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Abstract

Using information from all IMF conditionality programs from 1990 to 2018, we implement a dynamic *Augmented Inverse Probability Weighting Regression Adjustment* approach to examine the effects of programs, including public sector dismissals, on the size of the shadow economy. The estimated effect five years after the policy intervention indicates an increase in the share of the shadow economy to GDP by about 1.3 percentage points. More importantly, this change involves a sizable reallocation of *private* economic activity from its formal to its informal part, i.e., the size of the formal private sector relative to the size of the informal sector decreases by seven percentage points. We interpret these findings through the lens of a two-sector model in which there is interdependence between worker incomes and the allocation of product demand across the formal and informal sectors.

JEL-Codes: O170, J450.

Keywords: shadow economy, public sector employment, IMF programs, informality.

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1. Introduction

The informal economy, defined as all market-based legal production of goods and services deliberately concealed from public authorities to avoid payment of taxes or social security contributions or meeting certain legal labor market standards (Schneider et al. 2010), is a global phenomenon. Still, there is great variation within and across countries. On average, it represents 35 percent of GDP in low- and middle-income countries versus 15 percent in advanced economies. Regarding employment, the International Labor Organization estimates (see Bonnet et al., 2019) that about 2 billion workers, or over 60 percent of the world's adult labor force, operate in the informal sector--at least part-time.

Both economists and policymakers have pointed to the large presence of the informal economy in developing countries as an inhibiting factor in a variety of economic outcomes. Loayaza (1997) has argued that a large informal economy limits the state's tax revenue and, thus, its ability to finance the provision of growth-enabling public goods such as education, health, and investment in infrastructure, thus impacting negatively on human capital accumulation, growth, and poverty reduction. This, in turn, limits the quality of public services and worsens public perceptions of government effectiveness, thus increasing citizens' incentive, or willingness, to avoid taxes, increasing informality, and further weakening public revenues and services (Schneider, 2004). The significantly lower productivity, size, and capital intensity of informal relative to formal firms have also been mentioned as growth-retarding features of the informal economy (Johnson et al., 2007; La Porta and Shleifer, 2014; Ulyssea, 2020).

The negative assessment of the influence of informality on economic outcomes is reflected in the statements made by officials of international economic organizations regarding policies to reduce the size of the informal sector. For example, Cristalina Georgieva, Managing Director of the IMF, stated that "Reducing informality over time is essential for sustained and inclusive development… " (Deléchat, C. and Medina, 2021, p. vi), while Mari Pangestu, Managing Director of Development Policy and Partnerships at the World Bank stated that "Widespread informality hampers development progress in a variety of ways" (Ohnsorge and Yu, 2021, p. xv).

In addition to informality, international economic organizations have, since the 1980s, been focusing on the size of the public sector as a problem that needs to be addressed.[1] The combination of the international debt and fiscal crises afflicting many developing countries in the 1980s cemented policymakers' opinion regarding the need to shrink bloated bureaucracies and cut public-sector pay (Rodrik, 2000). That was, to some extent, a response to the rapid increase in the size of government consumption and public-sector employment in developing economies of the previous decades,[2] as well as disaffection with the perceived inefficiencies and low-growth prospects engendered by state-led development strategies (Rama, 1999).

Taking as given the need for public-sector employment retrenchment, this paper examines the influence of prescribed public-sector employment cuts on the size of the informal sector. In other words, we enquire whether public-sector employment retrenchment may be incompatible with the goal of shrinking the informal economy. To this purpose, we use quasi-experimental data provided by policy-induced public sector dismissals programs introduced by all IMF conditionality programs from 1990 to 2018. Typically, IMF programs include several conditions regarding the size of public sector employment. Once a country borrows from the IMF, its government agrees to initiate a series of reforms to correct the underlying inefficiencies of its economy. Program conditions focus on macroeconomic, financial, and monetary issues; however, several programs include structural reforms in areas like the labor and product market. In this respect, one condition typically included in several programs is the need to reduce public sector employment or the total public sector wage bill. Besides improving government finances, this condition is expected to affect the wage and employment structure in the labor market (Malley and Moutos, 1996; Lamo et al., 2012; Adam, 2020).

The main empirical challenge, then, is to estimate the causal effect of the public sector employment reduction program on the share of the shadow economy, given that IMF

[1] This change in attitudes was reflected in the decision by the World Bank in 1996 to modify its operational rules to allow lending for severance pay aimed at restructuring the public sector; the International Monetary Fund also started favoring public sector downsizing because it could allow a more durable reduction in government expenditures than cuts in the wages of civil servants, which it deemed are not sustainable in the long run (Rama, 1999).

[2] According to ILO data, the public sector employs roughly one-third of the global workforce, and nearly half of all formal sector workers in low-income countries.

conditionality programs are nonrandom events. In particular, macroeconomic, structural, and political factors determine the probability that a public sector employment cutback is included as a condition of an IMF program. Similarly, one may think that countries with a higher share of the shadow economy will have a higher propensity to face macroeconomic turbulence after an exogenous shock and thus resort to IMF for emergency lending. To deal with both issues, we use a dynamic *Augmented Inverse Probability Weighting Regression Adjustment* (IPWRA) approach, introduced by Jordà & Taylor (2016) and Angrist et al. (2018). This method creates pseudo-randomization by first estimating the propensity of having a public sector employment reduction program and then rebalancing the sample so that observations with higher (lower) propensity receive lower (higher) weighting.

These estimation techniques are relatively new to economics (Jorda et al., 2016; Acemoglu et al., 2019; Kandilov & Renkow, 2020); however, they have a long tradition in medical research (Robins et al., 1994; Bang & Robins, 2005). Specifically, IPWRA methods, under some assumptions, can be considered a substitute for instrumental variables approaches when estimating causal effects.[3] Implementing the IPWRA requires the specification of two models, one for modeling the probability of receiving treatment, i.e., having a public sector employment reduction program, and one for modeling the outcome variable, i.e., the share of the shadow economy.

This empirical strategy has several advantages compared to alternative methods. First, it allows for non-linearities in the time response of the outcome (i.e., the share of the shadow economy) to the treatment (i.e., public sector employment reductions). Thus, we do not need to impose a specific lag structure in the treatment variable nor a specific time response for the outcome variable. Second, the model allows us to derive short-run and medium-run effects. Third, the IPWRA, by employing a simple *Augmented Inverse Probability Weighting* model to estimate the local projections of the share of the shadow economy model, is more robust to model misspecification (Jordà et al., 2016; Jordà & Taylor, 2016; Kuvshinov & Zimmermann, 2019). In other words, IPWRA estimates are doubly robust to misspecification, as they provide correct estimates as long as either of the two underlying models is correctly specified (Wooldridge 2010).

[3] The main assumption that needs to be satisfied is the selection on observables assumption. If this assumption is satisfied, then the *IPWRA* model estimates a true causal effect (Cerulli, 2015).

We can summarize our findings as follows: a public sector employment reduction program exerts a positive and statistically significant effect on the shadow economy's share in GDP. This increase persists for at least five years after the public sector employment reduction program began, reaching 1.3 percentage points of GDP. Interestingly, the identified effect is more pronounced in autocracies and countries with low institutional quality. Additionally, we provide evidence that this increase in the share of the shadow economy is not a mechanical outcome due to a reduction in the formal government sector, but it involves a sizable reallocation of *private* economic activity from its formal to its informal part, i.e., the size of the formal private sector relative to the size of the informal sector decreases by seven percentage points.

We explain our findings through a two-sector model. One of the sectors produces a homogeneous good, and the other produces a vertically differentiated product (VDP). We identify the homogeneous-good sector with agriculture and assume that its output is produced by informal firms only. The production of the VDP is segmented according to quality: high-quality varieties are produced by firms in the formal sector, whereas informal-sector firms produce low-quality varieties. This assumption is based on the "quality dualism" framework of Banerji and Jain (2007); La Porta and Shleifer (2014) provide convincing evidence in support of this hypothesis. They argue that in many developing countries, while informal firms produce goods and services that formal firms also produce, there is a quality gap between the outputs of the two sectors, with formal firms having a comparative advantage in high-quality varieties and informal firms in low-quality substitutes. We assume that those working in the informal (urban or agrarian) sectors receive the market-clearing wage, whereas those working in the formal sector receive a binding minimum wage; this is also the wage received by government employees. We complement the aforementioned supply structure with a preference structure which, owing to differences in tastes and income across households, generates demand for both the high-quality variety produced by formal firms and the low-quality variety produced by informal firms.

We demonstrate that a reduction in public-sector employment in this model impacts on the size of the informal sector in two ways. First, as the number of workers available for hire in the private sector increases, the market-clearing wage received by informal

workers declines, thus generating an increase in employment and output in the informal sectors. This effect would also be obtained in a model without this paper's quality dualism preference structure. What is new in the present model is that the decline in the informal wage rate generates a switch in demand from the high-quality to the low-quality variety, leading to a further increase in the output of the informal sector and a decrease in the output of the formal sector. As a result, the relative size of the informal sector increases not only because there is a (mechanical) decrease in the size of the (formal) government sector but also because the formal private sector contracts.

The rest of the paper is organized as follows. Section 2 presents the empirical model and discusses the results of our investigation, while Section 3 develops a theoretical framework that can explain our findings. Concluding comments are offered in the last section.

2. Empirical Model and Results

The main goal is to estimate the effect of dismissals of public sector employees on the shadow economy. To this end, we exploit the effect of policy-induced public sector dismissals introduced by IMF conditionality programs. One of IMF's policy prescriptions typically involves explicit public sector layoffs. However, this policy is not always employed in countries with an IMF program. Using the Database of IMF Conditionality (Kentikelenis et al., 2016), in the period from 1980 to 2015, out of the 185 total IMF programs initiated in all countries, only 42 programs involved a condition to reduce the number of civil servants, whereas 48 programs had a policy prescription of lowering the total public sector wage bill.[4] To estimate the effect of public sector dismissal, we develop a dynamic model in the spirit of Angrist et al. (2018), Jordà and Taylor (2016), and Kuvshinov and Zimmermann (2019). More specifically, we compare the change in the share of the *shadow economy* from year 0, i.e., one year before a program that involved reductions in public sector employment, to year $h=1,2,3,4,5$. As the control group, we use all countries under an IMF program. However, as IMF programs are nonrandom policy events, we use the inverse probability weighting method (Angrist et al., 2018) to create pseudo-randomization.

[4] 17 of these programs also had a condition of reducing the number of civil servants.

This method has a series of advantages. First, it estimates the dynamic effect of IMF public sector employment reduction programs on the outcome variable. Second, it does not impose a specific functional form and accommodates possibly non-linear dynamic effects on the outcome variable. Third, we extend the empirical model to allow for the local projection of the *Shadow Economy* by estimating a two-stage model which relies on the inverse probability weighting and the regression adjustment method (Jordà et al., 2016; Jordà and Taylor, 2016). This latter model has the significant advantage that it requires only one of both stages, OLS or probit, to be correctly specified to derive correct estimates for the effect of treatment, i.e., public sector layoff programs (see Wooldridge 2010). In addition, neither method relies on any exclusion restrictions, and thus all variables can be considered endogenous in our dataset (Kuvshinov and Zimmermann, 2019). As a result, our analysis effectively takes into account the endogeneity.

To be more specific, we assume that the following probit model gives the estimated probability of having an IMF program that reduces public sector employment:

$$\widehat{PV_{\iota,t}} = \Phi\left(\sum_{j=1}^{2} S_{i,t-j}\,, X_{i,t}\,, \hat{\beta}\right) \qquad (1)$$

Where $\widehat{PV_{\iota,t}}$ is the predicted probability of a public sector employment reduction program in country *i* at time *t+1*, Φ is the cumulative distribution function of the standard normal distribution, $S_{i,t-j}$ is the lagged value of shadow economy as a share of GDP at *j* years before the program is enacted , $X_{i,t}$ is a vector of control variables, and finally $\hat{\beta}$ is a vector estimated coefficients.[5] Following Jordà and Taylor (2016), the Average Treatment Effect (ATE) of the treatment for each *h*, i.e., public sector employment reduction under the Augmented Inverse Probability Weighting Scheme, is given by

$$\Lambda_{AIPW}^{h} = \frac{1}{n}\sum_i \sum_t \left\{\left[\frac{D_{i,t}(S_{i,t+h}-S_{i,t})}{\widehat{PV_{i,t}}} - \frac{(1-D_{i,t})(S_{i,t+h}-S_{i,t})}{1-\widehat{PV_{i,t}}}\right] + \left[m_1^h\left(X_{i,t}^n, \hat{\theta}_1^h\right) - m_0^h\left(X_{i,t}^n, \hat{\theta}_0^h\right)\right] - \left[\frac{D_{i,t}m_1^h(X_{i,t}^n,\hat{\theta}_1^h)}{\widehat{PV_{i,t}}} - \frac{(1-D_{i,t})m_0^h(X_{i,t}^n,\hat{\theta}_0^h)}{1-\widehat{PV_{i,t}}}\right]\right\} \qquad (2)$$

[5] We follow Imbens (2004) and truncate the estimated propensity score to 0.05 and 0.95, so that no observation takes a very high weight, ensuring in this way that our results are not driven by a specific observation. However, we examine the robustness of our results in a model with an non-truncated propensity score.

where $m_1^h(X_{i,t}^n, \hat{\theta}_1^h)$, $m_0^h(X_{i,t}^n, \hat{\theta}_0^h)$ are the conditional mean of a regression of $(S_{i,t+h} - S_{i,t})$ on $X_{i,t}^n$,[6] and $D_{i,t}$ is the dummy that separates treatment and control groups (i.e., IMF programs with and without layoffs of public sector workers).

Note that (2) is estimated for each time horizon *h=1,…, 5;* thus, we compute the change in the share of the shadow economy for each period *h* after the treatment.[7] Then, for each period after that, we examine the associated change compared to the value at *t*. We follow Jordà and Taylor (2016) and use cluster robust methods to compute the estimated coefficients' standard errors.

To measure the size of the shadow economy, we use the Dynamic General Equilibrium (DGE) estimates of the share of the shadow economy of Elgin et al. (2021). The DGE model considers labor allocation between formal and informal sectors and its associated change over time, assuming optimizing households (Elgin and Oztunali, 2012). The main advantage of this method is that it covers a wide range of countries over a considerable period. In the present paper, we use the available estimates for 156 countries over the 1990- 2019 period. However, and this is a standard drawback of the DGE approach, all results rely heavily on the assumed functional forms (Schneider and Buehn, 2016). To ensure that our results are not driven by the choice of the DGE model estimates, for robustness, we also use the Multiple Indicators Multiple Causes (MIMIC) model-based estimates provided by the same authors. This measure uses six causes and three indicators to estimate the size of the informal sector as a share of the official GDP.[8]

[6] With $X_{i,t}^n \subset X_{i,t}$, as in Jordà and Taylor (2016), and Kuvshinov and Zimmermann (2019). In the regression adjustment model we also include country and time fixed effects.

[7] To estimate the ATE the above model relies on three assumptions: (i) conditional independence, i.e., after conditioning on the covariates, the outcomes are conditionally independent of the potential outcome, (ii) overlap, i.e., each treated observation has a positive probability of being allocated to each treatment level and (iii) independently and identically distributed sampling, which in our setting rules out interactions between countries in each period. For more details on the assumptions, see Imbens and Wooldridge (2009) and Angrist and Pischke (2009). To inspect visually whether the overlap assumption holds, in Figure A1 in the Appendix we present the smoothed densities of the estimated propensities of treatment and control, using a standard Epanechnikov kernel. As the reader can verify, considerable overlap is found among treated and control propensities, with the control observations covering almost all truncated estimated probabilities of the treated observations. This evidence provides support for the required overlap assumption and gives suggestive evidence in favor of our empirical strategy.

[8] The six causes are namely: the size of government, the share of direct taxation, Business Freedom index, a Fiscal Freedom index, the unemployment rate, and the GDP per capita. The three indicators are: the growth rate of GDP per capita, the labour force participation rate, and the share of M0/M1 currency (see Schneider et al., 2010 and Elgin et al., 2021 for more details).

We employ a series of macroeconomic controls to model the selection into treatment, i.e., equation (1). These are the current account balance as a share of GDP, the government budget balance as a share of GDP, a dummy that takes the value of 1 when a country is a democracy, the log of GDP per capita, the growth rate of GDP per capita, the number of years that the country has spent under an IMF program, the unemployment rate, the degree of public sector corruption, the share of the urban population, and, finally, the labor force participation rate. Table A1 in the appendix presents all variables' data sources and definitions.

The results of estimating model (2) are presented in Table 1. First, we estimate the effect of an IMF public sector dismal program on the share of the shadow economy to GDP. According to the first line of Table 1, a public sector dismissal program, i.e., a program that postulates that the government should reduce the share of public sector employment or reduce the public sector wage bill, has a positive and statistically significant effect on the share of the shadow economy. Moreover, the estimated effect increases over time, reaching a 1.3 percentage points increase in the share of the shadow economy after five years. Figure 1 provides a visual representation of the estimated effect for five years after treatment, together with the 5% (dark gray) and 10% (light gray) confidence intervals.

In the lines that follow, we perform a series of robustness tests. In the second line, we use the MIMIC measure of the share of the shadow economy instead of the DGE estimates. The estimated effect is very close to the one obtained in the first line, suggesting that the underlying measure of the shadow economy does not drive our results. Next, in line 3, we re-estimate the same model; however, this time, we consider only IMF programs with public sector layoffs instead of including programs with provisions for public sector wage bill reductions. The nature of our results remains unaltered in this case as well.

Table 1: Main Results and robustness

	(1) t	(2) t+1	(3) t+2	(4) t+3	(5) t+4	(6) t+5	Obs
Main Mode	0.19***	0.48***	0.54***	0.72***	0.99***	1.33***	2114
	(5.07)	(6.27)	(4.84	(4.88)	(5.77)	(6.97)	
MIMIC	0.06	0.25**	0.53***	0.59***	0.78***	0.95***	1872
	(1.27)	(2.04)	(3.89)	(4.90)	(5.61)	(5.75)	
Only Dismisals	0.19	0.31*	0.55**	0.80**	0.99**	1.31**	2113
	(1.35)	(1.82)	(2.07)	(2.01)	(2.28)	(2.37)	
Only Lags (no covariates)	0.19***	0.32***	0.36***	0.47***	0.62***	0.86***	2776
	(7.49)	(6.38)	(5.36)	(5.18)	(5.53)	(6.41)	
With 3rd lag	0.18	0.47***	0.51***	0.67***	0.97***	1.29***	2079
	(4.41)	(6.03)	(4.45)	(4.49)	(5.62)	(6.66)	
Single Lag	0.24***	0.52***	0.60***	0.78***	1.03***	1.37***	2147
	(6.61)	(6.98)	(5.48)	(5.26)	(5.92)	(6.87)	
No fixed effects	0.17***	0.42***	0.56***	0.76***	1.01***	1.36***	2147
	(4.37)	(6.27)	(5.70)	(5.36)	(5.76)	(6.58)	
Government Spending (% of GDP)	-0.97***	0.24	-0.06	-0.55	-0.56	-1.12	1640
	(-3.16)	(0.35)	(-0.08)	(-0.71)	(-0.83)	(-1.37)	

Notes: Each line corresponds to a different model, whereas each column gives the ATE at time t after the program. Clustered robust, t-statistics in parentheses. *, **, *** denote statistical significance at the 10%, 5% , and 1% level of statistical significance, respectively.

In the rest of the lines in Table 1, we examine whether our results hold under various empirical model specifications. Specifically, we first estimate (1) and (2) using only lagged values of the dependent variable and dropping all the rest of the covariates. Next, in lines 5 and 6, we experiment with the lag length of the dependent variable. In other words, we estimate the empirical model with the complete set of covariates and use one and three, respectively. Finally, in line 7, we estimate the main model, excluding the fixed effects from the regression adjustment model. In all cases, the qualitative nature of our results remains, and the estimated effects are very close to the baseline case, i.e., line 1.

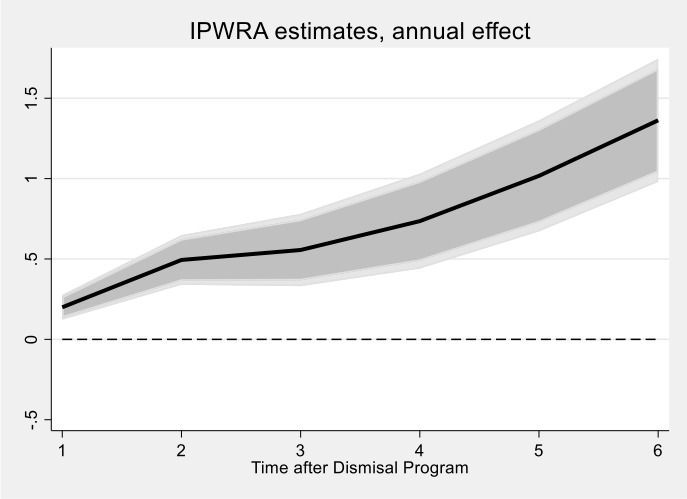

Figure 1: The effect of a reduction in Public Sector Employment on the share of the shadow economy (DGE measure).

It bears noting that our finding that a program involving public sector layoffs induces a reduction in the *share* of the shadow economy in aggregate economic activity could be just a purely mechanical implication of the reduction in the size of the government sector; since the government sector is part of the official economy, a drop of its size would produce a rise in the share of the shadow economy even if there was no change in the absolute size of the shadow economy. To remedy this and to examine whether our results correspond to a structural change in the economy involving the reallocation of private economic activity between the formal and informal sectors, in the final line of Table 1, we examine the impact of public sector layoffs on the evolution of the share of government spending in GDP. We find that a public sector employment reduction program does not negatively affect the relative size of the public sector. In fact, after the initial decline in the share of government spending, we observe a reversal in the following period and a non-significant impact from the period *t+2* onwards. When we combine this finding about the constancy of the share of government spending in GDP with (i) our finding that the share of the shadow economy in GDP rises by 1.3 percentage points (line 1 of Table 1), (ii) that the share of government spending in GDP is in our sample about 30%, and (iii) that the average share of the shadow economy in our sample is about 35% of GDP, we conclude that there is a reduction in the size of the *formal* private sector relative to the size of the shadow economy by about seven

percentage points[9], thus involving a sizable reallocation of private economic activity from its formal to its informal part.

In Table 2, we present further results regarding the effect of policy-induced public sector layoffs on the share of the shadow economy. All results are obtained using the first line of Table 1 as the baseline model. As a first exercise, we examine the underlying relationship depending on the level of institutional quality. For example, political and economic institutions are expected to affect the ease workers, and firms can relocate between the formal and informal sectors. The results in the first four lines of Table 2 indicate this is the case. First, we differentiate between democratic and autocratic countries using the dichotomous democracy variable of Bjørnskov and Rode (2020), which classifies political regimes according to a minimalistic definition of democracy.[10] According to the estimates, the positive effect of public sector layoffs on the share of the shadow economy is more pronounced in the case of autocracies, where all effects are statistically significant for all years after the program's initiation. Furthermore, the point estimates are more than double in magnitude than in the case of democracies. Moreover, as the first line indicates, the ATEs for democracies are much lower in size and statistically significant only for 4 and 5 years after treatment.

A similar picture emerges when we split our sample into countries with high and low institutional quality. We consider a country with high institutional quality when the International Country Risk Guide indicator of Quality of Government (taken from Teorell et al., 2016) is above the median value of the variable. In contrast, countries with a value of the index below its median value are categorized as countries with a low institutional quality. The results indicate that the effect of public sector employment reductions is more pronounced in countries with low institutional quality. All point estimates, except for *t*

[9] This is calculated as follows. Given that the shadow economy represents 35% of GDP, and the size of government is 30% of GDP, it obtains that the size of the formal private sector is about 35% of GDP. (Due to lack of data for the GVA of the public sector for many countries in our sample, we approximate the size of GVA generated by the private sector (both formal and informal) as GDP minus public sector expenditure.) Thus, the relative size of the formal private sector to the shadow economy is equal to 1. Following the public sector layoffs, we find that the share of government remains at 30% of GDP whereas the shadow economy expands to 36.3 % of GDP, thus reducing the share of the formal private sector to 33.7% of GDP, and its relative size to the shadow economy to 0.93 (=33.7/36.3).

[10] According to the Bjørnskov and Rode (2020) measure, a country is classified as a democracy if free and fair elections are conducted and if there was a peaceful turnover of offices after those elections.

when they are statistically the same, are more than twice in magnitude in countries with low institutional quality.

Table 2: Additional results

	(1) t	(2) t+1	(3) t+1	(4) t+3	(5) t+4	(6) t+5	Obs
Only Democracies	0.04	0.21	0.25	0.23	0.42	0.64	1206
	(0.62)	(1.36)	(1.13)	(0.77)	(1.09)	(1.35)	
Only Autocracies	0.03	0.44***	0.42***	0.73***	0.89***	1.36***	684
	(1.47)	(3.57)	(6.05)	(8.45)	(8.42)	(9.85)	
High Institutional Quality	0.22***	0.34	0.48	0.57	0.66*	0.84**	933
	(2.83)	(1.44)	(1.54)	(1.63)	(1.76)	(2.12)	
Low Institutional Quality	0.14**	0.60***	0.46**	0.59**	0.91***	1.36***	824
	(2.36)	(6.30)	(3.88)	(3.25)	(3.94)	(5.62)	
Placebo (any program)	0.05	0.12	0.19	0.28	0.37	0.46	2114
	(1.46)	(1.48)	(1.53)	(1.55)	(1.53)	(1.51)	
Random Treatment Assignment	0.00	0.04	0.03	0.00	-0.03	-0.04	2114
	(0.22)	(1.62)	(0.92)	(0.10)	(-0.62)	(-0.91)	
Exclude Africa	0.11**	0.26**	0.39**	0.46**	0.59*	0.86**	1457
	(2.36)	(2.39)	(2.52)	(1.98)	(1.91)	(2.27)	
Exclude Europe	0.23***	0.55***	0.60***	0.79***	1.11***	1.48***	1597
	(4.70)	(6.23)	(4.71)	(4.27)	(4.68)	(5.40)	
Exclude M.East	0.18***	0.47***	0.54***	0.70***	1.00***	1.32***	1966
	(4.30)	(5.44)	(4.32)	(4.34)	(5.31)	(6.40)	
Exclude Asia	0.29***	0.79***	0.84***	1.03***	1.41***	1.91***	1753
	(5.25)	(7.17)	(5.32)	(5.37)	(6.23)	(7.50)	
Exclude America	0.22***	0.56***	0.64***	0.87***	1.19***	1.59***	1683
	(3.31)	(4.07)	(2.82)	(3.08)	(4.08)	(5.00)	

Notes: Each line corresponds to a different model, whereas each column gives the ATE at time t after the program. Clustered robust, t-statistics in parentheses. *, **, *** denote statistical significance at the 10%, 5%, and 1% level of statistical significance, respectively.

In the rest of Table 2, we perform a series of additional robustness tests. First, we perform two placebo tests. In the first one (line 5), we use as treatment the occurrence of any IMF program. In this way, we want to verify that our results are not the outcome of an IMF program in general but are due to reductions in public sector employment. Then, in

line 6, we create a random treatment assignment, using the same probability of having a public sector employment reduction program as in the main treatment variable. Both cases indicate a non-statistically significant effect, suggesting that what we derive is not a placebo effect. Interestingly, in the case where we use as treatment all IMF programs, we find a negative effect but (marginally) statistically significant effect, at least at the 10% level of statistical significance and for five years after the treatment.

As a final robustness test, in the rest of Table 2, we exclude one country group at a time. Except for when we exclude Africa, the rest of the results indicate no statistically significant difference with the baseline case. When we exclude Africa, the statistical significance of the results remains; however, the estimated ATEs drop in magnitude. Of course, this is consistent with our previous results: most countries in this group have low institutional quality. Hence, excluding them from our sample increases the sample of the countries with high institutional quality and thus somehow replicates the results of line 3.

3. A Theoretical Framework

In this section, we provide a theoretical framework that can explain the main findings of our empirical analysis. To this purpose, we consider the case of an economy consisting of two perfectly competitive sectors. One produces a homogeneous good, and the other produces a vertically-differentiated product. We identify the homogeneous-good sector with agriculture and assume that its output is produced by informal firms only. The production of the vertically-differentiated product (VDP) is segmented according to quality: high-quality varieties are produced by *formal* firms (indexed by *F*), whereas low-quality varieties are produced by *informal* firms (indexed by *IN*). For ease of exposition in what follows, we refer to the sector producing the vertically-differentiated product (VDP) as the *modern* sector and the agricultural sector as the *agrarian* sector. We will reserve the adjective "informal" only for (that subset of) modern-sector firms, with the understanding that *all* producers in the agrarian sector are informal.

3.1 Sectoral Specification

3.1.1 Agrarian Sector

The agrarian good is produced with the use of informal labor and of a factor in fixed supply. The factor in fixed supply is provided by landowners (e.g. land), and we normalize its supply to unity. The labor used by the agrarian sector is denoted by L_A.

The agrarian sector's production function displays diminishing returns:

$$A = \gamma L_A - \frac{\delta}{2} L_A^2 , \quad (3)$$

where A denotes output, and the parameters γ and δ are both positive.

Denoting the (informal) wage rate as w, and using the agrarian good as the numeraire (P_A=1), the sector's profit-maximizing demand for labor is:

$$L_A = \frac{\gamma - w}{\delta} . \quad (4)$$

The resulting aggregate profits of agrarian sector producers are equal to:

$$\Pi = \frac{\delta}{2} \left(\frac{\gamma - w}{\delta}\right)^2 . \quad (5)$$

We assume that profits are equally distributed among the landowners, whose number is equal to *T*.

2.1.2 The Modern Sector

The modern sector is essentially made up of two distinct sub-sectors: the formal sector and the informal sector. What distinguishes the two sectors is that the formal sector produces a high-quality variety of the VDP, whereas the informal sector produces a low-quality variety. The VDP is produced with the use of labor only. Quality is measured by an index Q, $0 < Q < 1$, and there is complete information regarding the quality index. We assume that there exists a "cottage" technology available to all for producing low-quality varieties of the VDP, and a modern technology allowing the production of high-quality varieties. Low-quality varieties are defined as those for which $Q < \bar{Q}$, whereas high-quality varieties are identified with $Q > \bar{Q}$. Firms that have access to the technology which allows the production of high-quality varieties belong to the formal sector, whereas the rest of the firms are informal. We may think that the production technology is such that formal firms have access to excludable public inputs, allowing them to produce the high quality good at lower cost than informal firms (e.g., access to electricity at subsidized prices). Moreover, this categorization of firms is motivated by the fact that consumers of high-quality, high-priced

items are more likely to demand after-sales services (guarantees, repairs, etc) to which only formal sector firms can credibly commit to (and be legally responsible).

For informal firms to be able to produce the low-quality variety at a lower cost than formal firms, we need to assume that the difference in productivity between formal and informal producers is small when quality is low - since then, any wage advantage of informal firms (explained below) could offset their productivity disadvantage (see, Flam and Helpman, 1987; Eswaran and Kotwal, 1997; Malley and Moutos, 2001; Fotoniata and Moutos, 2013, for applications of this idea in other contexts). Rauch (1991) was the first to formalize the idea that the inferior technological capability of informal firms is the reason for their inability to compete on an equal footing with formal firms, thus forcing them to operate in the informal sector where the ability to avoid some costs related to regulation allows them to survive. Kar and Marjit (2011) have introduced an informal labor market in a Rauch-type model and show how firms below a productivity threshold employ only informal workers, whereas high-productivity firms employ both formal and informal workers. Our assumption that modern technology is available to a subset of firms that hire only formal workers is used as a convenient shortcut to concentrate on the implications of the interactions between the structure of product demand, informality, and government employment.

As long as this productivity disadvantage of the informal producers gets larger as quality increases, there will be a quality threshold after which formal producers will have lower costs than informal ones. Our assumption that the modern technology is available only to a subset of firms provides a stark manifestation of this idea.[11]

This simple formulation adopted here, captures two fundamental features of a typical dual developing economy regarding (i) the quality gap between sectors and (ii) the limited access of the informal sector to public services. These features have been extensively documented in the literature. Banerji and Jain (2007) quote many studies documenting the existence of quality gaps: for example, Myint (1985) claims that typical features of developing countries are "… large factories producing more expensive and better quality products and small handicraft industries producing cheaper and lower quality products", whereas Livingstone (1991) in his discussion of the informal sector in Kenya, says that "…

in a market dominated quantitatively by low-income consumers, [informal sector producers] offer cheap and 'appropriate' goods." The goods and services consumed by low-income consumers "… serve similar purposes at a much lower price - informal sector taxis, local beer instead of canned beer … and less hygienic eating houses and food kiosks instead of modern hotels." The lack of access by the informal sector to public services is particularly acute with respect to the legal and judicial system and the police, as well as to the capital markets, since informal businessmen cannot exercise full property rights over their capital and product (Loayza, 1996), an implication of which is a rise in the cost of their capital (De Paula and Scheinkman, 2011).

Formal firms face labor market regulation in having to pay a (binding) minimum wage, $\overline{w}$. In addition to labor market regulations, formal firms have to incur a cost, *F*, per physical unit of output. We may think of this cost as the "price of formality," representing the burden of various taxes[12] imposed on formal firms or the costs of complying with various environmental, health, or work-safety regulations. Informal firms do not comply with any of the above regulations, and pay their workers the (market-clearing) informal wage rate w. We assume that the minimum wage rate, $\overline{w}$, is higher than the informal wage rate, $w < \overline{w}$.

Following Flam and Helpman (1987) and Banerji and Jain (2007) we assume that average costs depend on quality and that, for any given quality level, average cost is independent of the number of physical units produced. Perfect competition then ensures that prices will be equal to average (and marginal) costs. We write the average cost functions (as functions of quality) for formal and informal firms as,

$$AC(Q_F) = P(Q_F) = \overline{w}Q_F + F \tag{6}$$

$$AC(Q_I) = P(Q_I) = wQ_I. \tag{7}$$

Since $\overline{w} > w$ and $Q_F > Q_I$, it follows that the price of the formal firms will be higher than of informal firms:

$$P(Q_F) > P(Q_I).$$

This specification of average costs implies that as quality increases, more units of labor are required to produce each physical unit of the VDP product. This assumption is consistent with the fact that increases in quality – for a given state of technological capability – involve

[12]We abstain from any explicit treatment of issues relating to the government budget constraint.

the employment of a larger number of personnel not only for the production of a higher number of features attached to each good that directly absorb labor, but also to the development and refinement of these features as well.

2.2 Households

The economy is populated by a fixed number of landowners (*T*) and identical working households (*L*) who are endowed with one unit of labor, which they offer inelastically[13]. For simplicity we assume that the landowning households do not supply any labor.

Following Flam and Helpman (1987) we treat the homogeneous good as being divisible, while the VDP is assumed to be indivisible and households can consume only one unit of it. A convenient characterization of household preferences over the consumption of goods (for either landowners or working households) is given by the following utility function for household *i*,

$$U_i = \theta_i lnQ + lnA_i \qquad (8)$$

In equation (8), *Q* stands for the quality (either Q_F or Q_I) level of the VDP, A_i is the quantity of the homogeneous good (agricultural) consumed by agent i and θ_i is a parameter that differentiates the intensity of preferences among households for the quality level of the *VDP*.

In order to conform with the empirical observations on the economic environment of developing economies, we make the following assumptions regarding the purchasing behavior of different households.

We first assume that all households working in the informal (either modern or agrarian) sector have the same preferences, with taste parameter $\theta_I = 1,$ and always decide to consume the low-quality, informally-produced VDP (Q_I). The budget constraint of these households is,

$$w = P(Q_I) + A_I = wQ_I + A_I,$$

[13]Although there is no empirical evidence on the elasticity of labour supply in developing countries, the assumption that is inelastic seems reasonable for these economies which are characterized by the lack of social security nets and the widespread poverty.

where, A_I is the consumption of the homogeneous good, and wQ_I is the price of the low-quality variety offered by informal firms. Given the above preferences, the utility-maximizing demand for the homogeneous good A_{IN} is

$$A_I = w - wQ_I \tag{9}$$

Figure 2 displays the choices of a household receiving the informal wage. The two quality levels of the VDP are depicted on the horizontal axis, and the quantity of the homogeneous good (as well as household income given that $P_A = 1$) is depicted on the vertical axis. The household's income determines the budget constraint, which, since only two quality levels of the VDP are available, comprises just of points **1** and **2**.

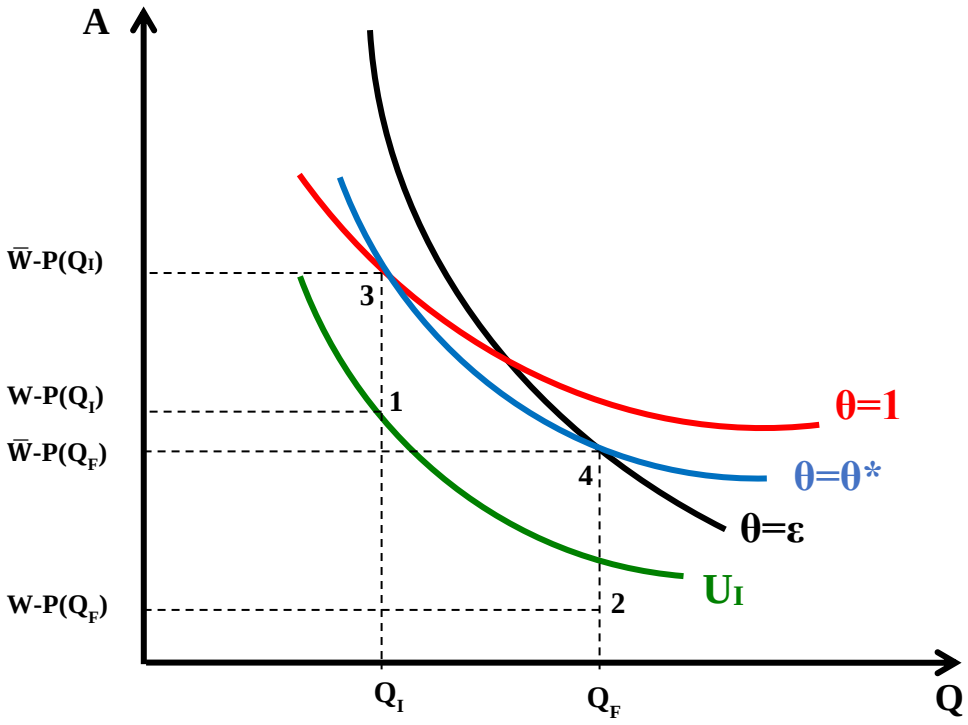

Figure 2: Consumption behavior of formal-sector and informal-sector households.

Low-income households select between these points, the one giving them the highest utility, which in Figure 2 is point **1** - the one associated with consumption of the informally-produced, low-quality variety of the VDP.

For households earning the minimum wage, we assume that there are differences in their intensity of preferences over the quality level, implying the willingness to pay for the high quality Q_F. For this income group, we assume that the taste parameter is distributed according to a continuous uniform distribution in the interval $[1, \varepsilon\ ]$ and its cumulative density function is given by:

$$D(\theta) = \begin{cases} 0 & \text{if} \quad \theta < 1 \\ \frac{\varepsilon - \theta}{\varepsilon - 1} & \text{if} \quad 1 \leq \theta \leq \varepsilon \\ 1 & \text{if} \quad \theta > \varepsilon \end{cases} \tag{10}$$

For simplicity, and without much loss of generality, in what follows, we assume that changes in the employment status of households will be associated with changes in their preference structure; i.e., households switching from informal to formal employment will acquire the preference traits (through peer pressure or social osmosis) of formal-sector households.

In Figure 2, we depict the formal-sector households with income equal to the minimum wage; their budget constraint comprises points 3 and 4. Among these households, the one with the highest value of $\theta(=\varepsilon)$, has a map of "steep" indifference curves (one of which is denoted by $\theta = \varepsilon$) and achieves maximum utility by consuming bundle 4. As a result, the utility-maximizing demand for the homogeneous good is,

$$A_F^H = \overline{w} - P(Q_F) = \overline{w} - (\overline{w}Q_F + F). \tag{11}$$

To ensure that this household purchases both goods, we assume that $\overline{w}(1 - Q_F) > F$, which can be the case only if $Q_F < 1$. In contrast, the household with the lowest value of θ, is represented by indifference curve $\theta=1$, and chooses to consume bundle 3, i.e., the informally-produced good. The demand for good A by this household is,

$$A_F^L = \overline{w} - P(Q_I) = \overline{w} - \overline{w}Q_I. \tag{12}$$

Equations (11) and (12) imply that for a *formal*-sector household with $\theta = \theta_i$, the indirect utility function takes the form:

$$V_F^H = \theta_\iota lnQ_F + \ln(\overline{w} - \overline{w}Q_F - F), \text{ if it consumes the high-quality good} \tag{13}$$

$$V_F^L = \theta_\iota lnQ_I + \ln(\overline{w} - \overline{w}Q_I), \quad \text{if it consumes the low-quality good} \tag{14}$$

Let θ^* denote the value of θ for which a household is indifferent between consuming one unit of quality Q_F at price $P(Q_F)$ and one unit of quality Q_I at price $P(Q_I)$. For this household, it must hold that, $V_F^H = V_F^L$, which implies:

$$\theta^* \ln Q_F + \ln(\bar{w} - \bar{w}Q_F - F) = \theta^* \ln Q_I + \ln(\bar{w} - wQ_I) \quad (15)$$

Solving equation (12) for θ* we find,

$$\theta^* = \frac{\ln(\bar{w} - wQ_I) - \ln(\bar{w} - \bar{w}Q_F - F)}{\ln Q_F - \ln Q_I} \quad (16)$$

As expected, equation (16) implies that $\frac{d\theta^*}{dw} < 0$, since a rise in the informal wage would increase the cost of the (low-quality) informal variety and induce more households to purchase the (high-quality) formal variety.

A formal-sector household with $\theta = \theta^*$ is depicted in Figure 2 as possessing the indifference curve passing from points 3 and 4.

Using the specification of the uniform distribution adopted above, we find that the number of formal-sector households that consume the high-quality variety (i.e., those with $\theta \geq \theta^*$) is equal to $(\frac{\varepsilon - \theta^*}{\varepsilon - 1})L_F$, where L_F is employment in the formal sector.

We assume that landowners earn significantly more than minimum-wage earners so that they always choose to consume the high-quality variety of the VDP, produced in the formal sector, implying that their consumption of homogeneous good , A_T , is

$$A_T = \frac{\pi_A}{T} - P(Q_F) = \frac{(1-\alpha)BL_A^{\alpha}}{T} - (W_M Q_F + F),$$

Where $\frac{(1-\alpha)BL_A^{\alpha}}{T}$ is the profits accruing to each of the *T* landowners.

2.3 Government Sector

In addition to setting (and enforcing) the minimum wage, the government is assumed to employ workers for the production of basic public services (e.g., law and order, national defense), and it pays these workers the minimum wage.[14] The number of these workers is denoted by L_G and we assume that these workers have the same preferences as formal-sector workers who also receive the minimum wage, i.e. ($U_i = \theta_i lnQ + lnA_i$), with the distribution of the taste parameter θ being also given by equation 10. This implies that the number of government-employed households which consume the high-quality variety (i.e., those with $\theta \geq \theta^*$) is equal to $(\frac{\varepsilon - \theta^*}{\varepsilon - 1})L_G$.

[14] We abstain from a full treatment of the government's presence in the economy.

2.4 Analysis

To examine the effects of reductions in government employment on the relative size of the informal economy, we start by describing the allocation of workers across sectors. We assume that workers are mobile across sectors and, thus, should they fail to find employment either in the government sector or in the formal (modern) sector at the minimum wage, they offer their services in the informal (modern plus agrarian) sectors at the market clearing wage, w.

The demand for labor by formal-sector firms is induced by the demand for high-quality varieties registered by two groups of households. In the first group belong the formal-sector and government-sector households that choose to purchase the high-quality variety of the VDP; the size of this group is equal to $(\frac{\varepsilon-\theta^*}{\varepsilon-1})(L_F + L_G)$. The second group consists of all landowning households (T) . Thus, the demand for labor by formal-sector firms is equal to $(\frac{\varepsilon-\theta^*}{\varepsilon-1})(L_F + L_G)Q_F + TQ_F$. Adding government employment to this, we get the (aggregate) demand for formal employment (L_F^D) , i.e.

$$L_F^D = (\frac{\varepsilon-\theta^*}{\varepsilon-1})(L_F + L_G)Q_F + TQ_F + L_G. \quad (17)$$

Since $\frac{d\theta^*}{dw} < 0$ (i.e., equation (16)), we conclude that the demand for formal labor is an increasing function of the informal sector wage rate.

The demand for labor by informal firms in the modern sector is induced by the consumption of the low-quality variety of the VDP by households (working) in both the formal and informal sectors. The number of formal-sector plus government-sector households consuming the low-quality variety is equal to $(\frac{\theta^*-1}{\varepsilon-1})(L_F + L_G)$. The number of informal and agrarian households is equal to $L - (L_F + L_G)$, where L is the total number of workers/households. Thus, the demand for informal labor by low-quality producers of the VDP is equal to $(\frac{\theta^*-1}{\varepsilon-1})(L_F + L_G)Q_I + (L - (L_F + L_G))Q_I$. Adding to this the demand for labor by the agrarian sector (see equation (4)), we get that the aggregate demand for informal labor is

$$L_I^D = (\frac{\theta^*-1}{\varepsilon-1})(L_F + L_G)Q_I + (L - (L_F + L_G))Q_I + \frac{\gamma-w}{\delta}. \quad (18)$$

We note that the aggregate demand for informal labor is decreasing in the informal wage rate, *w*, not only because the demand for labor in the agrarian sector is a negative function of the wage rate but also because an increase in *w* reduces the proportion of formal-sector and government-sector households purchasing the low-quality variety of the VDP.

Under the assumption of inter-sectoral labor mobility, the wage rate in the agrarian and informal sectors will be determined by the requirement that the number of labor units demanded in the informal and agrarian sectors equal the relevant labor supply. Since the latter is equal to the workers not employed in the formal and government sectors ($L_I = L - (L_F + L_G)$), and assuming that workers prefer to find employment either in the formal or government sector (so that $L_F^D = L_F$), we can state the labor-market clearing condition for workers in the informal and agrarian sectors as,

$$L - (L_F + L_G) = (\frac{\theta^* - 1}{\varepsilon - 1})(L_F + L_G)Q_I + (L - (L_F + L_G))Q_I + \frac{\gamma - w}{\delta} \ . \qquad (19)$$

Equation (19), along with equations (16) and (17), can be used to solve for the market-clearing wage rate *w*, θ^*, and L_F. Employment in the agrarian sector can then be determined by equation (4), which further allows to determine informal employment in the modern sector as the difference between total informal employment (=$L - (L_F + L_G)$) and employment in the agrarian sector.

We now provide a diagrammatic representation of the equilibrium allocation of employment across sectors.[15] In Figure 3, the size of the horizontal axis $O_I O_F$, is equal to the total labor supply, L, which is divided between (total) formal employment (=$L_F + L_G$), and (total) informal employment (L_I=$L - (L_F + L_G)$). Informal employment is measured rightwards from the origin *A*, whereas formal employment is measured leftwards from the origin *B*. The demand curve for informal labor, drawn with respect to the origin *A*, is depicted as the downward sloping curve L_I^D (equation 15), whereas the demand curve for formal labor is drawn with respect to the origin B, and is depicted as the upward sloping curve L_F^D

[15] We assume throughout that the (exogenous) changes considered are small so as to ensure that the induced changes in the market-clearing wage paid to informal-sector workers (modern plus agrarian) do not cause it to rise to (or, above) the level of the minimum wage.

(equation 17). The latter curve is drawn assuming that the (exogenous) number of government employees is measured by the line segment $B\Gamma$. [16]

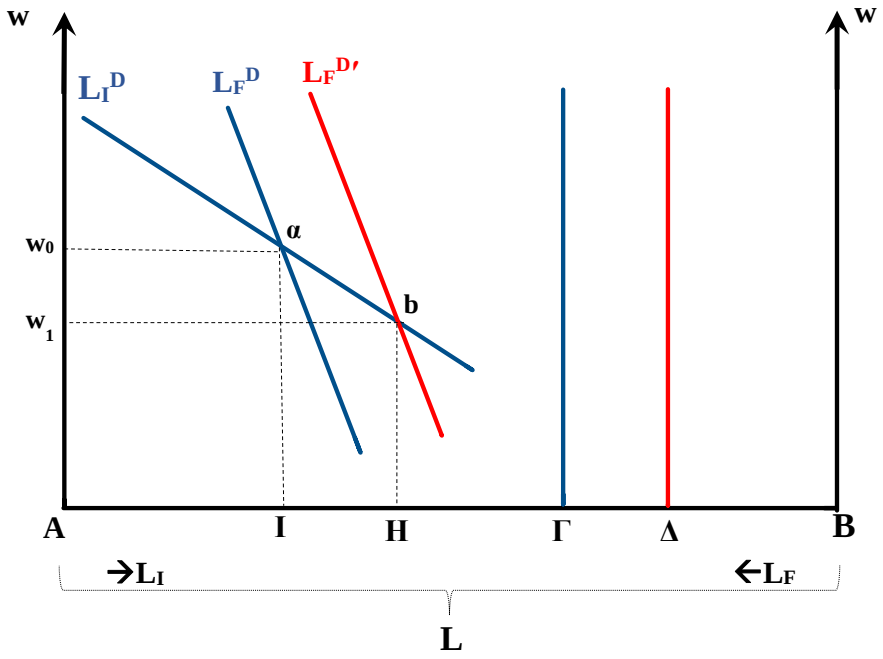

Figure 3. Effects of Reductions in Government Employment on Labor Allocation Across Sectors

The initial, full-employment, equilibrium allocation of labor across sectors is determined at the intersection of the L_I^D and L_F^D curves at point α, with total informal employment being equal to AI, and private formal-sector employment being equal to $I\Gamma$. The informal wage rate is equal to w_0.

Consider now a reduction in government employment to $B\Delta$. As a result, the L_F^D curve shifts to the right ($L_F^{D'}$), and the new equilibrium informal wage rate drops to w_1- as determined by point *b*, whereas there is an expansion of informal employment by IH units, to AH. Note that informal employment (modern plus agrarian) expands by more than the reduction in government employment. This happens because private employment in the

[16] The diagram is drawn so that the L_I^D curve is flatter than the L_F^D curve. This is done since a, e.g., fall in the informal wage rate impacts on the total demand of informal labours not only by switching demand from the high-quality variety of the VDP to the low-quality variety produced by informal firms in the modern sector, but also by the increased demand for (informal) labour by the agrarian sector.

formal sector contracts also due to the switch in demand toward the low-quality variety of the VDP produced by informal producers as a result of the drop in the informal wage rate. Thus, the informal sector's size (both employment and output) increases not only in relationship to the total size of the formal sector (i.e., the sum of the formal private sector plus the government sector), but also in relationship to the formal private sector.

We note that our framework can also be used to analyze the effects of a reduction in the public sector wage bill without public sector layoffs – i.e., a reduction in public sector wages. This reduction in the income of public sector employees would induce some of them to switch from consuming the high-quality varieties (produced by formal firms) to the low-quality varieties offered by informal firms, thus inducing a reallocation of economic activity in the private sector from formal to informal producers.

4. Conclusion

Using information from all IMF conditionality programs from 1990 to 2018, we find that programs, including public sector dismissals, exert a positive and statistically significant effect on the share and the absolute size of the shadow economy. We interpret this finding through the lens of a model in which there is interdependence between worker incomes and the allocation of product demand across the formal and informal sectors.

Our finding implies that programs aiming at public-sector employment retrenchment may be incompatible with the goal of shrinking the informal economy. Therefore, to the extent that reductions in public employment are deemed necessary for meeting a country's stabilization and growth objectives, care should be taken that complementary policies are enacted that prevent the growth of the shadow economy, thereby avoiding the inimical effects of informality on economic growth.

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Table A1: variable sources and definitions		
Variable	**Definition**	**Source**
Institutional Quality	The mean value of the ICRG variables "Corruption", "Law and Order" and "Bureaucracy Quality" scaled 0-1.	Teorell et al., (2016)
Democracy dummy	Dichotomous indicator of democracy based on a minimalist definition. A country is defined as democratic, if elections were conducted, these were free and fair, and if there was a peaceful turnover of legislative and executive offices following those elections.	Bjørnskov and Rode (2020)
GDP per capita growth	Annual percentage growth rate of GDP per capita based on constant local currency.	World Bank's World Development Indicators (WDI)
Log GDP per capita	The log of the GDP per capita is gross domestic product (in constant 2010 dollars) divided by midyear population.	WDI
Unemployment Rate	The share of the labor force that is without work but available for and seeking employment.	WDI
Corruption	Model-based country-year point estimates, aggregated from multiple codings submitted by country experts on the question "How routinely do public sector employees grant favors in exchange for bribes, kickbacks, or other material inducements".	Varieties of Democracy (V-Dem) project.
Urban Population	The share of people living in urban areas as defined by national statistical offices.	WDI
Labor Force Participation Rate	The proportion of the population ages 15-64 that supply labor for the production of goods and services during a specified period (ILO estimates).	WDI
No of years in IMF program	The total number of years (since 1980) that the country has spent in an IMF program.	Kentikelenis (2016) and author calculations
CA balance	Record of all transactions in the balance of payments covering exports and imports of goods and services, payments of income, and current transfers between redisents of a country and nonresidents as a share of GDP	IMF's World Economic Outlook (WEO)
Budget Balance	Difference between the share of total revenue and the share of government expenditure to GDP (variables as defined in WEO)	WEO and author calculations
Share of the Shadow Economy (DGE)	Dynamic general equilibrium model-based (DGE) estimates of informal output (% of official GDP)	Elgin et al. (2021)
Share of the Shadow Economy (MIMIC)	Multiple indicators multiple causes model-based (MIMIC) estimates of informal output (% of official GDP)	Elgin et al. (2021)

Figure A1. Overlap plot