

# CHAPTER 3

## Growing Apart or Moving Together? Synchronization of Informal- and Formal-Economy Business Cycles

*Given its relative large size and the potential to dampen formal-economy business cycles, the informal economy needs to be factored into macroeconomic policy decisions. This chapter provides empirical evidence that informal output moves in the same direction as formal output, but in a more muted manner, with the direction of causality running from the formal economy to the informal economy. Informal employment, in contrast, does not co-move with the formal economy. Hence, the informal sector can provide a short-term buffer to formal-economy labor market disruptions even if, in the long run, it can act as a poverty trap. Policies that aim to curtail informal employment therefore need to be complemented with interventions that provide other buffers to short-term adverse shocks.*

### Introduction

In an average emerging market and developing economy (EMDE), the informal sector accounts for about one-third of gross domestic product (GDP), compared with about 18 percent of GDP in advanced economies (figure 3.1). Its large size makes the informal economy a potential amplifier or dampener of business cycles that policy makers need to take into account when deciding on countercyclical macroeconomic policies. If the informal economy expands while the formal economy contracts, it may support household incomes and consumer demand during economic downturns and serve as a safety net (Loayza and Rigolini 2011). If the informal economy behaves procyclically (that is, grows during expansions in the formal economy), it could function as an auxiliary “growth engine” during economic expansions (Chen 2005; Dell’Anno 2008; Meagher 2013).

In theory, the cyclical relationship between informal and formal sectors is ambiguous.<sup>1</sup> Some theoretical models have shown that the informal economy may absorb a larger share of workers as jobs become scarce in the formal sector during economic downturns (Bosch, Goni, and Maloney 2007; Dix-Carneiro et al. 2021; Loayza and Rigolini 2011). Such behavior by the informal sector could facilitate economic recovery—by providing a potential supply of labor to the formal sector and preventing the hysteresis costs on unemployment—if reentry into the formal sector is possible when the formal economy returns to expansion (Colombo, Onnis, and Tirelli 2016; IMF 2017).

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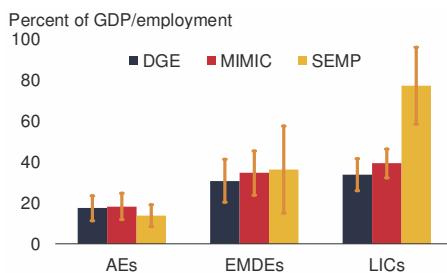
*Note:* This chapter was prepared by Ceyhun Elgin, M. Ayhan Kose, Franziska Ohnsorge, and Shu Yu. Research assistance was provided by Hrisyana Doytchinova and Maria Hazel Macadangdang.

<sup>1</sup> Some early research suggested that the degree of cyclicity of the informal economy depends on the measure of informality used and country characteristics.

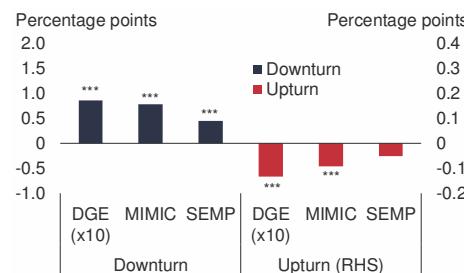
### FIGURE 3.1 Formal- and informal-economy business cycles

*Informal economic activity may amplify or dampen formal-economy business cycles. In EMDEs, the shares of informal output and informal employment rise significantly above their long-term averages during formal-economy downturns, even though informal output growth falls significantly below its long-term average. Informal employment growth remains around its long-term average during both upturns and downturns in the formal economy.*

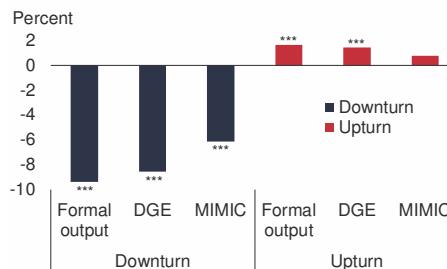
A. Share of informal economy



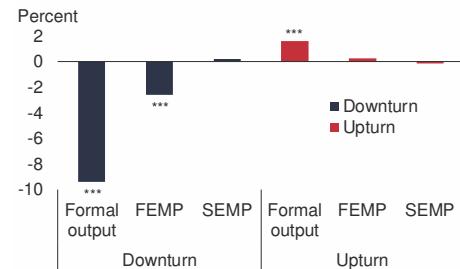
B. Changes in shares of informal economy during formal economy upturns and downturns in EMDEs



C. Output growth during formal economy upturns and downturns in EMDEs



D. Employment growth during formal economy upturns and downturns in EMDEs



Sources: Penn World Table 9.1; World Bank.

Note: Data are for 1990-2018. AEs = advanced economies; DGE = dynamic general equilibrium model estimates; EMDEs = emerging market and developing economies; FEMP = formal employment; LICs = low-income countries; MIMIC = multiple indicators and multiple causes model estimates; RHS = right-hand side; SEMP = self-employment. “Downturn” refers to growth rates of official GDP below zero, while “upturn”

refers to growth rates of official GDP equal to or above zero. In B-D, \*\*\* indicates that the group average is significantly different from zero at the 10 percent level.

A. Bars show unweighted group averages for the latest year available, with the whiskers showing one standard deviation.

B. Shares of informal output (in percent of official GDP) and informal employment (in percent of total employment) are first-differenced and demeaned to capture detrended annual changes. Bars show unweighted group averages of detrended annual changes in shares of informal output/informal employment. Results for DGE-based estimates are shown in tenths.

C.D. Levels of output and employment in both formal and informal economies are logged, first-differenced and demeaned to capture detrended annual growth rates. Bars show unweighted group averages of detrended annual growth rates of output/employment levels.

In contrast, if informal firms provide services, as well as final and intermediate goods, to the formal sector, formal and informal sectors move in tandem. In addition, informal-economy income can support formal-economy demand. In these circumstances, the informal economy would amplify macroeconomic fluctuations.<sup>2</sup>

<sup>2</sup> For cyclical linkages between the formal sector and informal sector, see Arvin-Rad, Basu, and Willumson (2010); Docquier, Müller, and Naval (2017); Gibson (2005); Lubell (1991); Restrepo-Echavarria (2014); Roca, Moreno, and Sánchez (2001); and Schneider (1998).

Empirical evidence on the behavior of the informal economy over the business cycle is also inconclusive. This has been attributed partly to different country characteristics and the roles of different economic shocks.

After presenting a brief review of the literature on the cyclical behavior of the informal economy, this chapter addresses the following questions:

- How synchronized are movements in informal and formal economies?
- Do fluctuations in formal economy output “cause” fluctuations in output or employment in the informal economy?

**Contributions.** The chapter makes three contributions to the literature. First, it is the first analysis of the cyclical relationships between formal and informal sectors using data for multiple measures of informality for a large set of economies—about 160 economies, comprising 36 advanced economies and about 120 EMDEs. It covers a long, recent period—1990–2018—and is the first study of the behavior of both output and employment in the informal economy because previous studies have focused on either one or the other of these two variables. The comparison yields valuable insights into the cyclicity of labor productivity.

Second, the chapter focuses on the absolute size of the informal economy whereas earlier studies examined the informal economy only in relation to the formal economy. This allows for a more precise understanding of cyclical dynamics. Earlier studies examined the size of the informal economy relative to that of the formal economy without explaining the underlying mechanism. For instance, when the relative size of the informal sector rises during recessions, it could reflect an expanding informal economy or an informal economy that shrinks less than the formal economy. Some previous studies have interpreted the rising ratio as evidence for an expanding informal economy during recessions. The few previous studies of the procyclicality of informal output levels have been restricted to a small group of countries and study either solely output (Bajada 2003; Dell’Anno 2008; Giles 1997) or solely employment (Fiess, Fugazza, and Maloney 2010).

Third, the chapter is the first to document a causal linkage from formal-economy cyclical developments to the informal economy by using an instrumental variables approach. This improves on existing studies that have tested for basic Granger causality between formal and informal economies within individual countries. The previous Granger causality tests help to determine whether one time series is useful in forecasting another. However, they do not test for “true” causality as instrumental-variable regressions are able to identify (Angrist and Pischke 2009), because omitted variables can generate spurious causality (Eichler 2009).

**Main findings.** The chapter reports two major results. First, informal-economy output moves in step with formal output: informal-economy output movements are strongly positively correlated with formal-economy output movements. Hence, when earlier studies found that the share of the informal economy rose during formal-economy

recessions, this reflected a slower absolute decline in informal output than in formal output rather than an absolute increase in informal activity. In addition, this chapter finds that informal employment largely behaves “acyclically.”

Second, in an instrumental variable estimation, the study shows that the direction of causality runs from the formal economy to the informal economy. Specifically, it documents a causal linkage from fluctuations in formal-economy output to fluctuations in informal-economy output. In terms of employment, such a causal linkage is not found: whereas informal output behaves procyclically, informal employment behaves acyclically. The latter may indicate that informal labor markets do not adjust in terms of employment status during economic cycles but in terms of wages or working hours (Guriev, Speciale, and Tuccio 2016; Meghir, Narita, and Robin 2015).

The rest of the chapter is organized as follows. First, the chapter summarizes past studies of the co-movement between formal and informal business cycles, followed by a section on the data and methodologies. The chapter then presents evidence on the co-movement of formal and informal economies. The chapter further provides new estimates of the causal relationship between formal and informal economy business cycles and discusses potential explanations for the cyclical behavior of the informal economy. Finally, it concludes with a discussion of policy implications and directions for future research.

## Literature review: Linkages between formal and informal sectors

The literature on the cyclical behavior of the informal economy offers mixed conclusions. Studies focusing on the share of the informal economy in total output or employment tend to find countercyclical behavior whereas studies focusing on output or employment levels tend to find procyclical behavior. The theoretical literature suggests that the nature and degree of cyclicity will depend on the type of shocks causing business cycle fluctuations and on the presence of labor market rigidities. This section summarizes that literature.<sup>3</sup>

### Informal economy as a countercyclical safety net

The informal sector can serve as a buffer and safety net for the poor if it absorbs labor during recessions. This can facilitate an economic recovery provided that reentry into the formal sector is possible when the formal economy returns to expansion (Colombo, Onnis, and Tirelli 2016; IMF 2017; Loayza and Rigolini 2011).

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<sup>3</sup> Several recent studies argue that pervasive informality may influence the measured cyclicity of the formal economy. For example, models with a large and poorly measured informal sector can generate excess volatility of formal consumption relative to formal output—a common feature of business cycles in many EMDEs (Horvath 2018; Restrepo-Echavarria 2014).

**Macroeconomic evidence.** Macroeconomic studies suggest that the informal economy can behave “countercyclically” in the sense that the share of informal employment rises during business cycle downturns. For example, one study reported that, on average in 54 economies during 1984–2008, a 1-standard-deviation slowdown in GDP per capita growth (that is a slowdown of 3 percentage points a year) was associated with a short-run increase in the share of self-employment in the total labor force by 1.2 percentage points, although with considerable cross-country heterogeneity (Loayza and Rigolini 2011).

In one study, the correlation between informal employment and official GDP has been estimated as modestly negative (about -0.3), whereas the correlation between formal employment and formal output was strongly positive (Fernández and Meza 2015). A study that used electricity consumption as a proxy for total economic activity found that the informal economy expanded following banking crises in 48 economies over the 1984–2005 period (Colombo, Onnis, and Tirelli 2016). Several studies have found that, during economic downturns, the share of informal output tended to increase (Busato and Chiarini 2004; Elgin 2012; Kaufmann and Kaliberda 1996).

More procyclical fiscal policy in less developed economies with weaker institutions may contribute to the countercyclicality of informal activity. Fiscal policy tends to be more procyclical in countries with higher informality (Çiçek and Elgin 2011). In particular, procyclical fiscal consolidation during recessions, including through higher taxes, may encourage more informal employment and output.

**Microeconomic evidence.** Work-flow data for Brazilian metropolitan labor markets between 1983 and 2002 showed that the informal sector was able to absorb more labor during economic downturns as jobs became scarcer in the formal sector (Bosch, Goni, and Maloney 2007). The share of formal employment fell as formal-economy output contracted, in part because the rate at which workers found formal jobs plummeted while the rate at which they found informal jobs remained broadly stable (Bosch and Esteban-Pretel 2012).

### Informal economy as a procyclical engine of growth

Because informal firms provide services, as well as final and intermediate goods to the formal sector, a positive correlation between formal and informal sector activity may emerge. In addition, informal-economy income can support formal-economy demand.<sup>4</sup>

**Macroeconomic evidence.** In studies focusing on absolute output levels rather than the share of the informal economy, movements in informal-economy output have been

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<sup>4</sup> For linkages between the two sectors, see Arvin-Rad, Basu, and Willumsen (2010); Lubell (1991); and Moreno-Monroy, Pieters, and Erumban (2014). For links focusing on income support, see Docquier, Müller, and Naval (2017); Eilat and Zinnes (2002); Gibson (2005); Kanbur (2017); Schneider (1998); and World Bank (2014). Although the relationship between formal and informal sectors may be symbiotic in the short run, in the long run pervasive informality may create poverty traps and stymie economic development.

found to be positively correlated with movements in formal-economy output in Australia, Canada, New Zealand, and a group of 19 Latin American economies (Bajada 2003; Dell'Anno 2008; Giles 1997; Tedds and Giles 2000). In a group of developing countries, episodes during which relative demand or productivity shocks expanded the nontradable sector (as opposed to the tradable sector) were associated with higher informal employment (hence, procyclicality; Fiess, Fugazza, and Maloney 2010). In Brazil and Mexico, higher separation rates from informal jobs and a large drop of the formal job finding rate may induce labor outflows from the informal sector during recessions (Bosch and Maloney 2008). A theoretical model establishes procyclical informal-formal sector linkages when formal firms subcontract labor-intensive stages of production to the informal sector (Arvin-Rad, Basu, and Willumsen 2010).

**Microeconomic evidence.** In firm-level data for India, formal and informal sector employment have been found to be positively correlated, in part because subcontracting by formal-sector firms to informal firms contributes to job creation in the informal sector (Moreno-Monroy, Pieters, and Erumban 2014).<sup>5</sup> An examination of data from Indian manufacturing firms showed that the gross value added of several predominantly informal industries was positively correlated with that of the formal sector as well as with foreign direct investment. This may be indicative of technological spillovers to both formal and informal sectors (Beladi, Dutta, and Kar 2016).

### Factors influencing the cyclical of the informal economy

Some studies have sought to reconcile the mixed evidence by pointing to country characteristics that would generate different degrees of procyclicality. Others have pointed to different kinds of shocks that would lead to different types of cyclical linkages.

**Cross-country heterogeneity.** There is considerable cross-country heterogeneity in the degree of procyclicality of informal employment. It has been found to be higher when informality was greater (Loayza and Rigolini 2011), when informal employment was more common (Shapiro 2014), or when there were stronger informal-formal sector linkages such as through subcontracting (Mbaye, Benjamin, and Gueye 2017; Moreno-Monroy, Pieters, and Erumban 2014).

**Sources of shocks causing business cycles.** The informal economy can move procyclically or countercyclically, depending on the sectoral origin of the shocks that generate business cycles in the presence of wage rigidities, especially in the formal sector (Fiess, Fugazza, and Maloney 2010; Leyva and Urrutia 2018). Positive relative demand or productivity shocks to the nontradable sector, especially services, where the share of informal employment tends to be higher could increase informal employment,

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<sup>5</sup> In an earlier study focusing on two European countries, it was found that at least two-thirds of the income earned in the informal economy was immediately spent in the formal economy, providing a considerable stimulus for it (Schneider 1998).

generating procyclicality in informal employment, especially when combined with wage rigidities in the formal sector.<sup>6</sup> Conversely, in the presence of wage rigidities, a negative shock to the tradable sector would expand informal (nontradables) employment and thus appear as countercyclical.

## Data and methodology

This chapter relies on the database discussed in the previous chapter. It applies a battery of statistical tests used, first, to establish the co-movement between formal output and measures of informal activity and, second, to analyze the direction of causality.

**Data.** This chapter uses the two model-based estimates of informal output—the multiple indicators multiple causes (MIMIC) estimates and the dynamic general equilibrium (DGE) estimates (chapter 2).<sup>7</sup> Annual MIMIC estimates are available for 160 economies (including 36 advanced economies) for 1993-2018. Annual DGE estimates are available for 158 economies (including 36 advanced economies) for 1990-2018. These measures of informal output are complemented with self-employment as a proxy indicator of informal employment (La Porta and Shleifer 2014). Annual data on shares of self-employment are available for 179 economies (including 36 advanced economies) between 1990 and 2018. All measures of informal activity are defined in levels of output or levels of employment, rather than as shares of total activity or employment as is standard practice in the business cycle literature (for example, Claessens, Kose, and Terrones 2012; Fernández and Meza 2015). Data for formal output are from the Penn World Table 9.1 and the World Development Indicators (WDI) (in 2011 U.S. dollars; data from Penn World Table 9.1 were expanded using WDI). The Hodrick-Prescott (HP) filter is used to detrend the time series with the smoothing parameter set to 100. All exercises rely on detrended logarithms of these levels. The findings are robust to using annual growth of formal and informal output and employment or to using the Baxter-King filter to detrend series.

**Methodologies.** To quantify the co-movement of formal output with the various measures of informality, the chapter employs a wide range of measures, including correlation, factor models, coincidence of turning points and business cycle phases, and probit regression models (Claessens, Kose, and Terrones 2012; Kose, Prasad, and Terrones 2003; Restrepo-Echevarria 2014). Some methodological details are presented in annex 3B. As a second step, the chapter uses a two-stage least squares instrumental variable approach to estimate the direction of causality between formal output and measures of informal activity. Specifically, formal-economy output is instrumented using government consumption, export growth, and trade-to-GDP ratios. The methodology is described in greater detail in annex 3C.

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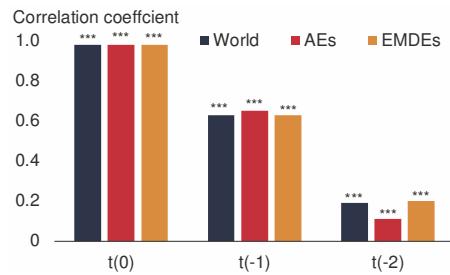
<sup>6</sup>See chapter 4 for a discussion about sectoral distribution in the informal economy. Informality tends to be higher in labor-intensive service sectors, which are largely nontradable.

<sup>7</sup>The correlation of the DGE measure does not occur by construction (see annex 3A for details).

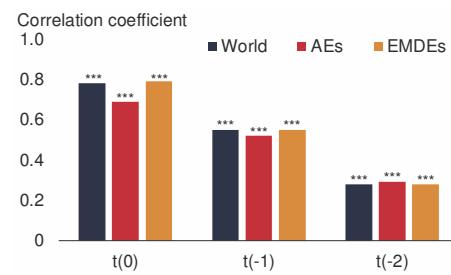
### FIGURE 3.2 Correlations of informal output with formal output

*Informal-economy output is highly and positively correlated with formal-economy output, both contemporaneously and in lagged terms. Formal employment is also positively and significantly correlated with formal-economy output, whereas informal employment is largely uncorrelated with formal-economy output in EMDEs.*

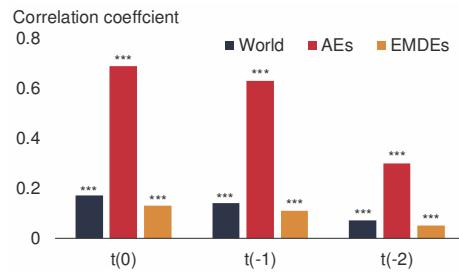
**A. Correlation between formal output and informal output (DGE-based estimates)**



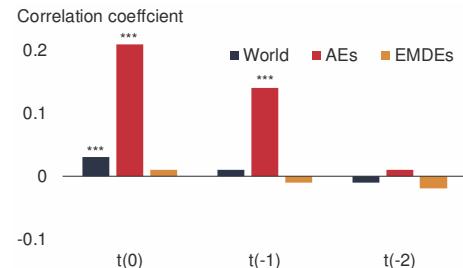
**B. Correlation between formal output and informal output (MIMIC-based estimates)**



**C. Correlation between formal output and formal employment**



**D. Correlation between formal output and informal employment**



Sources: Penn World Table 9.1; World Bank.

Note: Data are for 1990-2018. AEs = advanced economies; DGE = dynamic general equilibrium model estimates; EMDEs = emerging market and developing economies; MIMIC = multiple indicators multiple causes model estimates. \*\*\* denotes 10 percent significance. A-D. Each bars shows the correlation between the cyclical components of formal-economy output (in logs, of year t(-2), t(-1) and t(0)) and the cyclical components of informal-economy output (A, B; in logs), formal employment (that is, total employment excl. self-employment in logs; in C) and informal employment proxied by self-employment (in D; in logs) of year t(0).

## Synchronization of formal and informal business cycles

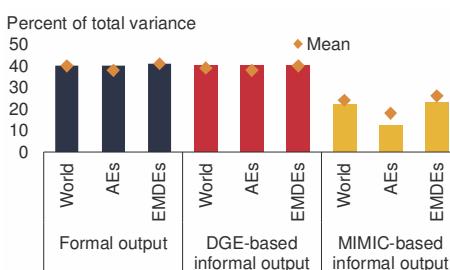
A battery of statistical exercises suggests that informal output is strongly positively correlated with formal output; hence, it behaves in a procyclical manner. In contrast, informal employment is largely unrelated to formal output movements; hence, it behaves in an acyclical manner.

**Correlations.** Contemporaneously, informal-economy output movements are highly and statistically significantly correlated with formal-economy output movements (figure 3.2). Formal employment is also positively and statistically significantly correlated with

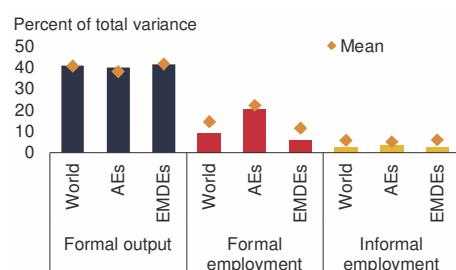
### FIGURE 3.3 Co-movement between formal and informal business cycles

A common factor explains about 40 percent of variance in formal-economy output. It also explains 40 percent of variance of informal-economy output when based on DGE estimates, and 24 percent using MIMIC estimates. However, it explains only about 10 percent or less of movements in formal employment and informal employment.

**A. Share of variance in formal output and informal output explained by a common factor**



**B. Share of variance in formal output and formal and informal employment explained by a common factor**



Sources: Penn World Table 9.1; World Bank.

Note: Data are for 1990–2018. All data series are transformed into cyclical components and standardized before the estimations. Formal employment is proxied by total employment excluding self-employment. Informal employment is proxied by self-employment. AES = advanced economies; DGE = dynamic general equilibrium model estimates; EMDEs = emerging market and developing economies; MIMIC = multiple indicators multiple causes model estimates.

A.B. Bars show the median (diamond for mean) fractions of variance explained by the common dynamic factor in each group. The results here are obtained from estimating dynamic common factor model, as in Stock and Watson (2011), for each country in the sample (see annex 3B for details). AR(1) process for the common dynamic factor is used, as suggested by the estimation results.

formal-economy output, although considerably less strongly, particularly in EMDEs, whereas informal employment is largely uncorrelated with formal-economy output, again particularly in EMDEs. Lag correlations are considerably smaller than contemporaneous correlations, suggesting that informal output responds to formal-economy output fluctuations within a year.<sup>8</sup>

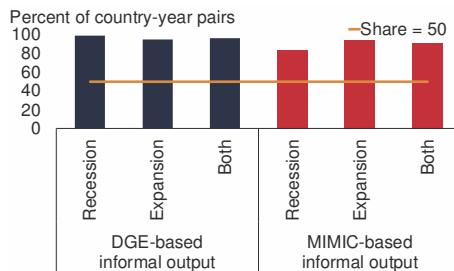
**Common factor approach.** For each country, a common factor is extracted from informal- and formal-sector output as well as informal and formal employment, in a dynamic factor model (annex 3B; Kose, Prasad, and Terrones 2003). The results are broadly in line with the correlations discussed above. On average, the common factor explains about 40 percent of the variance in both formal-economy output and DGE-based informal-economy output (figure 3.3). It explains somewhat less (24 percent) of the variance in MIMIC-based informal-economy output, in part because MIMIC estimates tend to be more stable than DGE estimates as a result of the reliance of the former measure on slow-moving country characteristics such as economic and business freedom indexes. The common factor also explains a modest fraction of movements in formal employment, especially in advanced economies. In contrast, informal employment does not appear to share a common factor with formal employment or with informal- or formal-economy output in either advanced economies or EMDEs.

<sup>8</sup>In EMDEs, however, lag correlations are statistically indistinguishable from contemporaneous correlations.

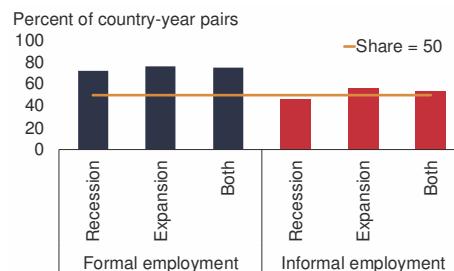
### FIGURE 3.4 Coincidence of formal and informal business cycles

In more than 90 percent of country-year pairs, formal and informal output are in the same business cycle phase. This coincidence of business cycle phases is less pronounced for employment than for output, with informal employment being in the same phase as formal output in about a half of country-year pairs.

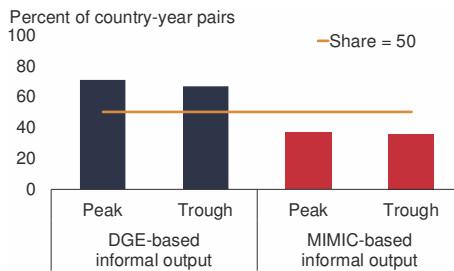
**A. Coincidence of business cycle phases: Formal and informal output**



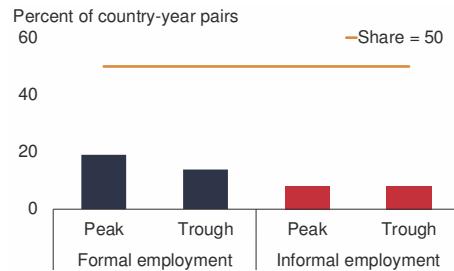
**B. Coincidence of business cycle phases: Formal output and employment**



**C. Coincidence of business cycle turning points: Formal and informal output**



**D. Coincidence of business cycle turning points: Formal output and employment**



Sources: Penn World Table 9.1; World Bank.

Note: Data are for 1990–2018. Business phases and turning points are identified as in chapter 2. Recessions are the periods from peak to trough whereas expansions are the periods from trough to peak (Claessens, Kose, and Terrones 2012). Trough and peaks are identified as in chapter 2, where the Bry and Boschan (1971) method is used to identify turning points. Formal employment is proxied by total employment excluding self-employment. Informal employment is proxied by self-employment. DGE = dynamic general equilibrium model estimates; MIMIC = multiple indicators multiple causes model estimates.

A.B. Bars show the percent of country-year pairs where formal output and informal output (in A: formal or informality employment in B) are in the same business cycle phases (that is, both are in recession, or in expansions, or in either cases, labeled as “both”).

C.D. Bars show the share of formal peaks (or troughs) that happen to be informal peaks (or troughs).

**Coherence in business cycle phases and turning points.** Formal and informal sectors typically share the same business cycle phases (figure 3.4). In more than 90 percent of country-year pairs, formal and informal output are in the same business cycle phase. This coincidence of business cycle phases is considerably less pronounced for employment than for output. Formal employment and formal output share the same business cycle phases in 75 percent of all country-year pairs, whereas informal employment is in the same phase as formal output in 54 percent of country-year pairs. Similarly, between 30 and 70 percent (using MIMIC or DGE, respectively) of turning points (peak or trough) of formal output business cycles coincide with turning points of informal output business cycles, whereas informal employment turning points coincide about 10 percent of the time with formal-economy output turning points.

**Econometric approaches.** A probit regression is used to estimate the probability of the informal economy being in recession at the same time that the formal economy is (annex 3B). Indeed, the probability of informal output being in recession is statistically significantly higher when formal output is in a recession, even after controlling for country and year fixed effects as well as investment and credit growth (figure 3.5). On average, the probability of informal output being in recession is higher by about 25 percentage points when formal output is in recession than when formal output is not in recession.<sup>9</sup> Similar results pertain to the probability of a new recession starting in the informal sector when the formal economy is in recession. Again, this contrasts with the finding that the probability of informal employment declining is little affected by a formal-economy contraction.

## Causal linkages between formal- and informal-economy business cycles

The results described in the previous section suggest a strong correlation between formal and informal economies. Some previous studies reported strong evidence of Granger causality running from the formal economy to the informal economy in individual countries, and mild evidence of reverse causality in some cases (Bajada 2003; Giles 1997; Giles, Tedds, and Werkneh 2002). However, Granger causality does not establish “true” causality, and ignoring reverse causality could lead to biased estimation results (Angrist and Pischke 2009). Hence, the chapter employs a novel approach with an instrumental variables estimation to test for the direction of causality. The results based on this approach suggest that formal-economy output fluctuations “truly” cause informal-economy output fluctuations.

**Econometric approach.** Formal-economy output is instrumented using government spending and two trade-related variables: the cyclical components of the terms of trade and real exports (annex 3C). Being largely concentrated in the nontradable sector, the informal economy is unlikely to be highly influenced directly by movements in trade-related variables. In addition, government spending is typically restricted, by legislation and regulation, from purchasing goods and services from the informal economy. Therefore, movements in trade-related variables and changes in government consumption can be interpreted as exogenous instruments that directly affect the formal economy without directly influencing the informal economy.

**Results.** The regression results confirm that formal-economy output fluctuations in the previous year, as instrumented by lagged trade-related terms and government consumption, “cause” fluctuations in the informal economy in the following year. On average, a 1 percent increase in formal-economy output “causes” a 0.4-0.8 percent expansion in the following year in informal-economy output and formal employment.

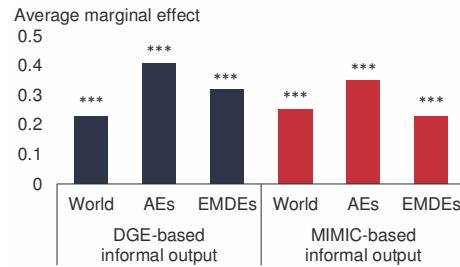
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<sup>9</sup> Probabilities for the global sample need not be near the average of the advanced economy and EMDE sample because of different year fixed effects.

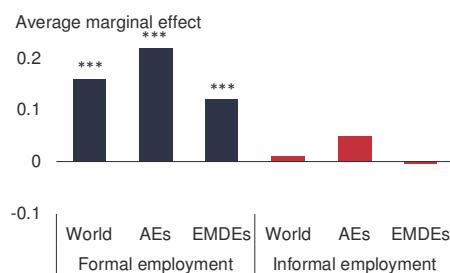
### FIGURE 3.5 Probability of a recession

*Informal output and formal employment are more likely to be in (or moving toward) a recession when formal output is in a recession. However, the same does not hold for informal employment.*

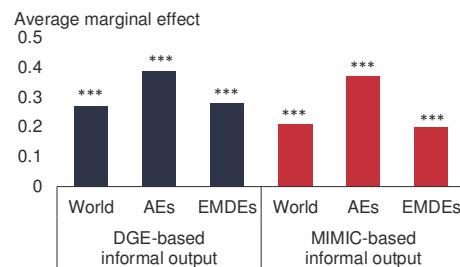
**A. Impact of formal output recession on probability of informal output recession**



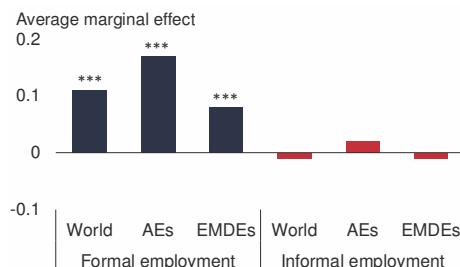
**B. Impact of formal output recession on probability of employment recession**



**C. Impact of formal output recession on probability of starting an informal output recession**



**D. Impact of formal output recession on probability of starting an employment recession**



Source: World Bank.

Note: Data are for 1990–2018. Average marginal effects are shown in bars. Recessions are the periods from peak to trough, whereas expansions are the periods from trough to peak (Claeysen, Kose, and Terrones 2012). Troughs and peaks are identified as in chapter 2, where the Bry and Boschan 1971 method is used to identify turning points. Formal employment is proxied by total employment excluding self-employment. Informal employment is proxied by self-employment. AEs = advanced economies; DGE = dynamic general equilibrium model estimates; EMDEs = emerging market and developing economies; MIMIC = multiple indicators multiple causes model estimates. \*\*\* denotes 10 percent significance.

A.B. Bars show regression results from the following probit model:  $Pr(ISREC_{it} + 1) = \phi(\alpha + \beta FS_{it} + \theta X_{it} + \pi_i + \mu_t + \epsilon_{it})$ , where  $ISREC_{it}$  is a dummy variable that equals one when the informal sector in country  $i$  and year  $t$  is in recession, and zero otherwise.  $FS_{it}$  is a dummy representing recession in the formal economy, and  $X_{it}$  is a vector of control variables (including the annual growth rates of real investment and domestic credit to the private sector; Penn World Table 9.1 and 2020 World Development Indicators). All regressions include country dummies ( $\pi_i$ ) and year dummies ( $\mu_t$ ). See annex 3B for details.

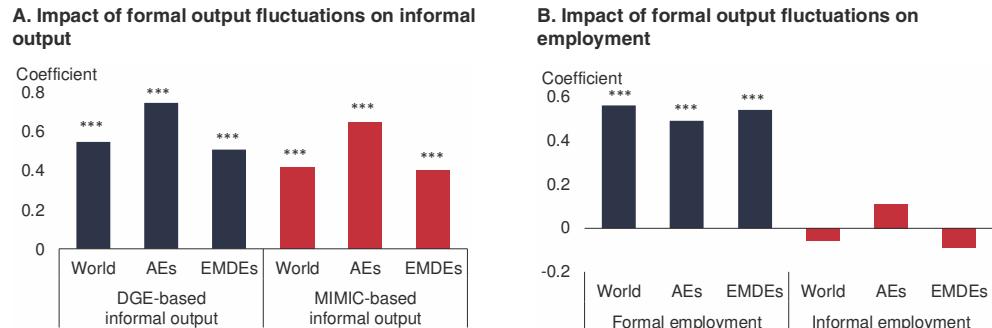
C.D. Bars show regression results from the probit model with the same form as in A and B. Here  $ISREC_{it}$  is a dummy variable that equals one when the informal sector in country  $i$  and year  $t$  is in the start of a recession, and zero otherwise. See annex 3B for details.

This impact does not differ materially between advanced economies and EMDEs. In contrast, such formal-economy output fluctuations do not cause significant fluctuations in informal employment, especially in EMDEs (figure 3.6).

**Robustness tests.** These results are robust to several alternative specifications. Instrumenting only with either trade-related variables or government consumption yields similar results. In addition, the results are robust to using system generalized methods of moments (GMM) estimation to address potential endogeneity; to specifying the dependent variable in terms of the share of the informal economy in the total

### FIGURE 3.6 Impact of formal output fluctuations on the informal sector

A 1 percent increase in formal economy output raises informal output and formal employment by 0.4-0.8 percent one year later, but does not affect informal employment significantly.



Source: World Bank.

Note: Data are for 1990-2018. See annex 3C for details. Government consumption and trade-related terms (proxied by terms of trade and exports) are included as instrumental variables (IVs) to explain the variation in formal output (proxied by official GDP). Formal employment is proxied by total employment excluding self-employment. Informal employment is proxied by self-employment. AEs = advanced economies; DGE = dynamic general equilibrium model estimates; EMDEs = emerging market and developing economies; MIMIC = multiple indicators multiple causes model estimates. \*\*\* denotes 10 percent significance.

A. Bars show estimated coefficients when DGE- or MIMIC-based estimates are used as the dependent variable.

B. Bars show estimated coefficients when formal employment or informal employment (defined as self-employment) are used as the dependent variable.

economy (annex 3C); and to using an alternative variant of the DGE measures to test for robustness to different modeling assumptions in the construction of the DGE estimates (annex 3D).

### Explaining the cyclicity of the informal sector

The previous sections have established that informal-economy output and formal employment behave “procyclically” in the sense of responding to formal-economy output fluctuations significantly and positively. Meanwhile, informal employment acts “acyclically” in the sense of not significantly and systematically responding to formal-economy output fluctuations. This accounts for the rising share of informal employment during formal-economy recessions documented by studies like Loayza and Rigolini (2011).

There are at least two possible reasons explaining why informal employment behaves acyclically. First, informal employment may respond to different shocks from informal output and formal employment, or it may respond differently to the same shocks. As an example of the latter, the informal labor market, being more flexible than the formal sector, may respond by reducing hours worked per person or by lowering wages, rather than by reducing the number of employed.<sup>10</sup> A second possible reason is that, although

<sup>10</sup> For discussions of these arguments, see Guriev, Speciale, and Tuccio (2016); Loayza and Rigolini (2011); Maloney (2004); and Meghir, Narita, and Robin (2015).

job separation rates rise during recessions in both formal and informal sectors, the rate at which workers find formal jobs plummets whereas that at which they find informal jobs remains broadly stable (Bosch and Esteban-Pretel 2012; Bosch, Goni, and Maloney 2007).

## Conclusion

This chapter presents a wide variety of approaches that document the strong co-movement of informal-economy output with formal-economy output, caused by movements in formal output, but the lack of such co-movement for informal employment. This suggests that, although output in the informal economy behaves procyclically and, therefore, may amplify aggregate output fluctuations (for example, Ferreira Tiryaki 2008; Roca, Moreno, and Sánchez 2001), the unresponsiveness of informal employment to the business cycle may provide a buffer for household incomes by ensuring continuity of employment in the informal economy.

The resilience of informal employment in the face of business cycle swings, juxtaposed with the weaker development levels associated with informality (discussed in chapter 4), suggests a trade-off. In the short run, informal employment can provide a safety net during business cycles; in the long term, however, the informal sector can exacerbate poverty and stymie development (Docquier, Müller, and Naval 2017). Policy measures that—deliberately or inadvertently—reduce informality and thus benefit longer-term development and poverty reduction could, therefore, usefully be accompanied by a strengthening of official social safety nets to protect vulnerable population groups from the short-term costs of the loss of the unofficial safety net provided by the informal sector. The necessity of strengthening the resilience of the informal sector is particularly relevant in the context of the COVID-19-induced recession (box 2.1).

Also, if co-movement between formal and informal output reflects synergies, such as through subcontracting, policy measures aimed at curtailing informal activity could disrupt formal activity. These effects could be mitigated if measures that reduce informality were accompanied by greater labor and product market flexibility in the formal sector that facilitates the absorption of informal participants (World Bank 2019).

**Directions for future research.** The results reported in this chapter point to several promising areas for future research. First, the cyclical behavior of other features of the informal economy could usefully be examined. For example, if greater flexibility of wages or hours worked is what ensures acyclical behavior of informal employment despite procyclical informal output, then informal wages or hours of employment should be particularly procyclical. It would be useful to establish whether this is the case. Second, the channels through which formal-economy business cycles affect the informal economy could be further explored and quantified. This includes the degree of interconnectedness between formal and informal firms.

## ANNEX 3A Theory behind the cyclicalities of the DGE-based estimates

The production function for official GDP is assumed to have the following form:

$$Y_{Ft} = A_{Ft} K_t^\alpha N_{Ft}^{1-\alpha} \quad (3A.1)$$

where  $Y_{Ft}$  is output in the formal sector in year  $t$ ,  $A_{Ft}$  is total factor productivity in the formal sector in year  $t$ ,  $K_t$  is the capital stock available in year  $t$ , and  $N_{Ft}$  is employment in the formal sector in year  $t$ .

The production function for informal output is assumed to have the following form:

$$Y_{It} = A_{It} N_{It}^\gamma, \quad (3A.2)$$

where  $Y_{It}$  is output in the informal sector in year  $t$ ,  $A_{It}$  is labor productivity in the informal sector, and  $N_{It}$  is employment in the informal sector. As assumed in Elgin and Oztunali (2012),  $\dot{A}_{It} = (\dot{K}_t + \dot{A}_{Ft}) / 2$  and  $N_{It}$  is a function of  $A_{Ft}$  and  $K_t$ . To simplify the discussion, it is assumed that  $A_{It} = (A_{Ft} + K_t) / 2 + c$ , where  $c$  is a constant.  $N_{It}$  has the following form:<sup>11</sup>

$$N_{It} = \left\{ \frac{\gamma A_{It}}{(1-\tau_t)(1-\alpha)A_{Ft}} \left[ \frac{\frac{1}{\beta} - 1 + \delta}{\alpha(1-\tau_t)A_{Ft}} \right]^{\frac{\alpha}{1-\alpha}} \right\}^{\frac{1}{1-\gamma}} \quad (3A.3)$$

Because  $A_{It}$  and  $N_{It}$  are functions of  $A_{Ft}$  and  $K_t$ ,  $Y_{It}$  can be expressed as a function of  $A_{Ft}$  and  $K_t$ . The co-movement between  $Y_{It}$  and  $Y_{Ft}$  can be driven only by shocks in  $A_{Ft}$  and  $K_t$ . Assuming that shocks in  $N_{Ft}$  are not related to shocks in  $K_t$  or in  $A_{Ft}$ , because  $\frac{\partial Y_{Ft}}{\partial K_{Ft}} > 0$  and  $\frac{\partial Y_{Ft}}{\partial A_{Ft}} > 0$ , the positive correlation between  $Y_{Ft}$  and  $Y_{It}$  could be driven by construction if  $\frac{\partial Y_{It}}{\partial A_{Ft}} > 0$  and  $\frac{\partial Y_{It}}{\partial K_{Ft}} > 0$ . Therefore, the values of  $\frac{\partial Y_{It}}{\partial A_{Ft}}$  and  $\frac{\partial Y_{It}}{\partial K_{Ft}}$  will be discussed below.

First,  $\frac{\partial Y_{It}}{\partial K_t} = N_{It}^\gamma \frac{\partial A_{It}}{\partial K_t} + A_{It} * \gamma N_{It}^{\gamma-1} * \frac{\partial N_{It}}{\partial K_t}$ , where  $\frac{\partial N_{It}}{\partial K_t} > 0$  and  $\frac{\partial A_{It}}{\partial K_t} = \frac{1}{2} > 0$ .

Hence,  $\frac{\partial Y_{It}}{\partial K_t} > 0$ .

Second, it is easy to derive that

$$\frac{\partial Y_{It}}{\partial A_{Ft}} = N_{It}^\gamma \frac{\partial A_{It}}{\partial A_{Ft}} + A_{It} * \gamma N_{It}^{\gamma-1} * \frac{\partial N_{It}}{\partial A_{Ft}} = N_{It}^\gamma \left( \frac{1}{2} + \gamma * \frac{A_{It}}{N_{It}} * \frac{\partial N_{It}}{\partial A_{Ft}} \right)$$

<sup>11</sup> See Elgin and Oztunali (2012) for the definitions of the parameters used here.

where

$$\frac{\partial N_{lt}}{\partial A_{Ft}} = \Omega * A_{lt}^{\frac{\gamma}{1-\gamma}} (A_{Ft})^{-\frac{1}{(1-\alpha)(1-\gamma)}} * \frac{1}{1-\gamma} * \left[ \frac{1}{2} - \frac{1}{1-\alpha} * \frac{A_{lt}}{A_{Ft}} \right]$$

and

$$\Omega = \left\{ \frac{\gamma}{(1-\tau_t)(1-\alpha)} \left[ \frac{\frac{1}{\beta} - 1 + \delta}{\alpha(1-\tau_t)} \right]^{\frac{\alpha}{1-\alpha}} \right\}^{\frac{1}{1-\gamma}}$$

Since  $\alpha = 0.36$  and  $A_{lt} = (A_{Ft} + K_t)/2 + c$ ,  $\frac{1}{2} - \frac{1}{(1-\alpha)} * \frac{A_{lt}}{A_{Ft}} < 0$  and  $\frac{\partial N_{lt}}{\partial A_{Ft}} < 0$ .

This yields  $\frac{\partial Y_{lt}}{\partial A_{Ft}} = N_{lt}^{\gamma} * \left[ \frac{1}{2} + \frac{\gamma}{1-\gamma} * \left( \frac{1}{2} - \frac{1}{(1-\alpha)} * \frac{A_{lt}}{A_{Ft}} \right) \right]$ .

Hence, if  $\frac{A_{lt}}{A_{Ft}}$  falls below  $\frac{1-\alpha}{2\gamma} \approx 0.75$ ,  $\frac{\partial Y_{lt}}{\partial A_{Ft}}$  turns from positive to negative.

Because the co-movement between  $Y_{lt}$  and  $Y_{Ft}$  is largely driven by the assumption that  $A_{lt} = (K_t + A_{Ft})/2$ , the DGE model is reestimated by benchmarking  $N_{lt}$  to survey-based self-employment in annex 3D as a robustness check. This gives the estimates of  $A_{lt}$  and subsequently  $Y_{lt}$  without relying on specific assumptions. The regression results for instrumental variables two-stage least squares (IV-2SLS) models using DGE estimates benchmarked to self-employment are largely in line with those shown in the main text.

## ANNEX 3B Model specifications for measuring co-movement among informality measures

### Dynamic common factor model

The dynamic common factor model has the following form (Stock and Watson 2011):

$$Y_t = \beta f_t + \varepsilon_t ; f_t = \phi(L)f_{t-1} + \mu_t , \quad (3B.1)$$

where  $Y_t$  is a vector of variables that contains official GDP, DGE-based and MIMIC-based informal output estimates, formal employment, and informal employment.  $f_t$  is the dynamic common factor, which follows an autoregressive (AR(1)) process.  $\varepsilon_t$  and  $\mu_t$  are error terms that are independently and identically distributed (i.d.d.). The dynamic common factor model is estimated for each country. Robustness tests for longer lags indicate that the coefficients for additional lags of the common factor are insignificant. All data series are detrended and standardized before estimation. Additional results are available upon request.

### Probit model

The probit model has the following form:

$$Pr (ISREC_{it} = 1) = \phi(\alpha + \beta FS_{it} + \theta X_{it} + \pi_i + \mu_t + \epsilon_{it}),$$

where  $ISREC_{it}$  is a dummy variable that equals one when the informal sector in country  $i$  and year  $t$  is in recession, and zero otherwise.  $FS_{it}$  is a dummy representing recession in the formal economy, and  $X_{it}$  is a vector of control variables. Following Elgin and Oztunali (2012 and 2014),  $X_{it}$  includes the annual growth rates of real investment (Penn World Table [PWT] 9.1) and domestic credit to the private sector obtained from WDI. All regressions include country dummies ( $\pi_i$ ) and year dummies ( $\mu_t$ ) to control for macro trends across countries in a certain year and factors that are country specific. For probit model on the start of informal recessions,  $ISREC_{it}$  is a dummy variable that equals one when the informal sector in country  $i$  and year  $t$  is in the start of a recession, and zero otherwise. Recessions are identified as in chapter 2, where the algorithm in Bry and Boschan (1971) is used to identify peaks and troughs of business cycles and recessions are defined as the period from peak to trough (Claessens, Kose, and Terrones 2012).

### **ANNEX 3C Causal linkages between formal- and informal- economy business cycles**

The following instrumental variables that affect formal-economy output but do not directly influence informal-economy output are considered: movements in trade-related variables and changes in government consumption. Being concentrated in the nontradable sector (Fiess, Fugazza, and Maloney 2010), the informal economy is unlikely to be influenced by movements in trade-related variables directly. In addition, government consumption includes all government current expenditures for purchases of goods and services (including compensation of employees), without covering transfers such as social benefits, subsidies, and so on. Governments are typically restricted, by legislation and regulation, from purchasing goods and services directly from the informal economy. As governments purchase goods and services from the formal economy, changes in government consumption lead to fluctuations in the formal economy without affecting the informal economy directly. Therefore, movements in trade-related variables and changes in government consumption can be interpreted as exogenous instruments that directly affect the formal economy without directly influencing the informal economy.

Data on movements in trade-related variables and changes in government consumption are obtained from the WDI. Trade-related variables include terms of trade and exports of goods and services (at constant 2010 U.S. dollars). Government consumption captures general government final consumption expenditure (at constant 2010 U.S. dollars). These measures—as well as all the output and employment measures—are transformed into cyclical components as deviations from the HP-filtered trend with a smoothing parameter of 100. To further make sure that the causal direction runs only from the formal economy to the informal economy, cyclical movements in formal GDP are lagged in the following regressions. The results are robust to using annual growth rates of these variables and when cyclical movements in formal GDP are not lagged.

The IV-2SLS regression model has the following form:

$$FS_{it-1} = \alpha_1 + \beta_1 IV_{it-1} + \theta X_{it} + \pi_i + \mu_t + \epsilon_{it} \quad (3C.1: 1st stage)$$

$$IS_{it} = \alpha_0 + \beta_0 \widehat{FS}_{it-1} + \theta X_{it} + \pi_i + \mu_t + \epsilon_{it} \quad (3C.1: 2nd stage)$$

In the first stage, the lagged cyclical component of formal-economy output ( $FS_{it-1}$ ) is the dependent variable, whereas the lagged trade-related variables and government consumption in country  $i$  ( $IV_{it-1}$ ) are the explanatory variables. The regression results of the first stage are used to obtain the estimated cyclical component of formal economy output  $\widehat{FS}_{it-1}$ , which is used as the explanatory variable in the second stage.  $\widehat{FS}_{it-1}$  is used to explain the cyclical components of informal-economy output or informal employment ( $IS_{it}$ ) in year  $t$ . The coefficient estimate  $\beta$  measures the magnitude and direction of the impact of fluctuations in the formal business cycle on the informal economy. In both stages, a vector of control variables ( $X_{it}$ ), country fixed effects ( $\pi_i$ ), and year fixed effects ( $\mu_t$ ) are controlled for. The vector of control variables ( $X_{it}$ ) includes the growth rates of domestic credit to the private sector and real investment. These control variables are included because they influence the fluctuations in both formal and informal economies (for example, Elgin and Oztunali, 2014; Ferreira Tiyaki 2008; La Porta and Shleifer 2014). Data for investment are provided by PWT 9.1, updated with data from WDI, and credit data are obtained from WDI. Detailed baseline estimation results are shown in table 3C.1.

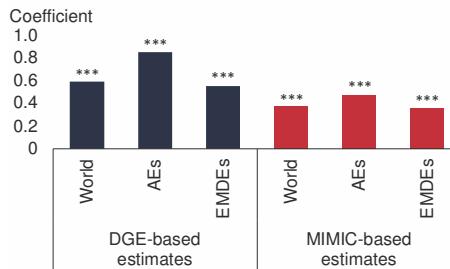
Movements in trade-related terms and changes in government consumption are jointly used as instruments for formal-economy output fluctuations. To remove the potential endogeneity of government consumption in the case of MIMIC, results are also obtained using trade-related instrumental variables (terms of trade and export growth) only (figure 3C.1).

Several robustness exercises are carried out. First, a system GMM model is carried out to address potential endogeneity bias. The results are strongly in line with baseline findings and results from fixed-effect models, where a 1 percent rise in formal economy output significantly increases output in the informal sector in the following year by 0.4–0.8 percent but has no significant response from informal employment (figure 3C.2). Second, an alternative variant of the DGE measures, detailed in methodological annex 3D, is used to test for robustness to different modeling assumptions in the construction of the DGE estimates. The results show that, on average, informal output expands significantly by 0.5–0.8 percent, especially in EMDEs, when formal-economy output rises by 1 percent in the previous year. Third, the same set of empirical analyses are applied to the shares of the informal economy in output and employment to ensure consistency with previous estimates in the literature. Both correlation and IV-2SLS regression analyses are carried out here. As expected, both shares of informal output and shares of informal employment are found to be significantly negatively correlated with formal-economy output, whereas shares of formal employment are positively correlated (figure 3C.3). The

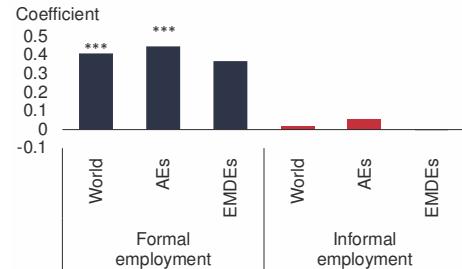
### FIGURE 3C.1 Impact of formal output fluctuations on the informal sector: Alternative instrumental variables

Results from using alternative sets of instrumental variables, such as trade-related variables or government consumption alone, confirm baseline results that expansion in formal-economy output significantly leads to a rise in informal output in the following year, while having no significant impact on informal employment.

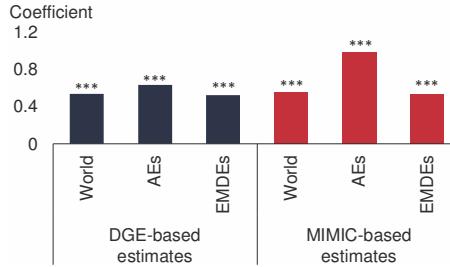
**A. Impact of formal output fluctuations on informal output: Trade-related variables**



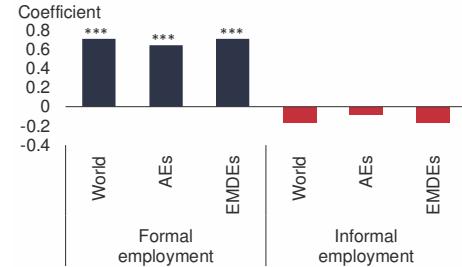
**B. Impact of formal output fluctuations on employment: Trade-related variables**



**C. Impact of formal output fluctuations on informal output: Government consumption**



**D. Impact of formal output fluctuations on employment: Government consumption**



Source: World Bank.

Note: Data are for 1990–2018. Trade-related variables (proxied by terms of trade and export) are used as the instrumental variable to explain the variation in formal output (proxied by official GDP) in A and B, whereas government consumption is used as the instrumental variable in C and D. See annex 3C for details. Formal employment is proxied by total employment excluding self-employment. Informal employment is proxied by self-employment. AEs = advanced economies; DGE = dynamic general equilibrium model estimates; EMDEs = emerging market and developing economies; MIMIC = multiple indicators multiple causes model estimates. \*\*\* denotes 10 percent significance.

A.C. Bars show estimated coefficients when DGE- or MIMIC-based estimates are used as the dependent variable.

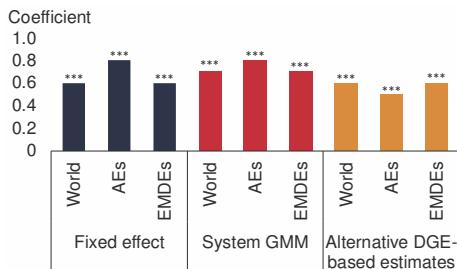
B.D. Bars show estimated coefficients when formal employment or informal employment (defined as self-employment) are used as the dependent variable.

regression results show that the share of informal output contracts significantly by 0.1–0.4 percentage point of GDP, on average, when formal-economy output expands by 1 percent in the previous year (figure 3C.4).

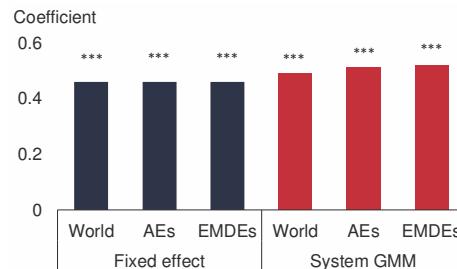
### FIGURE 3C.2 Impact of formal output fluctuations on the informal sector: Additional robustness checks

Robustness checks, such as ones using a fixed-effect estimator and a system GMM estimator, confirm formal findings that rises in formal-economy output significantly increase output in the informal sector in the following year while having no significant impact on informal employment, especially in EMDEs.

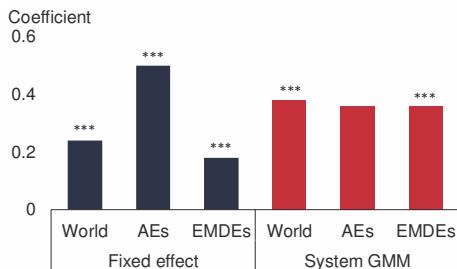
**A. Impact of formal output fluctuations on informal output (DGE-based estimates)**



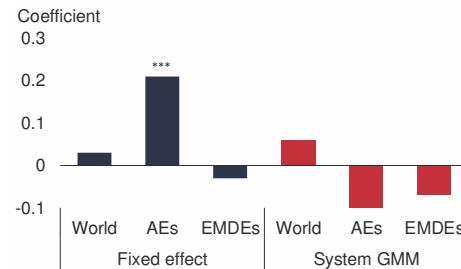
**B. Impact of formal output fluctuations on informal output (MIMIC-based estimates)**



**C. Impact of formal output fluctuations on formal employment**



**D. Impact of formal output fluctuations on informal employment**



Source: World Bank.

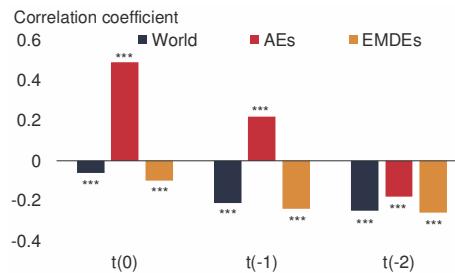
Note: Data are for 1990-2018. Formal employment is proxied by total employment excluding self-employment. Informal employment is proxied by self-employment. AEs = advanced economies; DGE = dynamic general equilibrium model estimates; EMDEs = emerging market and developing economies; GMM = generalized method of moments; HP = Hodrick-Prescott (filter); MIMIC = multiple indicators multiple causes model estimates. \*\*\* denotes 10 percent significance.

A-D. Bars show the estimated coefficients for the lagged cyclical component of official GDP. "Fixed effects" show results for the fixed-effect model, where the dependent variable is the cyclical component of informal output or employment derived using the HP filter, and the variable of interest is the lagged cyclical component of official GDP (HP filtered). Country fixed effects and year dummies are used here. "System GMM" shows regression results from system GMM estimators with informal output, formal employment and informal employment being the dependent variables and lagged official GDP being the explanatory variable. See annex 3D for details on "alternative DGE-based estimates." All dependent variables and official GDP are cyclical components (in logs) obtained using the HP filter. Control variables, such as the growth rates of domestic credit to private sector and real investment, are included in both models.

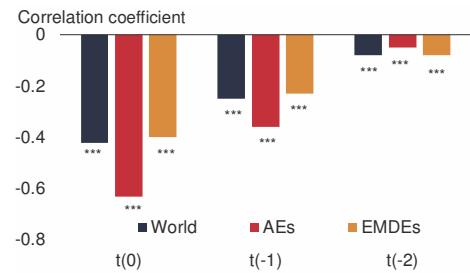
### FIGURE 3C.3 Correlations of informal output with formal output: Shares of informal output and employment

*Both shares of informal output and shares of informal employment are negatively correlated with formal-economy output, whereas shares of formal employment are positively correlated.*

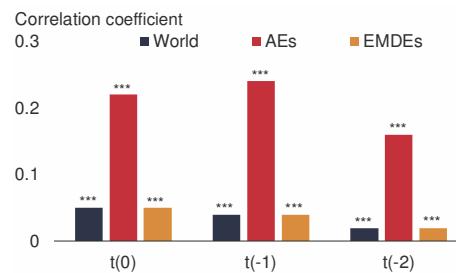
A. Correlation between formal output and informal output shares (DGE-based estimates)



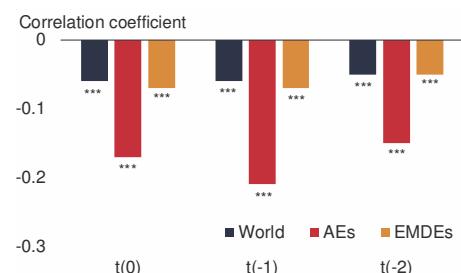
B. Correlation between formal output and informal output shares (MIMIC-based estimates)



C. Correlation between formal output and formal employment shares



D. Correlation between formal output and informal employment shares



Sources: Penn World Table 9.1; World Bank.

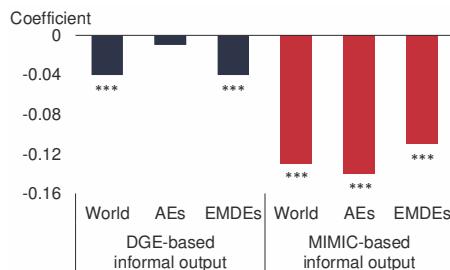
Note: Data are for 1990–2018. Formal employment is proxied by total employment excluding self-employment. Informal employment is proxied by self-employment. AEs = advanced economies; DGE = dynamic general equilibrium model estimates; EMDEs = emerging market and developing economies; MIMIC = multiple indicators multiple causes model estimates. \*\*\* denotes 10 percent significance. A-B. Bars show the correlations between the cyclical components of formal-economy output (in logs) in year t(-2), t(-1) and t(0), respectively, and the cyclical components of informal output shares in year t(0). Both DGE-based and MIMIC-bases estimates on informal output are in percent of official GDP.

C-D. Bars show the correlations between the cyclical components of formal-economy output (in logs) in year t(-2), t(-1) and t(0), respectively, and the cyclical components of employment shares in year t(0). Formal employment (in C) is proxied by total employment excluding self-employment and expressed in percent of total employment. Informal employment (in D) is proxied by self-employment in percent of total employment.

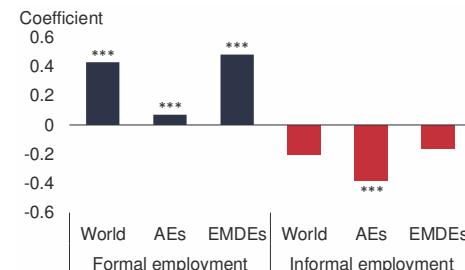
### FIGURE 3C.4 Impact of formal output fluctuations on shares of output and employment in the informal sector

During formal-economy recessions, formal-economy output shrinks slightly more than informal-economy output, raising the share of informal-economy output in percent of official GDP. Meanwhile, formal employment shrinks and informal employment remains largely stable.

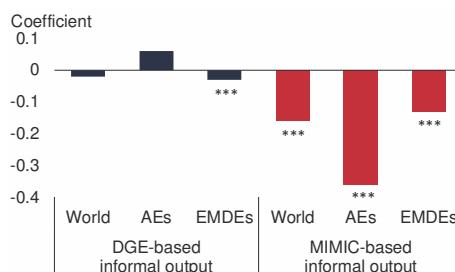
**A. Impact of formal output fluctuations on informal output: Full set**



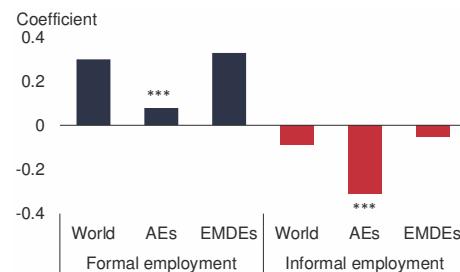
**B. Impact of formal output fluctuations on employment: Full set**



**C. Impact of formal output fluctuations on informal output: Trade-related variables**



**D. Impact of formal output fluctuations on employment: Trade-related variables**



Source: World Bank.

Note: Data are for 1990-2018. See annex 3C for details. Formal employment is proxied by total employment excluding self-employment. Informal employment is proxied by self-employment. "Full set" are models where both government consumption and trade-related variables (proxied by terms of trade and export) are included as instrumental variables (IVs) to explain the variation in formal output (proxied by official GDP). "Trade-related variables" are models where only trade-related variables are used as IVs. AEs = advanced economies; DGE = dynamic general equilibrium model estimates; EMDEs = emerging market and developing economies; MIMIC = multiple indicators multiple causes model estimates. \*\*\* denotes 10 percent significance.

A.C. Bars show estimated coefficients when DGE- (MIMIC)-based estimates (in percent of official GDP) are used as the dependent variable.

B.D. Bars show estimated coefficients when formal employment (informal employment proxied by self-employment; in percent of total employment) is used as the dependent variable.

**TABLE 3C.1 IV-2SLS regression: Baseline results**

	Informal output (DGE)				Informal output (MIMIC)				Formal employment				Informal employment			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)				
2nd stage dependent variable: Informal output/employment																
	Full	AE	EMDE	Full	AE	EMDE	Full	AE	EMDE	Full	AE	EMDE	Full	AE	EMDE	EMDE
Official GDP	0.55*** (0.05)	0.75*** (0.07)	0.51*** (0.05)	0.42*** (0.04)	0.65*** (0.05)	0.40*** (0.05)	0.56*** (0.25)	0.49*** (0.09)	0.54* (0.30)	-0.06 (0.16)	0.11 (0.14)	-0.09 (0.20)				
With controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	
Country dummy	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	
Year dummy	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	
Kleibergen-Paap rk LM stat	29.81 ***	14.10 ***	24.44 ***	30.58 ***	13.99 ***	25.00 ***	36.25 ***	14.01 ***	29.10 ***	36.25 ***	14.01 ***	29.10 ***				
Cragg-Donald Wald F stat	192.96	100.52	141.77	203.31	102.65	148.74	228.24	99.56	155.95	228.24	99.56	155.95				
Observations	2,947	637	2,310	2,847	629	2,218	2,263	626	1,635	2,263	626	1,635				
R-squared	0.50	0.79	0.47	0.37	0.62	0.35	0.05	0.60	0.04	0.03	0.10	0.04				
1st stage dependent variable: Official GDP																
	Full	AE	EMDE	Full	AE	EMDE	Full	AE	EMDE	Full	AE	EMDE	Full	AE	EMDE	EMDE
Terms of trade	0.09*** (0.03)	0.45*** (0.11)	0.08*** (0.03)	0.09*** (0.11)	0.46*** (0.03)	0.09*** (0.03)	0.13*** (0.11)	0.46*** (0.03)	0.11*** (0.03)	0.13*** (0.03)	0.11*** (0.03)	0.46*** (0.11)	0.46*** (0.03)	0.11*** (0.03)	0.11*** (0.03)	
Exports	0.13** (0.07)	0.07	0.12* (0.15)	0.15** (0.07)	0.07	0.15* (0.15)	0.13* (0.07)	0.23*** (0.07)	0.06	0.22*** (0.08)	0.23*** (0.08)	0.06	0.22*** (0.08)			
Government consumption	0.14*** (0.02)	0.24*** (0.04)	0.13*** (0.03)	0.14*** (0.02)	0.24*** (0.04)	0.14*** (0.03)	0.16*** (0.02)	0.23*** (0.02)	0.15*** (0.02)	0.16*** (0.02)	0.16*** (0.02)	0.23*** (0.02)	0.15*** (0.02)	0.15*** (0.02)		
With controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	
Country dummy	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	
Year dummy	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	
F-stats	17.06***	26.57***	13.78***	16.84***	26.89***	13.53***	24.39***	26.36***	19.01***	24.39***	26.36***	19.01***				
Obs	2,947	637	2,310	2,847	629	2,218	2,263	626	1,635	2,263	626	1,635				

Source: World Bank.

Note: First-stage F-stat show whether the concerning variable is a weak instrumental variable (IV), with a higher value suggesting a stronger IV. The equation is exactly identified. Kleibergen-Paap rk LM statistic shows the results for underidentification test, where a rejection shows the instrument is relevant. Significant Cragg-Donald Wald F statistic also shows that the used instrument is strong. Formal employment is total employment (excl. self-employment). Informal employment is proxied by self-employment. All dependent variables, official GDP, export and government consumption are cyclical components (in logs) obtained using the HP filter. Terms of trade is cyclical component (in percent of trend) obtained using the HP filter. Official GDP, government consumption, terms of trade and export are lagged to deal with the endogeneity issue. The control variables include the growth rates of domestic credit to private sector and real investment. See annex 3C for details. Full sample with period over 1990-2018 is used here. AE = advanced economy; EMDE = emerging market and developing economy; HP = Hodrick-Prescott (filter); IV-2SLS = two-stage least squares instrumental variable. Robust standard errors in parentheses. \*\*\* p < 0.01, \*\* p < 0.05, \* p < 0.10.

## ANNEX 3D Calibrating DGE estimates using survey-based self-employment data

As shown in Elgin and Oztunali (2012), the employment in the informal sector,  $N_{It}$  has the following form:

$$N_{It} = \left\{ \frac{\gamma A_{It}}{(1-\tau_t)(1-\alpha)A_{Ft}} \left[ \frac{\frac{1}{\beta} - 1 + \delta}{\alpha(1-\tau_t)A_{Ft}} \right]^{\frac{\alpha}{1-\alpha}} \right\}^{\frac{1}{1-\gamma}} \quad (3D.1)$$

After transforming equation (3D.1),  $A_{It}$  can be expressed as follows:

$$A_{It} = \frac{N_{It}^{1-\gamma}(1-\tau_t)(1-\alpha)A_{Ft}}{\gamma \left[ \frac{\frac{1}{\beta} - 1 + \delta}{\alpha(1-\tau_t)A_{Ft}} \right]^{\frac{\alpha}{1-\alpha}}} \quad (3D.2)$$

Following Fiess, Fugazza, and Maloney (2010) and Loayza and Rigolini (2011), data on self-employment, as shown in chapter 2, are used as estimates for  $N_{It}$  and to calculate  $A_{It}$  using equation (3D.2). Following the earlier literature,  $\alpha$  is assumed to be equal to 0.36, and  $\delta$  takes the country average of the depreciation rates reported in PWT 9.1 (expanded using WDI). Following Ihrig and Moe (2004),  $\gamma$  takes the value 0.425. Capital stock ( $K_t$ ) and formal employment ( $N_{Ft}$ ) are obtained from PWT 9.1. Assuming a balanced budget for the government,  $\tau_t$  is obtained as the share of government spending in GDP reported in PWT 9.1 (expanded using WDI).

Rewriting the production function of the informal sector ( $Y_{It}$ ) using equation (3D.2),  $Y_{It}$  is a function of  $A_{Ft}$  and  $N_{It}$ :

$$Y_{It} = N_{It} * \frac{(1-\tau_t)(1-\alpha)}{\gamma \left[ \frac{\frac{1}{\beta} - 1 + \delta}{\alpha(1-\tau_t)} \right]^{\frac{\alpha}{1-\alpha}}} * (A_{Ft})^{\frac{1}{1-\alpha}}, \quad (3D.3)$$

which gives  $\frac{\partial Y_{It}}{\partial A_{Ft}} > 0$ . Because  $\frac{\partial Y_{It}}{\partial A_{Ft}} > 0$ , it is possible that the DGE estimates will move procyclically in the presence of large shocks in formal productivity when other types of shocks are absent. However, when other types of shocks also occur at the same time,  $Y_{It}$  may not move procyclically. For instance, if  $N_{It}$  and  $N_{Ft}$  experienced shocks in different directions at the same time,  $Y_{It}$  might move countercyclically in the absence of other types of shocks.

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