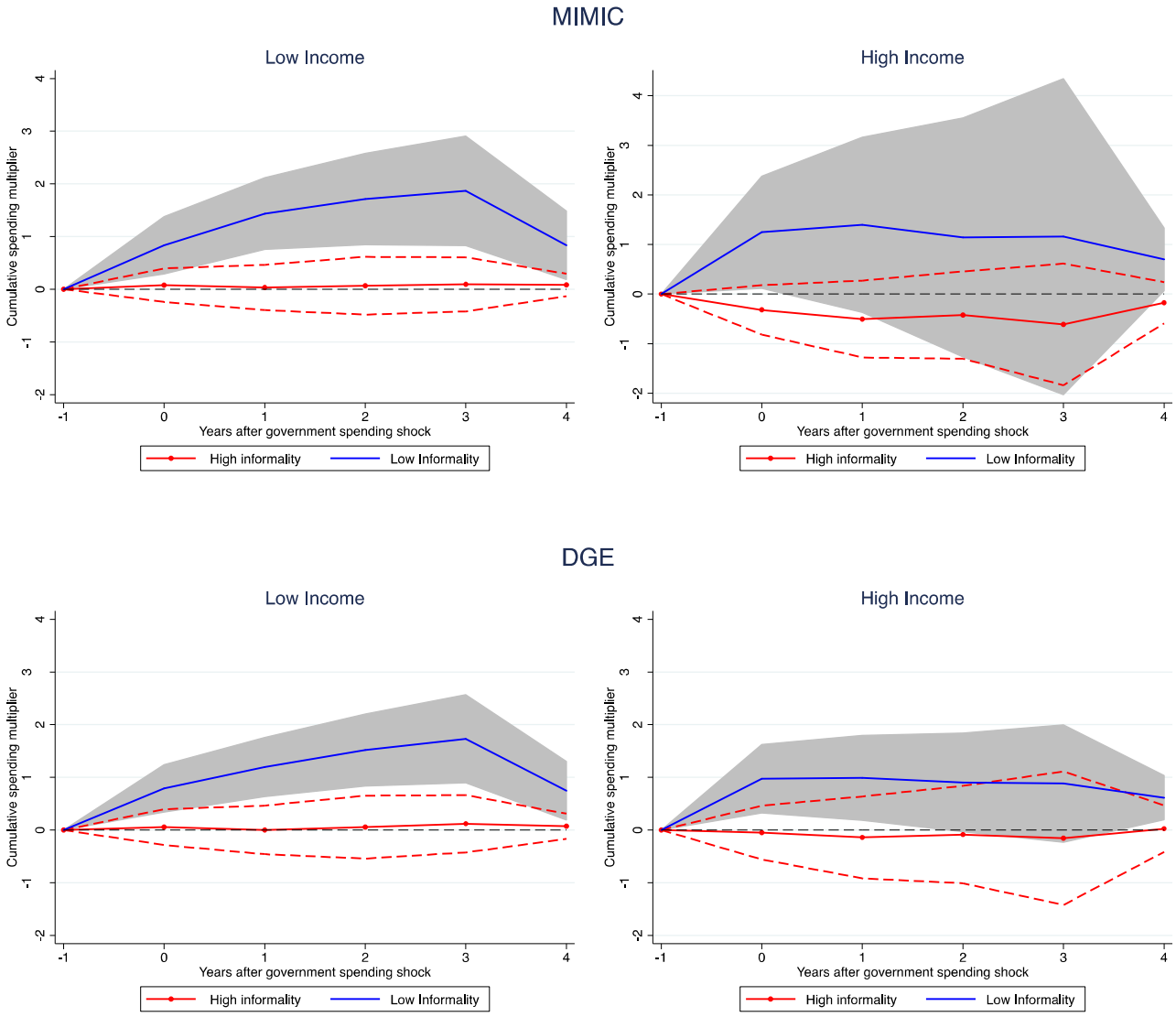
Note: The chart shows the impulse response functions and the associated 90 percent confidence bands; t = 0 is the year of shock. Estimates based on equation (1) using a sample of 141 countries over the period 1995-2015.

Figure 2. Cumulative fiscal multiplier – the role of the shadow economy



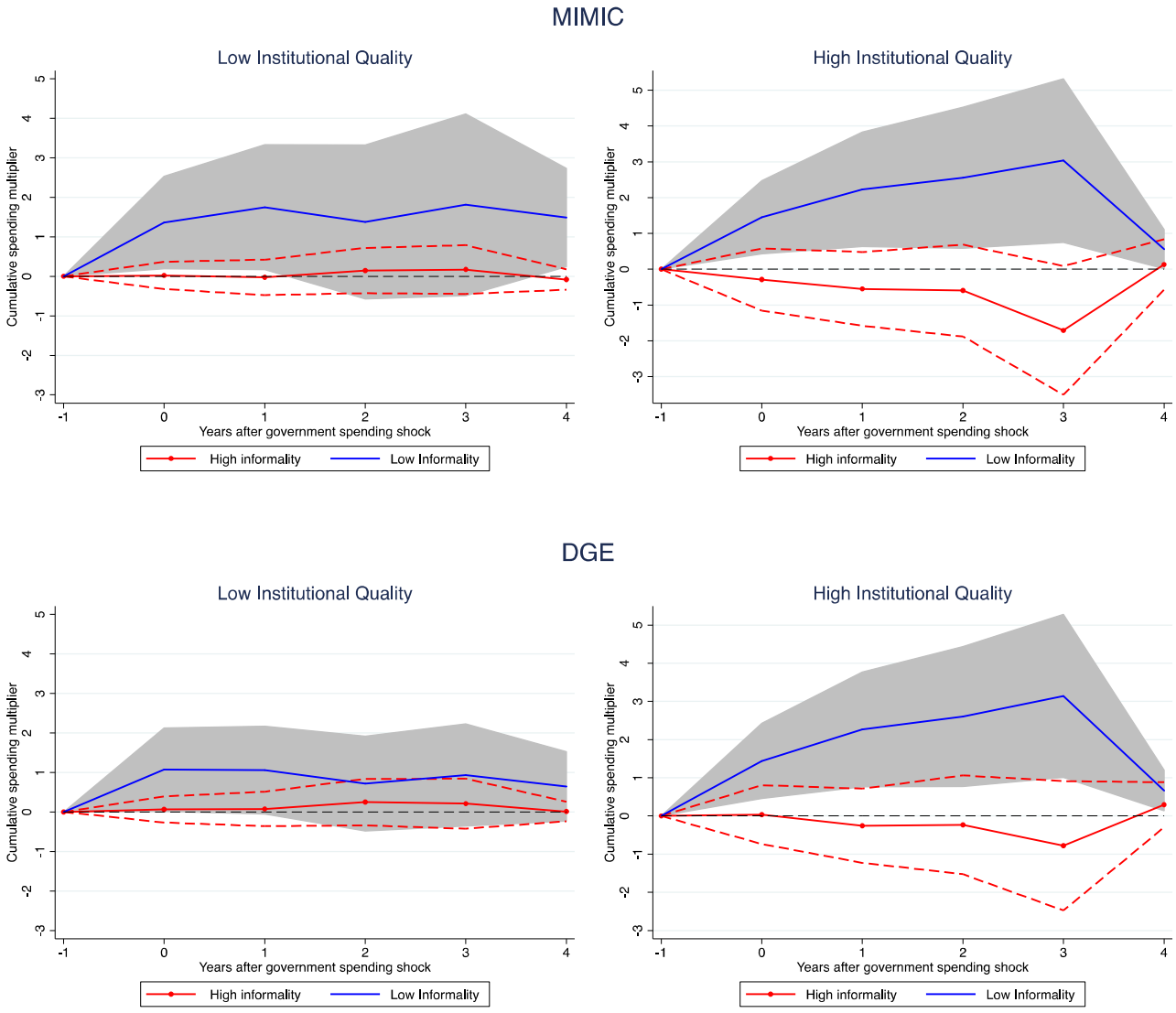
Note: The charts show the impulse response functions and the associated 90 percent confidence bands; t = 0 is the year of shock. Estimates based on equation (2) using a sample of 141 countries over the period 1995-2015. Shadow economy estimates are from MIMIC and DGE models.

Figure 3. The role of the shadow economy and level of economic development



Note: The chart shows the impulse response functions and the associated 90 percent confidence bands; t = 0 is the year of shock. Estimates based on equation (2) using a sample of 141 countries over the period 1995-2015. Shadow economy estimates are from MIMIC and DGE models.

Figure 4. The role of the shadow economy and level of institutional quality



Note: The chart shows the impulse response functions and the associated 90 percent confidence bands; t = 0 is the year of shock. Estimates based on equation (2) using a sample of 141 countries over the period 1995-2015. Shadow economy estimates are from MIMIC and DGE models.

Figure 5. The model economy

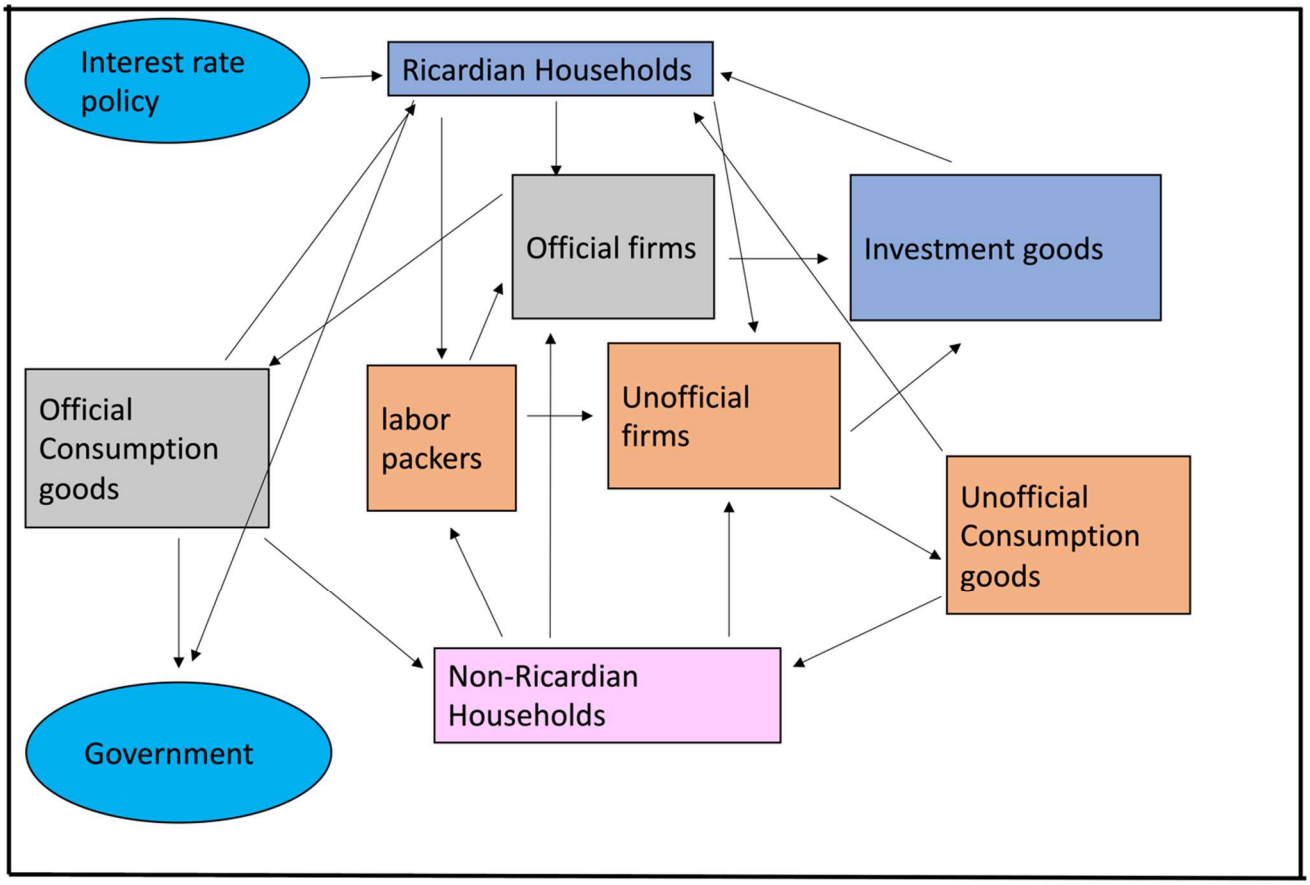
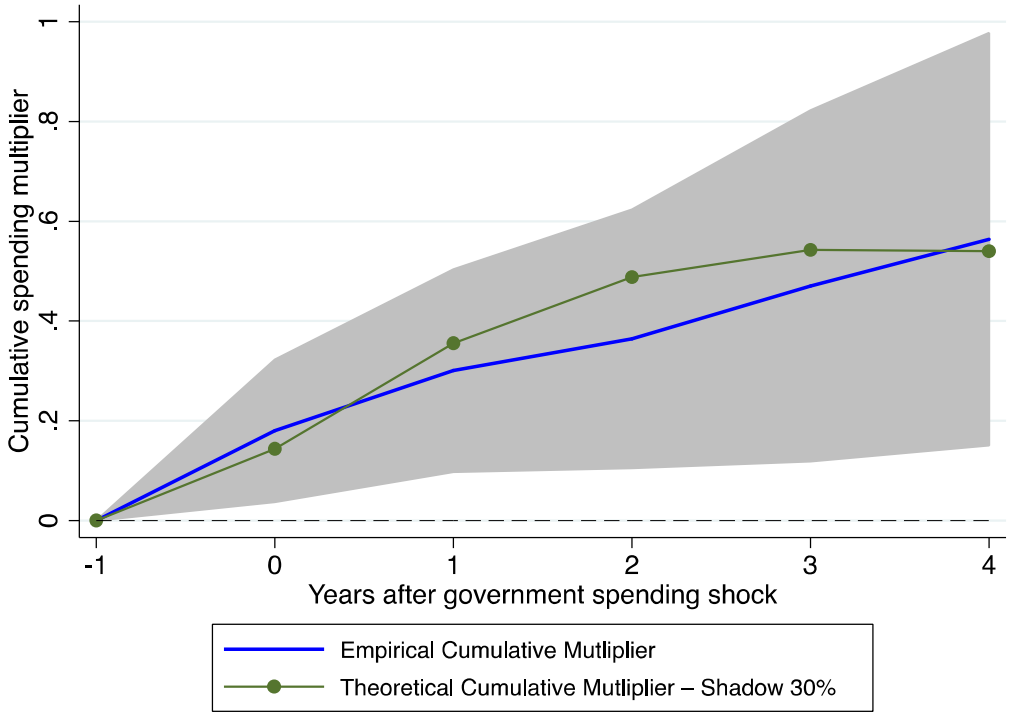
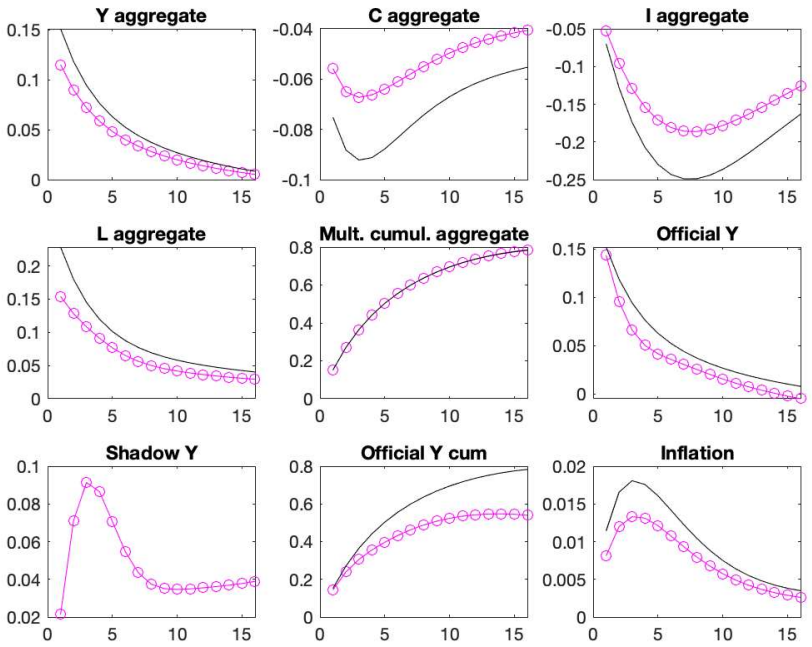


Figure 6. Cumulative fiscal multiplier – unconditional



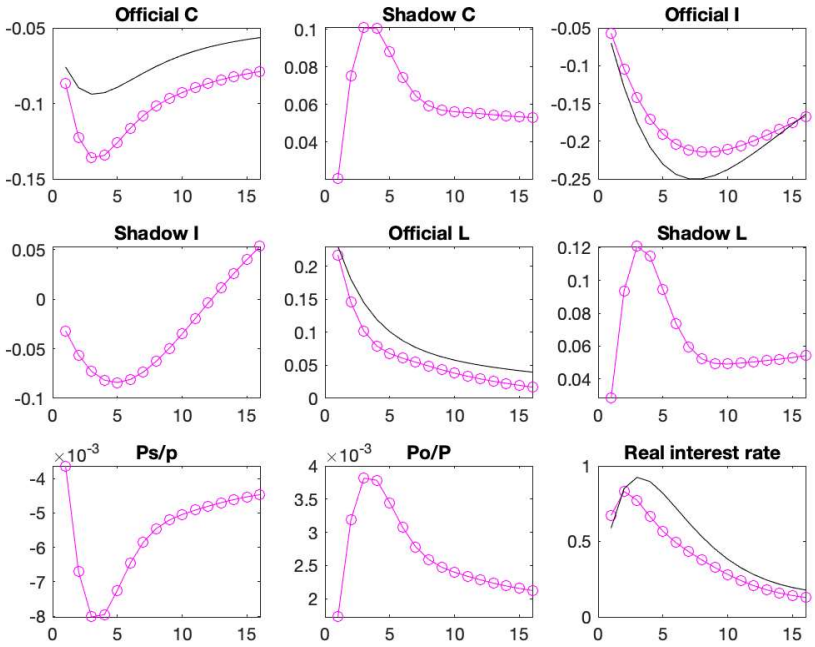
Note: The charts show the impulse response functions and the associated 90 percent confidence bands; t = 0 is the year of shock. Estimates based on equation (2) using a sample of 141 countries over the period 1995-2015. Theoretical multipliers are computed from IRFs of the benchmark model, separable utility and 30% share of the shadow economy, values are percentage deviations from the steady state.

Figure 7. IRF shadow economy at 30% (circled line) and at 0% (black line). Separable utility - 1



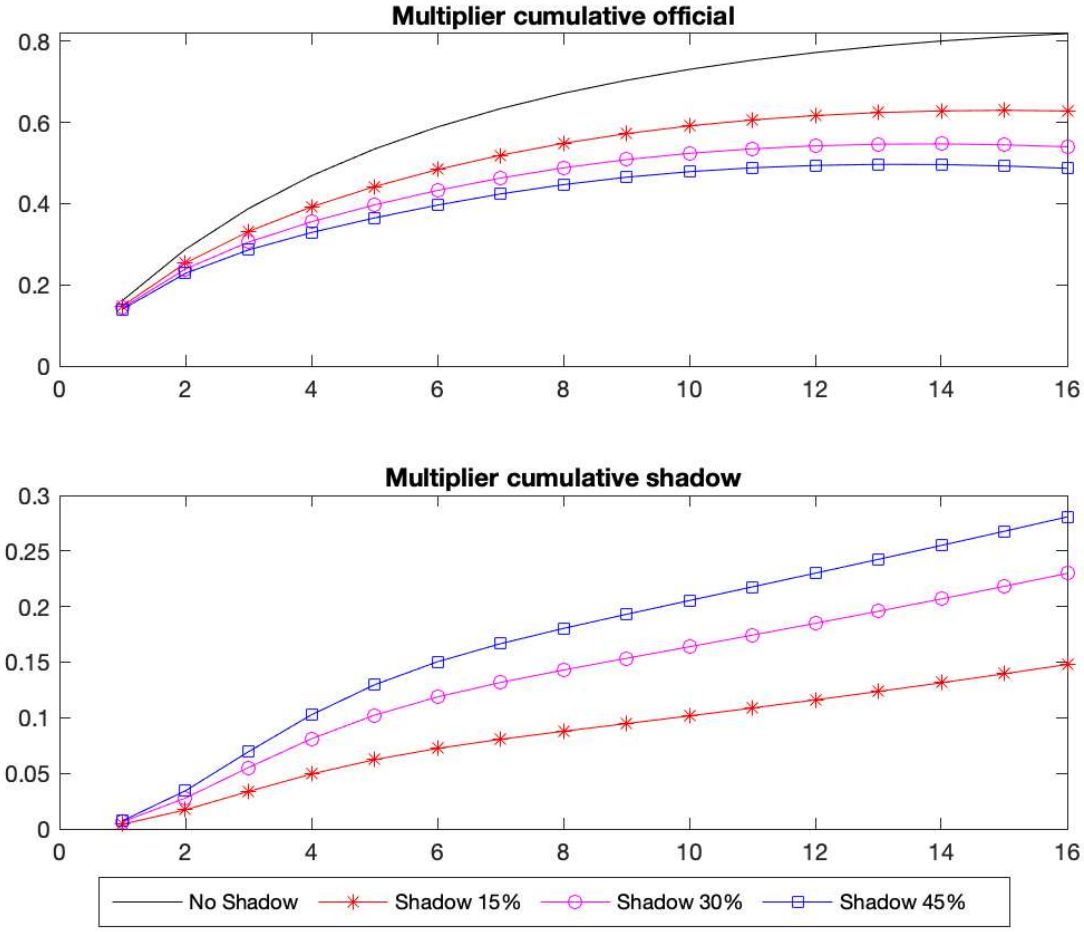
Note: The charts show IRFs of the model with, separable utility 30% share of the shadow economy (circled purple line) and 0% share of the shadow economy (black line), values are percentage deviations from the steady state. On the x-axis numbers represent quarters. Aggregate variables denote the artificial economy obtained by aggregating official and shadow sectors.

Figure 8. IRF shadow economy at 30% (circled line) and at 0% (black line). Separable utility - 2



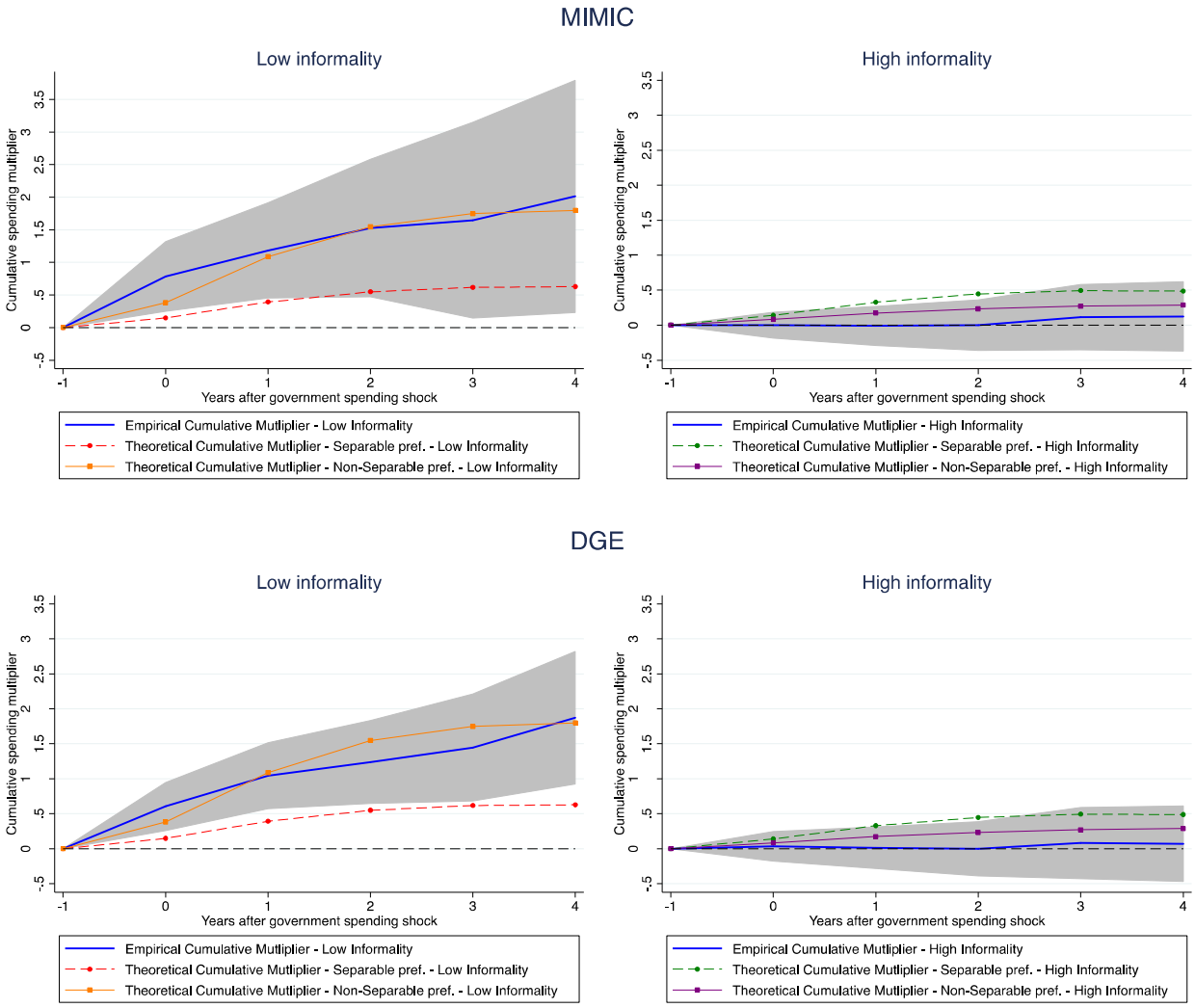
Note: The charts show IRFs of the model with, separable utility 30% share of the shadow economy (circled purple line) and 0% share of the shadow economy (black line), values are percentage deviations from the steady state. On the x-axis numbers represent quarters.

Figure 9. Cumulative fiscal multipliers at different degrees of informality



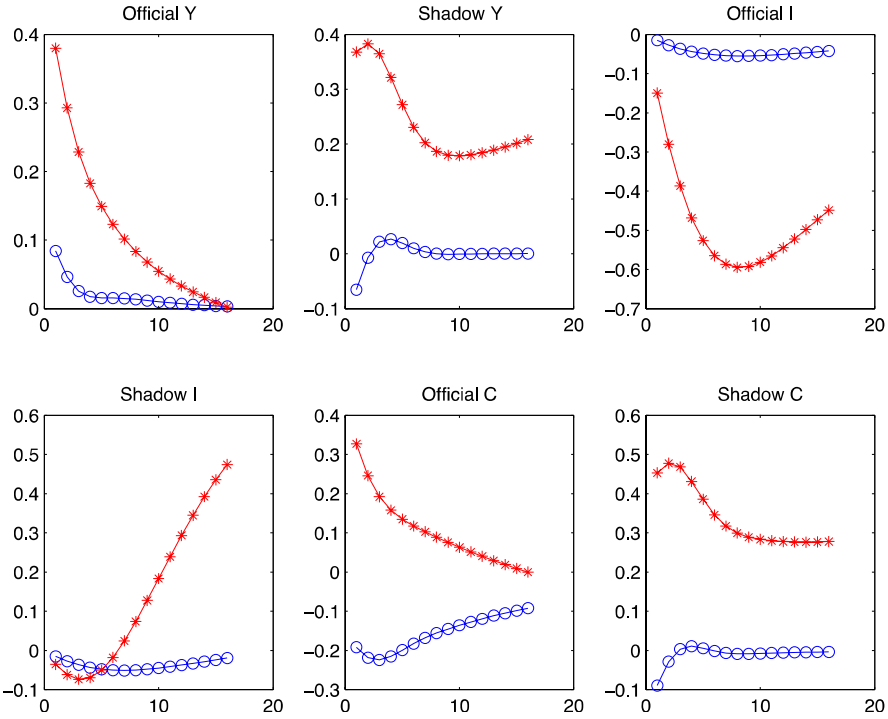
Note: The charts show IRFs of the model with separable utility at different shares of the shadow economy, values are percentage deviations from the steady state. On the x-axis numbers represent quarters.

Figure 10. Cumulative fiscal multiplier. Separable and non separable utility



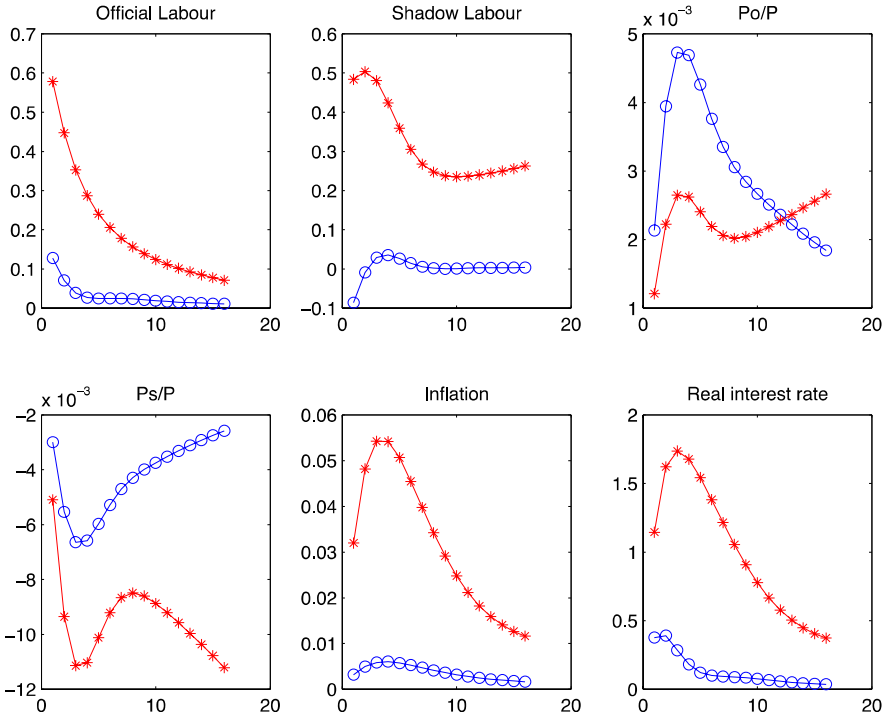
Note: The charts show the impulse response functions and the associated 90 percent confidence bands; t = 0 is the year of shock. Estimates based on equation (2) using a sample of 141 countries over the period 1995-2015. Shadow economy estimates are from MIMIC and DGE models. Theoretical multipliers are computed from IRFs of the benchmark model, separable and non-separable utility, 45% share of the shadow economy (high informality), and 15% share of the shadow economy (low informality); values are percentage deviations from the steady state.

Figure 11. IRF High share of shadow economy (circled blue line) and Low share (starred red line). Non-separable utility – 1



Note: The charts show IRFs of the model with non-separable utility, 45% share of the shadow economy (high informality, circled blue line), and 15% share of the shadow economy (low informality, starred red line), values are percentage deviations from the steady state. On the x-axis numbers represent quarters.

Figure 12. IRF High share of shadow economy (circled blue line) and Low share (starred red line). Non-separable utility – 2



Note: The charts show IRFs of the model with non-separable utility, 45% share of the shadow economy (high informality, circled blue line), and 15% share of the shadow economy (low informality, starred red line), values are percentage deviations from the steady state. On the x-axis numbers represent quarters.

Tables

Table 1. Robustness checks – Additional controls

		All controls		
Measure of informality	Horizon	Low Informality	High Informality	Significance level of difference
MIMIC	0	1.169***	0.152	0.052
	1	1.792***	0.264	0.013
	2	2.429**	0.635	0.027
	3	2.451	0.846	0.208
	4	3.130*	0.820	0.137
DGE	0	0.926**	0.279	0.138
	1	1.434**	0.437	0.066
	2	2.090*	0.776	0.102
	3	2.268	0.974	0.326
	4	2.369	1.118	0.359

Note: Estimates are obtained using a sample of 141 countries over the period 1995-2015 and based on equation (4). *** p<0.01, ** p<0.05, * p<0.1.

Appendixes

Appendix 1 – Empirical analysis

Figure A1. Distribution of Government Expenditure Shocks

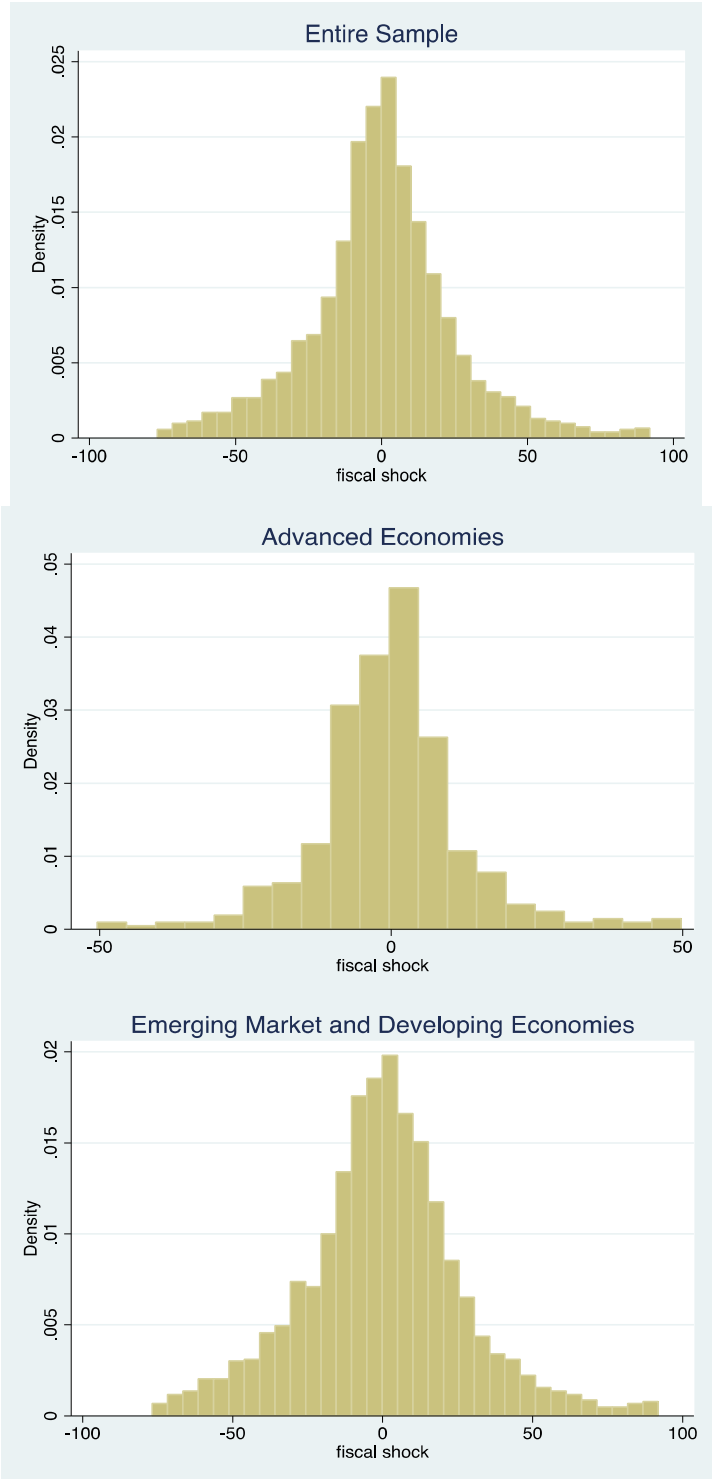
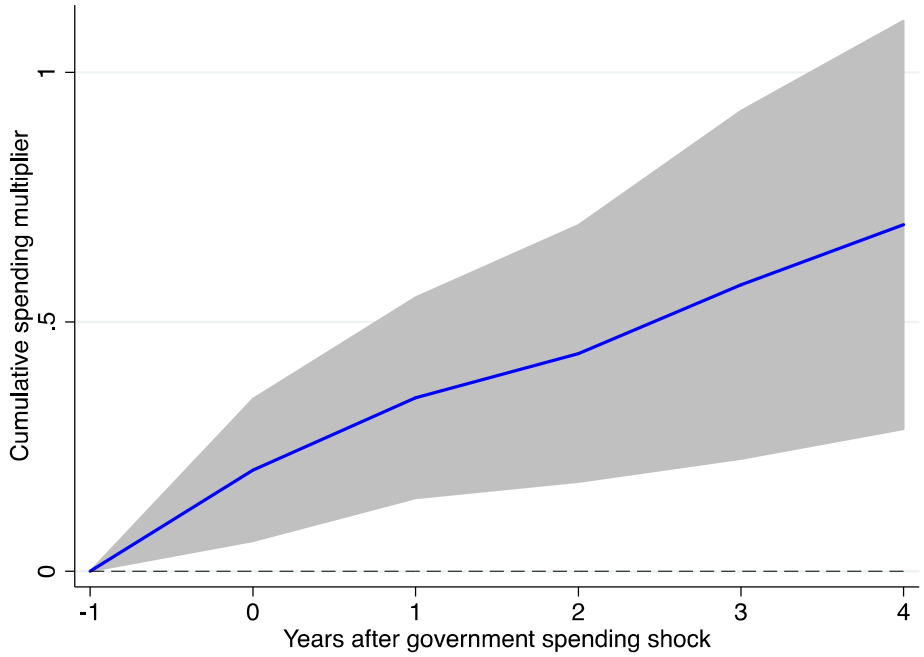
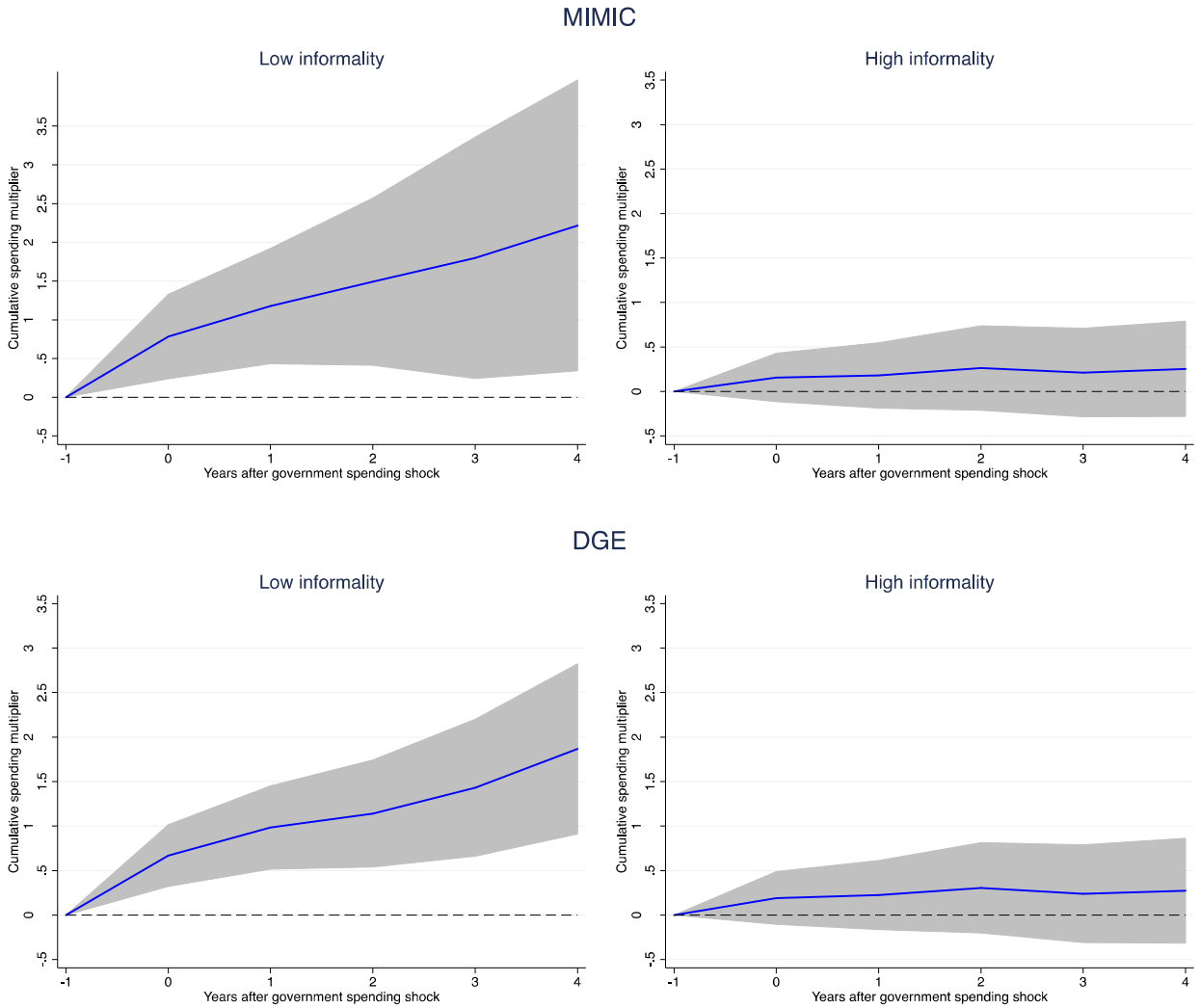


Figure A2. Fiscal multipliers – using forecasts of government expenditures made in April of the same year



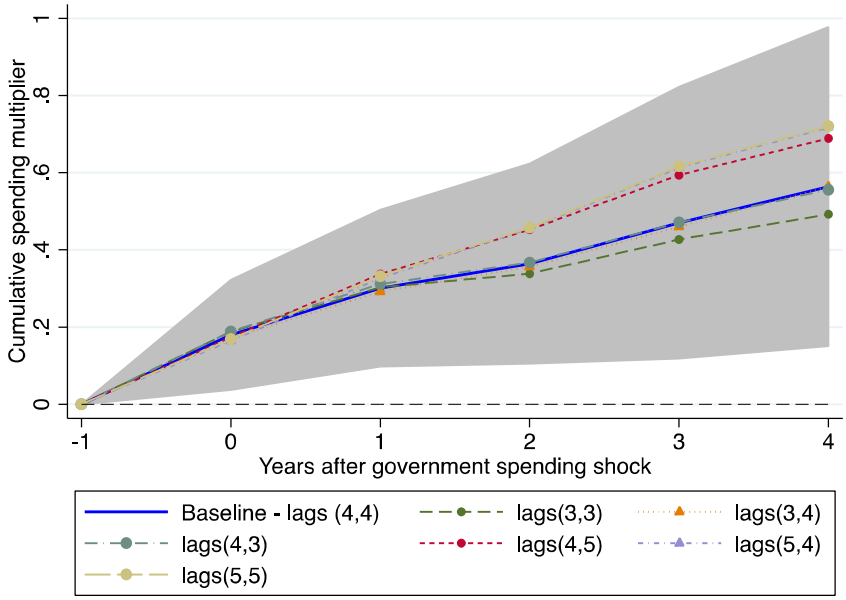
The chart shows the impulse response functions and the associated 90 percent confidence bands; t = 0 is the year of shock. Estimates based on equation (1) using a sample of 141 countries over the period 1995-2015.

Figure A3. Cumulative fiscal multiplier using forecasts of government expenditures made in April of the same year – the role of the shadow economy



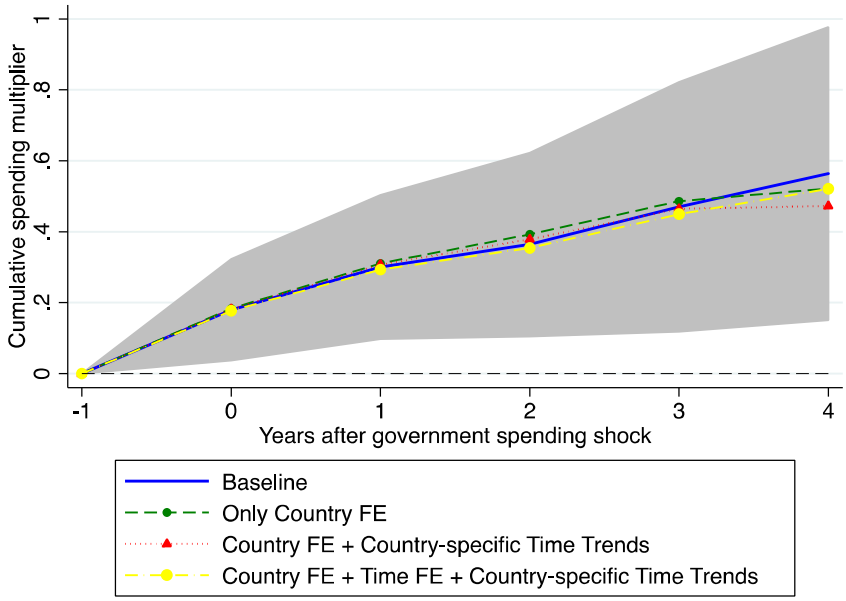
Note: The charts show the impulse response functions and the associated 90 percent confidence bands; t = 0 is the year of shock. Estimates based on equation (2) using a sample of 141 countries over the period 1995-2015 and forecasts of government expenditures made in April of the same year. Shadow economy estimates are from MIMIC and DGE models.

Figure A4. Alternative lag structures



Note: The chart shows the impulse response functions and the associated 90 percent confidence bands; t = 0 is the year of shock. Estimates based on equation (1) using a sample of 141 countries over the period 1995-2015.

Figure A5. Alternative specifications



Note: The chart shows the impulse response functions and the associated 90 percent confidence bands; t = 0 is the year of shock. Estimates based on equation (1) using a sample of 141 countries over the period 1995-2015.

Table A1. Government Expenditure Shocks – Descriptive statistics

Country	Mean	Standard deviation	Min	Max
Afghanistan	-7.68	26.25	-34.45	36.78
Albania	2.06	25.75	-57.00	37.00
Algeria	0.35	21.07	-47.55	33.61
Angola	-18.35	29.33	-52.98	55.99
Antigua and Barbados	5.44	47.76	-41.06	88.50
Argentina	4.14	30.13	-23.27	89.61
Armenia	12.21	27.74	-28.34	65.17
Australia	0.98	8.61	-11.81	15.47
Austria	-1.07	4.92	-7.64	7.05
Bahrain	-1.47	27.86	-58.05	48.59
Bangladesh	-0.35	17.16	-37.59	36.21
Barbados	5.39	32.79	-49.95	57.38
Belgium	3.61	5.65	-3.93	12.75
Belize	9.57	27.72	-28.83	59.36
Benin	-2.53	22.54	-49.58	50.49
Bhutan	-8.07	-	-8.07	-8.07
Bolivia	1.56	14.81	-27.33	33.25
Bosnia and Herzegovina	-6.66	20.16	-46.40	16.48
Botswana	-0.79	24.49	-56.72	31.29
Brazil	-15.67	14.58	-46.82	15.19
Bulgaria	-3.04	15.01	-36.39	20.81
Burkina Faso	-11.29	18.13	-39.53	19.89
Burundi	15.39	39.47	-55.78	73.02
Cotê d'Ivoire	0.98	31.67	-63.41	58.35
Cabo Verde	-5.75	24.50	-43.95	38.47
Cambodia	2.20	14.99	-28.87	25.37
Cameroon	0.56	34.13	-59.87	48.95
Canada	0.46	7.62	-8.23	11.24
Central African Republic	4.73	41.21	-66.63	79.03
Chad	2.65	21.42	-32.48	25.25
Chile	-3.48	10.36	-21.71	22.97
China	-1.31	5.97	-16.16	3.39
Colombia	-7.13	12.18	-29.95	21.25
Comoros	-1.54	27.84	-60.56	64.69
Congo, Democratic Republic of	8.04	43.06	-69.18	82.62
Congo, Republic of	6.58	30.72	-63.53	40.49
Costa Rica	-9.11	14.67	-45.55	5.74
Croatia	-7.26	22.51	-50.24	49.18
Czech Republic	-3.91	19.92	-44.39	49.16
Djibouti	2.99	35.29	-63.68	55.24
Dominican Republic	-29.05	23.14	-64.12	10.11
Ecuador	6.67	24.33	-25.80	50.06
Egypt	-2.26	13.67	-25.43	31.79
El Salvador	-0.38	18.32	-46.45	29.81
Equatorial Guinea	10.04	38.32	-57.09	65.82
Eritrea	-4.14	28.78	-74.79	19.29
Estonia	3.18	27.38	-47.20	44.49
Ethiopia	-5.61	29.14	-51.59	43.40
Finland	-2.11	4.52	-8.16	3.34
France	-0.79	4.10	-7.69	5.02
Gabon	-3.34	34.35	-46.49	68.16
Gambia, The	-8.99	34.78	-66.34	29.39
Georgia	-1.47	20.28	-15.81	12.87
Germany	3.81	3.31	-1.98	9.06

Ghana	1.33	29.26	-42.43	78.90
Greece	7.94	10.83	-8.63	20.46
Guatemala	8.21	18.79	-12.69	33.28
Guinea	4.05	31.71	-43.44	82.75
Guinea-Bissau	-6.49	47.79	-68.84	88.65
Haiti	4.02	36.91	-67.58	69.58
Honduras	-1.29	22.52	-46.89	32.39
Hong Kong SAR	5.91	5.69	-3.44	14.22
Iceland	0.15	10.93	-18.21	9.04
India	-2.11	9.44	-25.96	11.71
Indonesia	0.81	9.70	-14.53	15.64
Iran	0.12	31.47	-65.59	49.22
Ireland	-0.03	3.06	-2.20	2.14
Israel	-2.67	5.56	-11.17	5.35
Italy	-2.06	12.66	-20.73	19.63
Japan	2.14	3.68	-3.53	7.84
Jordan	15.76	-	15.76	15.76
Kazakhstan	0.64	22.49	-38.48	33.10
Kenya	-1.95	15.88	-21.46	33.25
Korea	-6.67	9.73	-26.94	3.88
Kuwait	-11.13	16.74	-35.47	19.12
Lebanon	-13.87	25.23	-57.39	12.35
Lesotho	-14.94	28.16	-63.48	27.57
Lithuania	-2.46	17.61	-44.56	24.45
Luxembourg	-2.22	37.80	-39.01	49.74
Madagascar	-4.10	37.42	-68.58	85.22
Malawi	1.39	28.13	-60.39	56.49
Malaysia	1.42	13.54	-22.78	23.12
Maldives	1.07	40.75	-59.93	90.87
Mali	-7.69	24.93	-39.14	44.10
Mauritius	-4.86	32.36	-54.06	84.89
Mexico	-7.28	11.78	-25.85	18.00
Moldova	2.05	23.40	-29.15	46.04
Mongolia	1.64	33.83	-56.51	50.85
Montenegro Rep.	-1.95	46.91	-70.42	32.70
Morocco	7.71	14.48	-14.57	28.69
Mozambique	0.54	20.41	-35.46	37.74
Myanmar	3.06	15.97	-30.03	39.20
Namibia	-0.92	17.87	-36.54	22.13
Nepal	-2.02	17.89	-18.56	23.42
Netherlands	2.08	2.50	-1.49	4.56
New Zealand	3.65	23.78	-35.55	41.37
Nicaragua	-2.12	19.57	-33.44	27.73
Niger	10.38	24.50	-48.98	40.57
Nigeria	-13.45	36.60	-55.82	75.01
Oman	-2.09	12.25	-20.02	19.02
Pakistan	-0.20	19.47	-34.65	33.83
Panama	4.14	15.17	-18.46	25.32
Paraguay	0.50	18.31	-42.05	26.65
Peru	1.33	14.57	-34.52	31.79
Philippines	-0.52	19.14	-33.58	39.03
Portugal	-4.64	17.81	-31.61	25.02
Romania	-13.69	19.03	-45.13	16.90
Russia	4.97	22.93	-52.22	39.91
Rwanda	1.29	23.58	-49.76	26.80
São Tomé e Príncipe	-10.80	24.05	-46.50	17.43
Saudi Arabia	0.65	22.51	-51.83	37.64

Senegal	1.78	16.26	-34.03	19.62
Serbia	-5.79	13.37	-22.46	9.74
Seychelles	-0.82	42.43	-67.97	91.85
Sierra Leone	9.02	42.49	-69.21	68.63
Singapore	2.17	7.53	-10.43	10.95
Slovak Republic	0.61	19.96	-27.06	39.41
South Africa	1.40	10.32	-25.33	13.81
Sri Lanka	-0.29	22.94	-29.54	45.70
Suriname	2.68	39.46	-51.83	34.22
Swaziland	-3.03	26.05	-67.23	32.77
Switzerland	0.97	3.60	-2.59	7.37
Syria	1.98	23.42	-31.09	38.98
Taiwan Province	-2.77	6.83	-14.83	7.48
Tanzania	4.33	16.04	-33.42	27.84
Thailand	-1.01	7.26	-11.89	13.45
Togo	12.26	28.81	-56.65	56.17
Trinidad and Tobago	7.18	34.09	-60.98	73.22
Tunisia	-3.87	21.18	-54.48	13.16
Turkey	-8.61	17.91	-39.59	15.78
Turkmenistan	11.21	32.87	-60.83	44.17
Uganda	-4.06	24.52	-37.95	49.96
Ukraine	2.36	25.57	-41.28	62.04
United Arab Emirates	0.99	24.57	-36.39	32.14
United Kingdom	-0.98	8.05	-18.23	9.01
United States	-0.02	1.80	-2.73	2.27
Uruguay	-4.28	18.30	-28.67	43.23
Venezuela	-5.31	32.77	-53.26	82.17
Vietnam	1.68	19.38	-32.56	42.28
Yemen	-9.15	25.31	-38.85	37.07
Zambia	1.29	25.36	-50.92	44.05

Table A2. Regression of Fiscal Shocks on macroeconomic variables

Lagged output gap	-0.211
	(-1.42)
Lagged Public Debt to GDP	-0.001
	(-1.40)
Change in Revenue	0.0346
	(-0.42)

Note. Fiscal shock is the dependent variable. Country and time fixed effects included but not reported.
t-statistics based on robust standard errors in parentheses

Table A3. Correlations between fiscal shocks, monetary policy shocks and WUI

	Fiscal shocks
Fiscal shocks	1
Monetary Policy shocks (source: Furceri et al. 2017)	-0.033
World Uncertainty Index (source: Ahir et al. 2021)	-0.007

Table A4. List of the countries included in the analysis

CG	Country	CG	Country	CG	Country
AE	Australia	EM	Equatorial Guinea	LIDC	Burundi
AE	Austria	EM	Gabon	LIDC	Cambodia
AE	Belgium	EM	Georgia	LIDC	Cameroon
AE	Canada	EM	Guatemala	LIDC	Central African
AE	Czech Republic	EM	India	LIDC	Chad
AE	Estonia	EM	Indonesia	LIDC	Comoros
AE	Finland	EM	Iran	LIDC	Congo, Democrati
AE	France	EM	Jordan	LIDC	Congo, Republic
AE	Germany	EM	Kazakhstan	LIDC	Cote d'Ivoire
AE	Greece	EM	Kuwait	LIDC	Djibouti
AE	Hong Kong SAR	EM	Lebanon	LIDC	Eritrea
AE	Iceland	EM	Lithuania	LIDC	Ethiopia
AE	Ireland	EM	Malaysia	LIDC	Gambia, The
AE	Israel	EM	Maldives	LIDC	Ghana
AE	Italy	EM	Mauritius	LIDC	Guinea
AE	Japan	EM	Mexico	LIDC	Guinea-Bissau
AE	Korea	EM	Montenegro, Rep.	LIDC	Haiti
AE	Luxembourg	EM	Morocco	LIDC	Honduras
AE	Netherlands	EM	Namibia	LIDC	Kenya
AE	New Zealand	EM	Oman	LIDC	Lesotho
AE	Portugal	EM	Pakistan	LIDC	Madagascar
AE	Singapore	EM	Panama	LIDC	Malawi
AE	Slovak Republic	EM	Paraguay	LIDC	Mali
AE	Switzerland	EM	Peru	LIDC	Moldova
AE	Taiwan Province	EM	Philippines	LIDC	Mongolia
AE	United Kingdom	EM	Romania	LIDC	Mozambique
AE	United States	EM	Russia	LIDC	Myanmar
EM	Albania	EM	Saudi Arabia	LIDC	Nepal
EM	Algeria	EM	Serbia	LIDC	Nicaragua
EM	Angola	EM	Seychelles	LIDC	Niger
EM	Antigua and Barbados	EM	South Africa	LIDCs	Nigeria
EM	Argentina	EM	Sri Lanka	LIDC	Rwanda
EM	Armenia	EM	Suriname	LIDC	Senegal
EM	Bahrain	EM	Swaziland	LIDC	Sierra Leone
EM	Barbados	EM	Syria	LIDC	São Tomé e Príncipe
EM	Belize	EM	Thailand	LIDC	Tanzania
EM	Bosnia and Herzegovina	EM	Trinidad and Tob	LIDC	Togo
EM	Botswana	EM	Tunisia	LIDC	Uganda
EM	Brazil	EM	Turkey	LIDC	Vietnam
EM	Bulgaria	EM	Turkmenistan	LIDC	Yemen
EM	Cabo Verde	EM	Ukraine	LIDC	Zambia
EM	Chile	EM	United Arab Emirates		
EM	China	EM	Uruguay		
EM	Colombia	EM	Venezuela		
EM	Costa Rica	LIDC	Afghanistan		
EM	Croatia	LIDC	Bangladesh		
EM	Dominican Republic	LIDC	Benin		
EM	Ecuador	LIDC	Bhutan		
EM	Egypt	LIDC	Bolivia		
EM	El Salvador	LIDC	Burkina Faso		

Note: CG indicates the country group. AE indicates Advanced Economies; EM indicates Emerging Market economies; LIDC indicates Low Income and Developing Economies. Country group classification follows the World Bank definition.

Table A5. Descriptive statistics - Informality

	N	mean	sd	min	max
Informality: MIMIC	2223	31.509	12.566	6.390	70.570
Informality: DGE	2286	31.962	11.908	7.909	65.994

Table A6. Cumulative fiscal multiplier – the role of the shadow economy

Measure of informality	Horizon	Low Informality	High Informality	Significance level of difference
MIMIC	0	0.783***	-0.000	0.031
	1	1.183***	-0.010	0.018
	2	1.527**	-0.001	0.036
	3	1.648*	0.114	0.139
	4	2.013*	0.125	0.118
DGE	0	0.604***	0.035	0.027
	1	1.044***	0.013	0.005
	2	1.239***	-0.001	0.009
	3	1.446***	0.082	0.029
	4	1.871***	0.072	0.014

Note: Estimates are obtained using a sample of 141 countries over the period 1995-2015 and based on equation (2). *** p<0.01, ** p<0.05, * p<0.1.

Table A7. Cumulative fiscal multiplier– different values of gamma

		gamma=3.5			gamma=6.5		
Measure of informality	Horizon	Low Informality	High Informality	Significance level of difference	Low Informality	High Informality	Significance level of difference
MIMIC	0	0.773**	-0.019	0.033	0.788**	0.009	0.030
	1	1.180***	-0.032	0.019	1.181***	0.002	0.017
	2	1.501**	-0.026	0.036	1.545**	0.012	0.036
	3	1.578*	0.097	0.140	1.705*	0.120	0.137
	4	1.940*	0.092	0.114	2.085*	0.136	0.120
DGE	0	0.624***	0.017	0.027	0.590***	0.042	0.028
	1	1.068***	-0.013	0.006	1.028***	0.023	0.004
	2	1.269***	-0.027	0.012	1.220***	0.007	0.008
	3	1.462***	0.060	0.037	1.436***	0.085	0.025
	4	1.912***	0.025	0.016	1.847***	0.087	0.012

Note: Estimates are obtained using a sample of 141 countries over the period 1995-2015 and based on equation (2) using a dummy variable (taking the value of 1 when the share of the shadow economy is above the median, and zero otherwise) instead of the smooth transition function (z_{it}) . *** p<0.01, ** p<0.05, * p<0.1.

Table A8. Robustness checks – linear interactions

Informality: MIMIC					
	k=0	k=1	k=2	k=3	k=4
Cumulative Fiscal Multiplier	0.880**	1.510***	1.671**	1.869*	2.912*
	(0.367)	(0.537)	(0.681)	(0.987)	(1.748)
Cumulative Fiscal Multiplier * Informality	-0.020**	-0.035**	-0.037**	-0.040	-0.068
	(0.010)	(0.014)	(0.017)	(0.024)	(0.047)
Observations	1,857	1,734	1,610	1,489	1,366
R-squared	1.000	1.000	1.000	1.000	1.000
Informality: DGE					
	k=0	k=1	k=2	k=3	k=4
Cumulative Fiscal Multiplier	0.793**	1.597***	1.950***	2.149**	2.799***
	(0.356)	(0.523)	(0.660)	(0.849)	(1.056)
Cumulative Fiscal Multiplier * Informality	-0.016*	-0.034***	-0.041**	-0.043**	-0.057**
	(0.009)	(0.013)	(0.016)	(0.021)	(0.025)
Observations	1,907	1,784	1,656	1,531	1,404
R-squared	1.000	1.000	1.000	1.000	1.000

Note: Estimates are obtained using a sample of 141 countries over the period 1995-2015 and based on equation (4). *** p<0.01, ** p<0.05, * p<0.1.

Table A9. Robustness checks – Dummy above/below the median

Measure of informality	Horizon	Low Informality	High Informality	Significance level of difference
MIMIC	0	0.575*	0.080	0.173
	1	0.792*	0.120	0.163
	2	1.032	0.160	0.214
	3	1.011	0.297	0.498
	4	1.228	0.346	0.483
DGE	0	0.430**	0.099	0.133
	1	0.771***	0.102	0.028
	2	0.876***	0.112	0.049
	3	1.037***	0.206	0.122
	4	1.316**	0.245	0.102

Note: Estimates are obtained using a sample of 141 countries over the period 1995-2015 and based on equation (4). *** p<0.01, ** p<0.05, * p<0.1.

Table A10. Robustness checks – Additional controls

		u= log(GDP)			u= debt-to-GDP ratio			u= KOF -Trade Openness		
Measure of informality	Horizon	Low Informality	High Informality	Significance level of difference	Low Informality	High Informality	Significance level of difference	Low Informality	High Informality	Significance level of difference
MIMIC	0	0.747***	-0.018	0.012	0.902**	-0.027	0.026	0.771***	0.005	0.016
	1	1.074***	-0.026	0.003	1.379**	-0.047	0.023	1.199***	-0.057	0.005
	2	1.379***	-0.016	0.004	1.651**	-0.010	0.064	1.541***	-0.065	0.013
	3	1.503**	-0.011	0.029	1.694	0.090	0.203	1.661**	-0.055	0.062
	4	1.751**	-0.098	0.023	1.891	0.130	0.318	1.829*	0.033	0.090
DGE	0	0.683***	0.003	0.008	0.696***	0.004	0.019	0.602***	0.055	0.041
	1	0.982***	-0.024	0.001	1.162***	-0.036	0.007	1.070***	-0.036	0.005
	2	1.216***	-0.042	0.001	1.268***	-0.007	0.022	1.269***	-0.058	0.006
	3	1.406***	-0.076	0.005	1.404***	0.071	0.065	1.483***	-0.091	0.019
	4	1.723***	-0.180	0.002	1.759***	0.044	0.056	1.799***	-0.028	0.012

		u= KOF Financial Openness			u= Exchange rate regime			u= Institutional Quality		
Measure of informality	Horizon	Low Informality	High Informality	Significance level of difference	Low Informality	High Informality	Significance level of difference	Low Informality	High Informality	Significance level of difference
MIMIC	0	0.758**	-0.030	0.017	0.824**	0.001	0.022	0.722**	0.118	0.188
	1	1.148***	-0.052	0.007	1.201***	-0.009	0.013	1.091***	0.150	0.088
	2	1.405**	-0.059	0.022	1.501**	0.004	0.032	1.409**	0.150	0.077
	3	1.477*	-0.017	0.101	1.644*	0.102	0.124	1.572**	0.251	0.169
	4	1.669	0.015	0.114	2.021*	0.141	0.130	1.980**	0.606	0.226
DGE	0	0.603***	0.006	0.018	0.634***	0.030	0.022	0.592***	0.179	0.163
	1	1.036***	-0.037	0.002	1.070***	0.017	0.004	0.976***	0.127	0.026
	2	1.206***	-0.061	0.004	1.262***	0.007	0.007	1.154***	0.095	0.020
	3	1.411***	-0.050	0.013	1.491***	0.064	0.021	1.374***	0.107	0.033
	4	1.732***	-0.017	0.010	1.877***	0.092	0.013	1.740***	0.257	0.052

Note: Estimates are obtained using a sample of 141 (109 for institutional quality) countries over the period 1995-2015 and based on equation (4) separately estimated for each control *u* as indicated on top of each panel. *** p<0.01, ** p<0.05, * p<0.1.

Table A11. The role of the shadow economy and level of economic development

Informality: MIMIC					
	k=0	k=1	k=2	k=3	k=4
High informality / High per-capita GDP	-0.174	-0.318	-0.503	-0.423	-0.611
	(0.253)	(0.302)	(0.471)	(0.535)	(0.746)
Low informality / Low per-capita GDP	0.834**	0.833**	1.435***	1.713***	1.867***
	(0.397)	(0.331)	(0.414)	(0.528)	(0.633)
High informality / Low per-capita GDP	0.081	0.077	0.033	0.067	0.092
	(0.130)	(0.193)	(0.261)	(0.334)	(0.312)
Low informality / High per-capita GDP	0.702*	1.246*	1.397	1.145	1.161
	(0.384)	(0.687)	(1.073)	(1.464)	(1.937)
Observations	1,810	1,689	1,568	1,450	1,330
R-squared	1.000	1.000	1.000	1.000	1.000
p-values of the F-test difference					
Hinf_Lpgdp vs Linf_Lpgdp	0.087	0.073	0.010	0.017	0.019
Hinf_Hpgdp vs Linf_Hpgdp	0.044	0.045	0.144	0.359	0.441
Linf_Lpgdp vs Linf_Hpgdp	0.825	0.619	0.976	0.743	0.754
Hinf_Lpgdp vs Hinf_Hpgdp	0.411	0.314	0.369	0.480	0.413

Informality: DGE					
	k=0	k=1	k=2	k=3	k=4
High informality / High per-capita GDP	0.025	-0.048	-0.141	-0.086	-0.154
	(0.269)	(0.310)	(0.473)	(0.562)	(0.770)
Low informality / Low per-capita GDP	0.745**	0.788***	1.196***	1.520***	1.733***
	(0.338)	(0.274)	(0.343)	(0.416)	(0.508)
High informality / Low per-capita GDP	0.071	0.056	0.002	0.055	0.119
	(0.144)	(0.206)	(0.280)	(0.363)	(0.331)
Low informality / High per-capita GDP	0.614**	0.975**	0.992**	0.904	0.883
	(0.256)	(0.395)	(0.491)	(0.570)	(0.679)
Observations	1,864	1,739	1,614	1,492	1,368
R-squared	1.000	1.000	1.000	1.000	1.000
p-values of the F-test difference					
Hinf_Lpgdp vs Linf_Lpgdp	0.086	0.057	0.016	0.016	0.012
Hinf_Hpgdp vs Linf_Hpgdp	0.104	0.044	0.109	0.217	0.300
Linf_Lpgdp vs Linf_Hpgdp	0.775	0.714	0.745	0.406	0.343
Hinf_Lpgdp vs Hinf_Hpgdp	0.892	0.800	0.815	0.847	0.759

Note: Estimates are obtained using a sample of 141 countries over the period 1995-2015 and based on equation (5). *** p<0.01, ** p<0.05, * p<0.1. Hinf_Lpgdp refers to "High share of informality and Low per-capita GDP"; Linf_Lpgdp refers to "Low share of informality and Low per-capita GDP"; Hinf_Hpgdp refers to "High share of informality and High per-capita GDP"; Linf_Hpgdp refers to "Low share of informality and High per-capita GDP". The F-test tests the difference between the coefficients the different regimes.

Table A12. The role of the shadow economy and the institutional quality

Informality: MIMIC					
	k=0	k=1	k=2	k=3	k=4
High informality / High institutional quality	0.130	-0.289	-0.551	-0.596	-1.711
	(0.431)	(0.528)	(0.627)	(0.781)	(1.094)
Low informality / Low institutional quality	1.490**	1.360*	1.748*	1.378	1.814
	(0.757)	(0.711)	(0.962)	(1.186)	(1.400)
High informality / Low institutional quality	-0.081	0.023	-0.027	0.146	0.172
	(0.156)	(0.210)	(0.272)	(0.348)	(0.375)
Low informality / High institutional quality	0.560*	1.454**	2.230**	2.554**	3.036**
	(0.333)	(0.621)	(0.973)	(1.200)	(1.389)
Observations	1,516	1,417	1,316	1,217	1,117
R-squared	1.000	1.000	1.000	1.000	1.000
	p-values of the F-test difference				
Hinf_Linstqual vs Linf_Linstqual	0.057	0.093	0.103	0.360	0.294
Hinf_Hinstqual vs Linf_Hinstqual	0.436	0.038	0.0181	0.029	0.008
Linf_Linstqual vs Linf_Hinstqual	0.326	0.933	0.773	0.572	0.615
Hinf_Linstqual vs Hinf_Hinstqual	0.654	0.596	0.453	0.399	0.107

Informality: DGE					
	k=0	k=1	k=2	k=3	k=4
High informality / High institutional quality	0.292	0.034	-0.256	-0.233	-0.781
	(0.359)	(0.468)	(0.591)	(0.787)	(1.029)
Low informality / Low institutional quality	0.644	1.071*	1.059	0.719	0.936
	(0.534)	(0.643)	(0.676)	(0.732)	(0.785)
High informality / Low institutional quality	0.011	0.064	0.076	0.249	0.209
	(0.150)	(0.201)	(0.265)	(0.357)	(0.385)
Low informality / High institutional quality	0.667**	1.443**	2.268**	2.602**	3.142**
	(0.322)	(0.601)	(0.913)	(1.115)	(1.298)
Observations	1,555	1,453	1,349	1,247	1,144
R-squared	1.000	1.000	1.000	1.000	1.000
	p-values of the F-test difference				
Hinf_Linstqual vs Linf_Linstqual	0.285	0.160	0.214	0.598	0.450
Hinf_Hinstqual vs Linf_Hinstqual	0.463	0.084	0.027	0.042	0.019
Linf_Linstqual vs Linf_Hinstqual	0.974	0.714	0.361	0.230	0.217
Hinf_Linstqual vs Hinf_Hinstqual	0.484	0.955	0.619	0.593	0.377

Note: Estimates are obtained using a sample of 109 countries over the period 1995-2015 and based on equation (5). *** p<0.01, ** p<0.05, * p<0.1. Hinf_Linstqual refers to "High share of informality and Low Institutional Quality"; Linf_Linstqual refers to "Low share of informality and Low Institutional Quality"; Hinf_Hinstqual refers to "High share of informality and High Institutional Quality"; Linf_Linstqual refers to "Low share of informality and High Institutional Quality". The F-test tests the difference between the coefficients the different regimes.

Table A13. model parameters

A	1	Normalized TFP
β	0.99	Household subjective discount factor
ω	0.25	Share of rule of thumb consumers
α^o	0.34	Capital income share
α^s	0.24	Capital income share
δ	0.02	Depreciation rate
ε	20	Degree of substitution formal and informal bundles
γ_I	4	Investment adjustment cost
τ^k, τ^w	0.20	Taxes, capital, labour
σ^o, σ^s	6	Price-elasticity of demand for a differentiated good
φ^o, φ^s	50	Price adjustment cost
ϕ_π	1.5	Taylor parameter
η_w	6	Wages elasticity demand
ξ_w	50	Adjustment cost wages
γ_c	0.7	Share of private goods in consumption bundle
e	0.4	Elasticity of substitution between public and private goods

Appendix 2 – Steady state derivation

The recursive solution for the steady state is obtained as follows

$$R = \frac{1}{\beta}$$

$$1 = \pi^o$$

$$1 = \pi^s$$

$$\pi = 1$$

$$mc^o = \frac{\sigma^o - 1}{\sigma^o}$$

$$mc^s = \frac{\sigma^s - 1}{\sigma^s}$$

$$r^{k,o} = \frac{\left[\frac{1}{\beta} - \left(1 - \delta(1 - \tau^k)\right)\right]}{(1 - \tau^k)}$$

$$r^{k,s} = \left[\frac{1}{\beta} - (1 - \delta)\right]$$

$$w^s = (1 - \alpha^s)\left[\frac{mc^s}{\left(\frac{r^{k,s}}{\alpha^s}\right)^{\alpha^s}}\right]^{\frac{1}{1-\alpha^s}}$$

$$w^o = (1 - \alpha^o)\left[\frac{mc^o}{\left(\frac{r^{k,o}}{\alpha^o}\right)^{\alpha^o}}\right]^{\frac{1}{1-\alpha^o}}$$

in SS we calibrate

$$l = 1$$

define $\frac{y^s}{y^o} = SH$ so

$$y^o = \frac{1}{\frac{l^o}{y^o} + \frac{l^s}{y^s} SH}$$

then, using

$$w^j = (1-\alpha^j)mc^j\left(\frac{y^j}{l^j}\right)$$

$$y^o = \frac{1}{\frac{(1-\alpha^o)mc^o}{w^o} + \frac{(1-\alpha^s)mc^s}{w^s}SH}$$

$$y^s = SHy^o$$

using $w = w^s\frac{P^s}{P}, w = w^o\frac{P^o}{P}(1-\tau^w)$ we get

$$\frac{P^o}{P^s} = \frac{w^s}{w^o(1-\tau^w)}$$

From

$$r^{k,j} = \alpha^j mc^j\left(\frac{y^j}{k^j}\right).$$

we obtain

$$k^o = \alpha^o mc^o\left(\frac{y^o}{r^{k,o}}\right)$$

$$k^s = \alpha^s mc^s\left(\frac{y^s}{r^{k,s}}\right)$$

$$I = \delta(k^o + k^s)$$

from

$$q_t^{I,o} = (1-\alpha_I)\left(\frac{P_t^o}{P_t^I}\right)^{-\varepsilon} I_t$$

$$q_t^{I,s} = \alpha_I\left(\frac{P_t^s}{P_t}\right)^{-\varepsilon} I_t$$

we get

$$\frac{q^{I,o}}{q^{I,s}} = \frac{(1-\alpha_I)}{\alpha_I}\left(\frac{P^o}{P^s}\right)^{-\varepsilon}$$

now we pick up

$$\alpha_I = \frac{\left(\frac{P^o}{P^s}\right)^{-\varepsilon}}{\overline{\left(\frac{q^{I,o}}{q^{I,s}}\right)} + \left(\frac{P^o}{P^s}\right)^{-\varepsilon}}$$

where $\overline{\left(\frac{q^{I,o}}{q^{I,s}}\right)}$ is the same we had in the previous model. Then from

$$P_t^I = [(1-\alpha_I)(P_t^o)^{1-\varepsilon} + \alpha_I (P_t^s)^{1-\varepsilon}]^{\frac{1}{1-\varepsilon}}$$

we obtain

$$\left(\frac{P^o}{P^I}\right) = \frac{1}{\left[(1-\alpha_I) + \frac{\alpha_I}{\left(\frac{P^o}{P^s}\right)^{1-\varepsilon}}\right]^{\frac{1}{1-\varepsilon}}}$$

$$\left(\frac{Ps}{P^I}\right) = \frac{1}{\left[(1-\alpha_I)\left(\frac{P^o}{P^s}\right)^{1-\varepsilon} + \alpha_I\right]^{\frac{1}{1-\varepsilon}}}$$

$$q^{I,o} = (1-\alpha_I)\left(\frac{P_t^o}{P_t^I}\right)^{-\varepsilon} I_t$$

$$q^{I,s} = \alpha_I \left(\frac{P_t^s}{P}\right)^{-\varepsilon} I_t$$

check whether $q^{I,o}$ and $q^{I,s}$ match the amounts of investment goods we had in the previous model.

Set $\frac{G}{y^o} = g$, hence from the market clearing conditions,

$$c^o = y^o(1-g) - q^{I,o}$$

$$c^s = y^s - q^{I,s}$$

Now

$$\frac{c^o}{c} = \left[(1-\alpha_c)^{\frac{1}{\varepsilon}} + (\alpha_c)^{\frac{1}{\varepsilon}}\left(\frac{c^s}{c^o}\right)^{\frac{\epsilon-1}{\varepsilon}}\right]^{-\frac{\varepsilon}{\varepsilon-1}}$$

further

$$P = [(1-\alpha_c)(P^o)^{1-\varepsilon} + \alpha_c(P^s)^{1-\varepsilon}]^{\frac{1}{1-\varepsilon}}$$

$$P = \left[(1-\alpha_c) + \alpha_c\left(\frac{P^s}{P^o}\right)^{1-\varepsilon}\right]^{\frac{1}{1-\varepsilon}} P^o$$

$$\frac{P^o}{P} = \left[(1-\alpha_c) + \alpha_c\left(\frac{P^o}{P^s}\right)^{-(1-\varepsilon)}\right]^{-\frac{1}{1-\varepsilon}}$$

then using $c^o = (1-\alpha_c)\left(\frac{P_t^o}{P_t}\right)^{-\varepsilon} c$ and $\frac{P^o}{P} = \left[(1-\alpha_c) + \alpha_c\left(\frac{P^o}{P^s}\right)^{-(1-\varepsilon)}\right]^{-\frac{1}{1-\varepsilon}}$ we solve for α_c

$$\alpha_c = \frac{\left(\frac{c^s}{c^o}\right)}{\left[\left(\frac{P^o}{P^s}\right)^{\varepsilon} + \frac{c^s}{c^o}\right]}$$

Then

$$\frac{P^o}{P^C} = \left[(1-\alpha_c) + \alpha_c\left(\frac{P^o}{P^s}\right)^{-(1-\varepsilon)}\right]^{-\frac{1}{1-\varepsilon}}$$

$$\frac{P^s}{P^C} = \left[(1-\alpha_c)\left(\frac{P^o}{P^s}\right)^{1-\varepsilon} + \alpha_c\right]^{-\frac{1}{1-\varepsilon}}$$

from$\left(\frac{P^o}{P^I}\right)$ and $\frac{P^o}{P}$ we get

$$\frac{P^I}{P^C} = \left\{\frac{\left[(1-\alpha_c) + \alpha_c\left(\frac{P^o}{P^s}\right)^{-(1-\varepsilon)}\right]}{\left[(1-\alpha_I) + \alpha_I\left(\frac{P^o}{P^s}\right)^{-(1-\varepsilon)}\right]}\right\}^{-\frac{1}{1-\varepsilon}}$$

using

$$w^j = \left(1-\alpha^j\right)mc^j\left(\frac{y^j}{l^j}\right)$$

we get

$$l^o = (1-\alpha^o)mc^o\left(\frac{y^o}{w^o}\right)$$

$$l^s = (1-\alpha^s) mc^s \left(\frac{y^s}{w^s}\right)$$

$$w = w^o \frac{P^o}{P}(1-\tau^w)$$

$$G = gy^o$$

$$c = \left[(1-\alpha_c)^{\frac{1}{\varepsilon}}(c^o)^{\frac{\varepsilon-1}{\varepsilon}} + (\alpha_c)^{\frac{1}{\varepsilon}}(c^s)^{\frac{\epsilon-1}{\varepsilon}}\right]^{\frac{\varepsilon}{\varepsilon-1}}$$

$$q^o = \frac{P^I}{P^C}$$

$$q^s = q^o$$

$$c^{Rot} = w[l^o(1-\tau^w) + l^s] + \tau^{Rot}$$

$$\tilde{C}^{Rot} = \left[\gamma_c^{\frac{1}{e}}(c^{Rot})^{\frac{e-1}{e}} + (1-\gamma_c)^{\frac{1}{e}}(G)^{\frac{e-1}{e}}\right]^{\frac{e}{e-1}}$$

$$\lambda^{Rot} = \frac{\tilde{C}^{Rot}}{\left(\tilde{C}^{Rot} - b\tilde{C}\right)}\left[\gamma_c^{\frac{1}{e}}(c^{Rot})^{\frac{e-1}{e}} + (1-\gamma_c)^{\frac{1}{e}}(G)^{\frac{e-1}{e}}\right]^{-1} \gamma_c^{\frac{1}{e}}(c^{Rot})^{-\frac{1}{e}}$$

$$c^{Opt} = \frac{c - \omega c^{Rot}}{(1-\omega)}$$

$$\tilde{C}^{Opt} = \left[\gamma_c^{\frac{1}{e}}(c^{Opt})^{\frac{e-1}{e}} + (1-\gamma_c)^{\frac{1}{e}}(G)^{\frac{e-1}{e}}\right]^{\frac{e}{e-1}}$$

$$\lambda^{Opt} = \frac{\tilde{C}^{Opt}}{\left(\tilde{C}^{Opt} - b\tilde{C}\right)}\left[\gamma_c^{\frac{1}{e}}(c^{Opt})^{\frac{e-1}{e}} + (1-\gamma_c)^{\frac{1}{e}}(G)^{\frac{e-1}{e}}\right]^{-1} \gamma_c^{\frac{1}{e}}(c^{Opt})^{-\frac{1}{e}}$$

$$\lambda = (1-\omega)\lambda^{Opt} + \omega\lambda^{Rot}$$

$$\chi = \frac{w\lambda(\eta_w - 1)}{\eta_w}$$

$$A^o = 1$$

$$A^s = 1$$