UNIVERSITÀ CATTOLICA del Sacro Cuore

Dipartimento di Economia Internazionale, delle Istituzioni e dello Sviluppo (DISEIS)

WORKING PAPER SERIES

WP 1801

January, 2018

Informality and the Labor Market Effects of Financial Crises

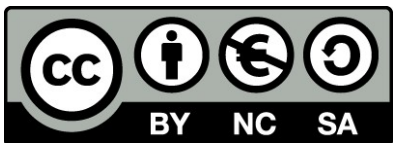
Emilio Colombo, Lorenzo Menna,

Patrizio Tirelli

Prior to being published, DISEIS working papers are subject to an anonymous refereeing process by members of the editorial board or by members of the department.

DISEIS Working Papers often represent preliminary work which are circulated for discussion and comment purposes. Citation and use of such a paper should account for its provisional character. A revised version may be available directly from the author.

DISEIS WP 1801



DISEIS
Dipartimento di Economia Internazionale, delle Istituzioni e dello Sviluppo
Università Cattolica del Sacro Cuore
Via Necchi 5
20123
Milano

Informality and the Labor Market effects of Financial Crises

Emilio Colombo[*] Università Cattolica del Sacro Cuore

Lorenzo Menna [†] Banco de Mexico

Patrizio Tirelli[‡] University of Milan Bicocca and Griffith University

January 2, 2018

Abstract

We provide evidence, based on a large sample of countries, on the effects of financial crises on key labor market indicators, including official and unofficial employment, unemployment and the participation rate. Crises are followed by a drop in the official market participation rate and by an increase in informal employment. These responses are strongly persistent. Empirical results are then interpreted with a DSGE model which accounts for informality and for financial and labor market frictions. In this framework the informal sector acts as a buffer which absorbs workers in bad times and vice versa. Our simulations suggest the informal sector also is a crisis amplifier for the official economy. In fact, the larger the pre-crisis informal sector, the stronger the labor reallocation, i.e. the fall in the participation rate, necessary to equilibrate the labor market.

Keywords: Financial crises, Informal Economy, labor market frictions, endogenous participation

JEL codes: E26, E32, G01.

[*]Corresponding author, Email: emilio.colombo@unicatt.it. We thank seminar participants at Royal Holloway University, Cardiff University, Rethymno (ICMAIF Conference) for useful comments. We thank Davide Furceri for sharing Stata codes.

[†]Email: lorenzo.menna@banxico.org.mx. The views expressed are those of the individual author and do not necessarily reflect official positions of the Banco de Mexico.

[‡]Email: patrizio.tirelli@unimib.it

1 Introduction

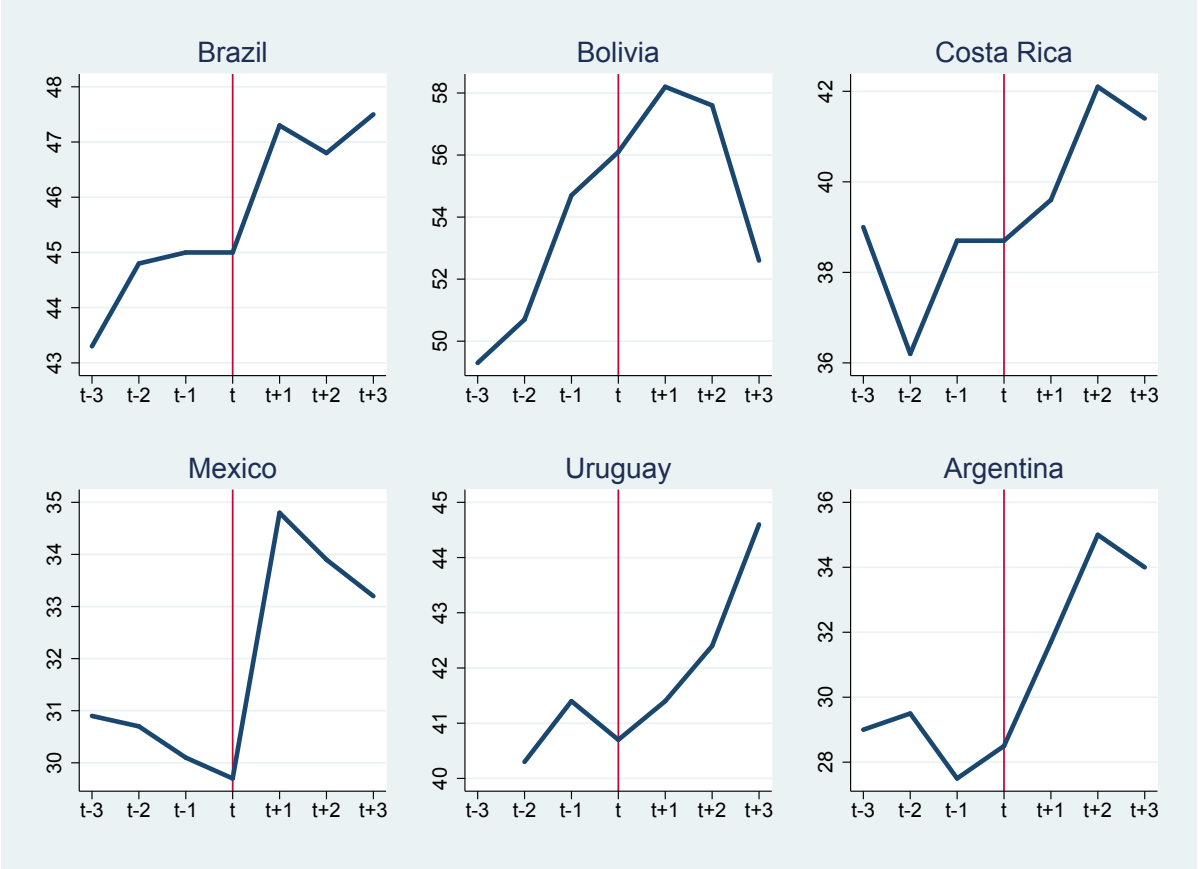
Cyclical movements in labor force participation are on average weak and for this reason standard business cycle analysis neglects movements in the participation rate, focusing instead on cyclical variations in the unemployment rate. The great financial crisis has spurred new interest in the response of the participation rate to recession episodes. Erceg and Levin (2014) forcefully argue that in the US the financial crisis accounts for a substantial part of the large decline in the U.S. labor force participation observed since 2007. In a similar vein, Howard, Martin, and Wilson (2011) and Duval, Eris, and Furceri (2011) find that long and deep recessions, quite often associated to financial crises, where followed by persistent reductions of participation rates in OECD countries.

Financial crises tend to disrupt economic activity with a size and depth that is larger than standard economic recessions (Rajan and Zingales, 1998; Kroszner, Laeven, and Klingebiel, 2007; Cerra and Saxena, 2008; Dell'Ariccia, Detragiache, and Rajan, 2008; Reinhart and Rogoff, 2009) and empirical evidence suggests they act as a large asymmetric shock leading to a strong reallocation of economic activity between the official and the informal sectors of the economy (Colombo, Onnis, and Tirelli, 2016). This supports the view that financial crises might have important and hitherto unexplored implications for the labor market, i.e. for the official participation rate and for the informal labor market. The issue is potentially quite relevant because in developing (developed) countries the informal sector has been estimated to be around 36% (13%) of GDP over the 1999-2007 period (see Schneider, Buehn, and Montenegro (2010)).

Unfortunately, direct evidence of informal labor markets is scarce, even though some studies suggest that in developing countries informal employment can be as high as 70% of total employment (Bosch and Esteban-Pretel, 2012). The ILO-KILM dataset has collected and organized available estimates on informal employment, measured through surveys either at household or at establishment level, but such information is available only for a few countries. As *prima facie* evidence Figure 1 shows that financial crises were associated to an increase in informal employment for all the episodes of banking crises included in the ILO-KILM dataset.

More data are available concerning the official participation rate and for the share of self-employed workers, often used as a rough-and-ready proxy for informal

Figure 1: Informal employment around episodes of banking crises



Note: Figures report the share of persons employed in informal activity in total non agricultural employment. t refers to the date of banking crisis and is as follows: Brazil, Mexico, Costa Rica and Bolivia 1994, Argentina 2001, Uruguay 2002.

employment (Loayza and Rigolini, 2011).[1]

Based on a large panel of countries, our empirical analysis shows that financial crises are followed by a drop in output and investment, and by a rise in unemployment. This outcome is associated to a reduction in the participation rate and to an increase in the share of self-employed workers.

To rationalize these results we build a DSGE model which accounts for both the official and the informal economy sectors, and incorporates banking frictions defined as in Gertler and Karadi (2011). The official labor market is characterized by search and matching frictions and we model both the intensive and extensive margin in the labor market. In our framework the official labor market participation rate is endogenous and driven by an optimal choice between being employed in the informal economy and searching for a job in the official sector. To the best of our knowledge this is the first paper that incorporates all these features in a dynamic general equilibrium framework.

Our results in a nutshell. The financial crisis, modeled as a shock to the net worth of bankers, raises the cost of capital for official firms and generates a drastic contraction in investment which is associated to a large and persistent fall in official output. The contraction in official economic activity induces firms to post fewer vacancies, and therefore causes an increase in unemployment. The central bank decision to lower interest rates dampens the contraction in the official sector and unambiguously stimulates demand in the informal sector. As a result, we observe a drop in the official participation rate and a prolonged expansion in informal economic activity and employment. In this regard the informal economy sector acts as a buffer which absorbs workers in bad times and vice versa. However, our simulations suggest the informal sector also is a crisis amplifier for the official economy. In fact, for a given financial shock, the ensuing contraction in the official economy is deeper and more persistent the larger the size of the unofficial sector. This crucial new result is determined by a relatively simple and straightforward mechanism. The labor force reallocation is driven by an arbitrage condition that relates the value of seeking for a a job in the official economy to the value of working in the informal sector, which in turn is determined by the labor income in the informal economy. Therefore, the larger the size of the informal sector the greater is the employment reallocation to the unofficial sector which is necessary to bring informal labor incomes in line with

[1] See also Fiess, Fugazza, and Maloney (2010)

the new value of a formal job.

Our theoretical approach adds to recent developments in the literature on business cycles in developing countries, where accounting for informality allows to rationalize the relatively large output volatility and the excess relative volatility of consumption to output observed in these countries (Horvath, 2017; Restrepo-Echavarria, 2014). The paper also adds to Garcia-Cicco, Pancrazi, and Uribe (2010), who show that financial frictions are important to explain business cycles in emerging markets.

Our reading of the twofold role of the informal sector is in line with the findings in Fernández and Meza (2015) but in their contribution the key transmission channel is the degree of substitutability between formal and informal goods in the consumption bundle. Here we emphasize the specific role played by the labor market. In this regard our work contributes to a strand of literature which sees informality as driven by voluntary decisions to exit the official labor market, and where labor market frictions play a key role (Zenou, 2008; Ulyssea, 2010; Bosch and Esteban-Pretel, 2015; Meghir, Narita, and Robin, 2015)

The remainder of the paper is structured as follows: section 2 presents the empirical evidence, section 3 describes the model, section 4 presents the results, section 5 concludes. The technical details of the model and the empirical section are relegated to the Appendix.

2 Empirical evidence

2.1 Data

Defining banking crises is often controversial, due to the lack of a consensual definition and the need of a certain degree of discretionary judgment. We adopt the well known classification by Laeven and Valencia (2010), who focus on systemic banking crises excluding distress events that affected isolated banks. Our choice is justified by the widespread use of this classification in the empirical literature.

Standard macroeconomic variables such as GDP and Investment are taken from the World Bank World Development Indicators.

Data on the labor market participation rate and on the unemployment rate are obtained from two datasets. The first one is the ILO-KILM dataset which covers

170 countries starting from 1990.[2] The second dataset is the OECD labor market statistics, available only for OECD countries but with longer time series, as for most countries it dates back to 1970.

We use data on self-employment as a proxy for informal employment. Data on self employment are from the ILO and the World Bank (WDI) and are available for a large panel of countries starting from 1980. As pointed out in La Porta and Shleifer (2008) the definition of self-employment does not include unpaid family workers whose contribution to informal production is probably high, and informal firms on average employ more than one worker. Further, self-employment can be high for structural reasons which are not related to the informal economy, but the cyclical evolution of the self-employed share is likely to exhibit a strong correlation with the informal economy share.[3]

2.2 Methodology

Following Romer and Romer (1989); Cerra and Saxena (2008); Colombo, Onnis, and Tirelli (2016), we estimate the following autoregressive model:

$$Y_{i,t} = \alpha_i + \sum_{s=1}^{3} \beta Y_{i,t-s} + \sum_{s=0}^{2} \gamma DBC_{i,t-s} + \epsilon_{i,t} \tag{1}$$

where $Y_{i,t}$ is the growth rate of the variable of interest (participation rate, unemployment rate, self-employment rate, GDP, Investment) in country i at time t, DBC is a dummy variable for the presence of a banking crisis. Variables are defined as growth rates given their non stationarity,[4] equation (1) is estimated with system GMM (Blundell and Bond, 1998) and then impulse response functions are calculated. We include time dummies to check whether crises reflect any other global shock.[5] The Appendix reports additional robustness checks, including Panel VAR estimates where we have analyzed the joint response of the participation rate and of GDP to a banking crisis. The Appendix also contains the tables underlying the

[2] The ILO dataset is also the basis of data on the participation rate included in the World Bank WDI.

[3] See the cross-country evidence discussed in the technical appendix of Fernández and Meza (2015).

[4] In the Appendix we report the Im-Pesaran-Shin panel unit root test for the dependent variables. The number of lags of both the dependent variable and the crisis dummy have been chosen to maximize the informativeness of the model given the relatively short sample period.

[5] Robust standard errors apply Windmeijer's finite sample correction. The results are robust to changes in the lag distribution.

impulse response functions with the relevant diagnostic tests.

2.3 Results

Figure 2 shows the impulse response functions of GDP and Investment to crisis episodes. They broadly match previous results (Cerra and Saxena, 2008; Colombo, Onnis, and Tirelli, 2016); we observe a large drop in both variables, which appears to be stronger for developed economies.

Figures 3-5 show impulse responses for labor market variables. Irrespective of the database used, banking crises are associated to a reduction in the participation rate and to an increase in the unemployment rate.

Some differences are detected between high income countries and the rest of the sample, where the latter is apparently characterized by a weaker increase in the unemployment rate and by a stronger fall in the participation rate. This latter result is complemented by the increase in the self employment ratio which appears to be significant only for the group of non high-income countries.

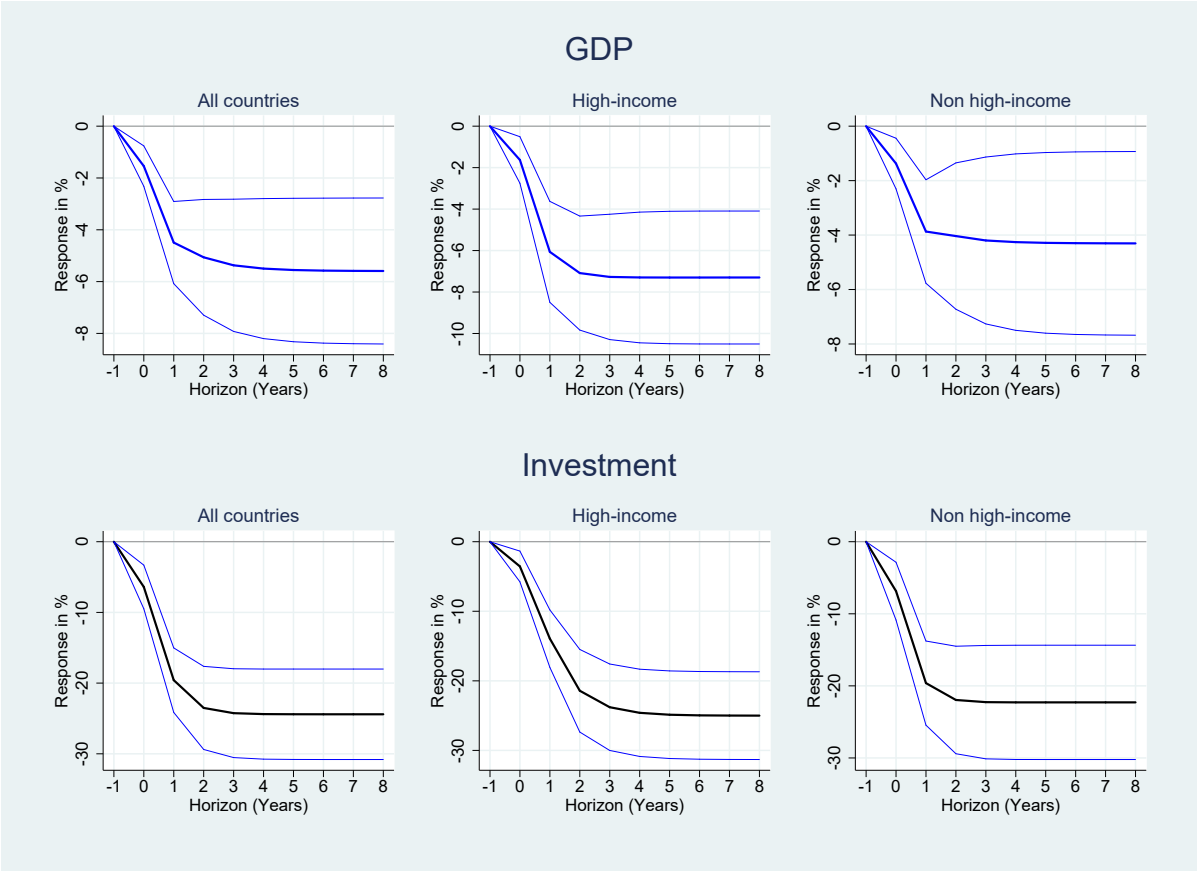
To interpret these results two caveats are in order. First, our approach is based on narrative identification of crisis episodes but is silent on the size of the shock. As such it allows to identify the specific sample *average* response of dependent variables to the *average* crisis, but it cannot identify the transmission mechanism. In other terms, our regressions do not allow to say whether a certain response to the crisis was determined by the size of the shock or by the specific features of the economy that define the transmission mechanism. It is therefore difficult to interpret results for subsets of countries which are qualitatively similar but quantitatively different. Second, our estimates signal that the responses of labor market variables to the banking crisis are permanent. This could be due to the difficulty that autoregressive models have in discriminating between permanent and temporary but very persistent responses in small samples.[6]

3 The model[7]

Our model accounts for both the official (o) and the informal (s) economy. Following Fernández and Meza (2015) and Restrepo-Echavarria (2014), to motivate the ex-

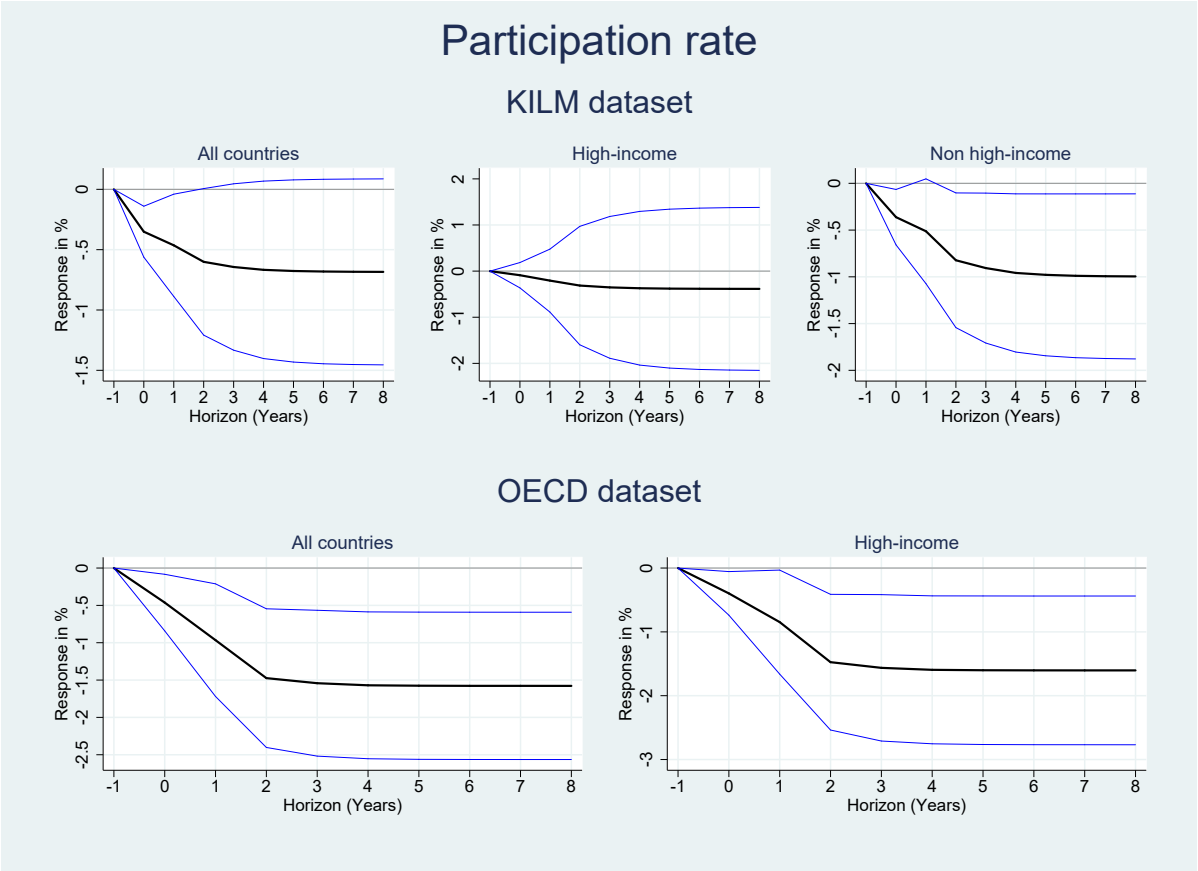
[6] See Breitung and Pesaran (2008) for a review on panel data estimation methods.
[7] See the Appendix for a full derivation of the model.

Figure 2: Response to banking crises



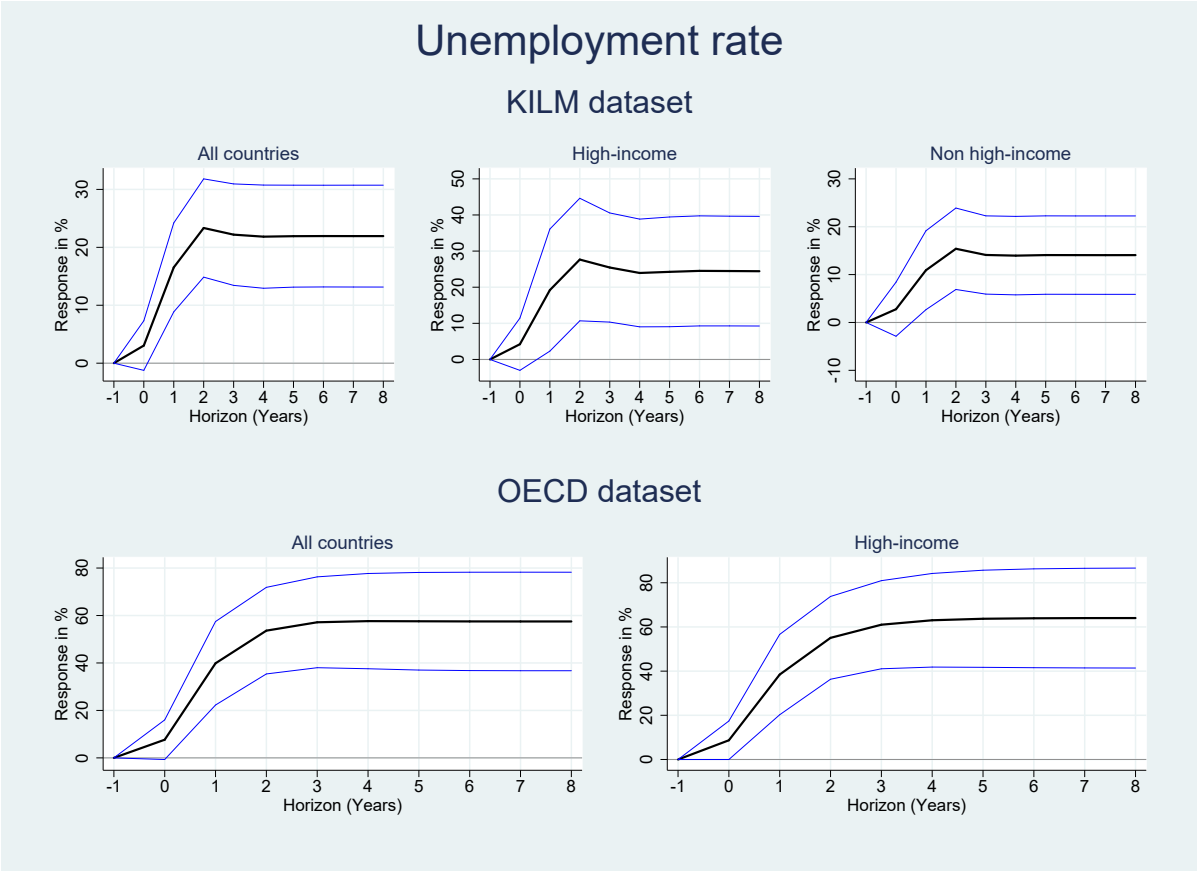
Note: the black line denotes estimated effect; light blue lines denote 90 percent confidence bands. X-axis units are years; t = 0 denotes the year of the financial crisis.

Figure 3: Response of participation rate to banking crises



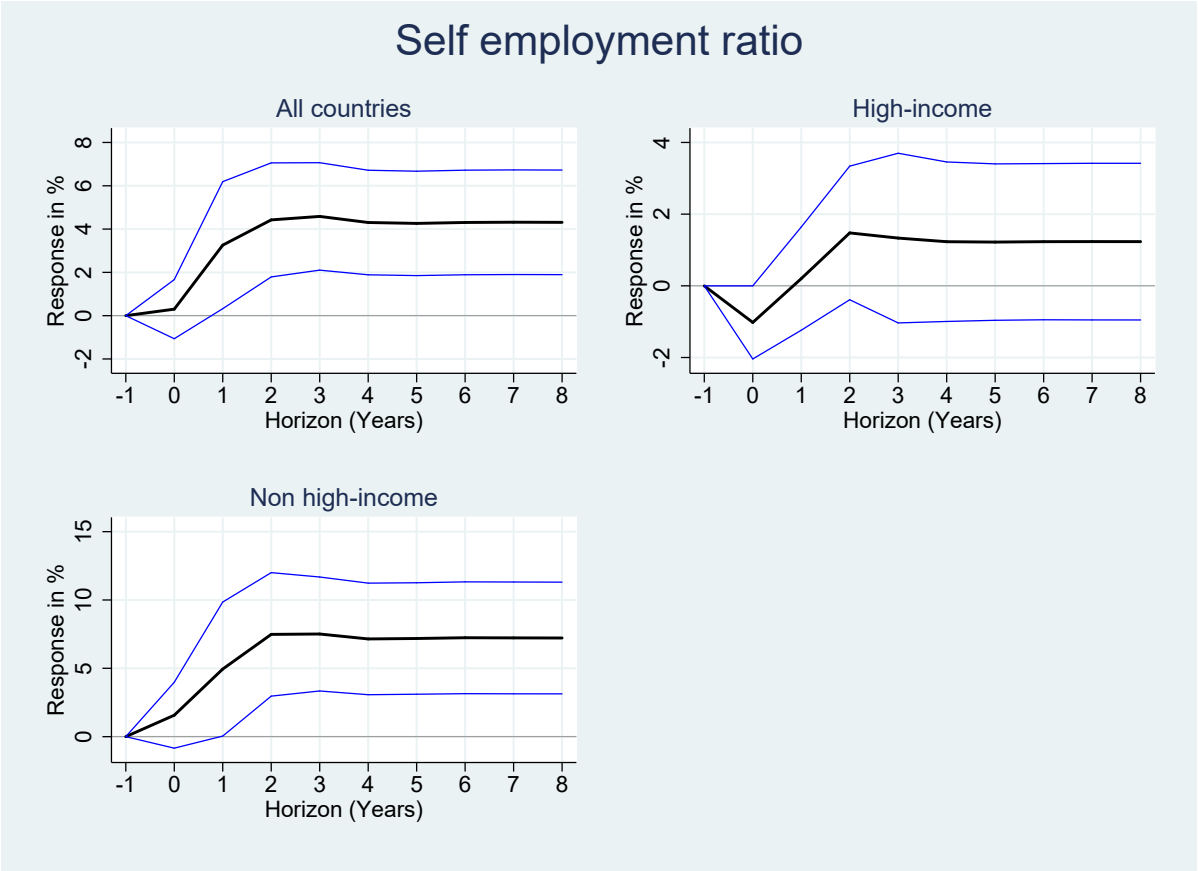
Note: the black line denotes estimated effect; light blue lines denote 90 percent confidence bands. X-axis units are years; t = 0 denotes the year of the financial crisis.

Figure 4: Response of unemployment rate to banking crises



Note: the black line denotes estimated effect; light blue lines denote 90 percent confidence bands. X-axis units are years; t = 0 denotes the year of the financial crisis.

Figure 5: Response of self employment rate to banking crises



Note: the black line denotes estimated effect; light blue lines denote 90 percent confidence bands. X-axis units are years; t = 0 denotes the year of the financial crisis.

istence of an informal sector we assume that the households' consumption bundle, c, is[8]

$$c_t = \left[(1-\alpha_c)^{\frac{1}{\varepsilon}} \left(c_t^o\right)^{\frac{\varepsilon-1}{\varepsilon}} + (\alpha_c)^{\frac{1}{\varepsilon}} \left(c_t^s\right)^{\frac{\epsilon-1}{\varepsilon}}\right]^{\frac{\varepsilon}{\varepsilon-1}} \tag{2}$$

where α_c is crucial to calibrate the relative size of the informal economy in steady state. Household have Dixit-Stiglitz preferences over the goods produced in sector j of the economy. It follows that demand functions for individual goods within each consumption bundle are:

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

where $\frac{P_t^{Rj}\left(z^j\right)}{P_t^{Rj}}$ is firm z^j relative retail price. Demand functions for the sectoral consumption bundles are:

$$c_t^o = (1-\alpha_c)\left(\frac{P_t^{R,o}}{P_t}\right)^{-\varepsilon} c_t$$

$$c_t^s = \alpha_c\left(\frac{P_t^{R,s}}{P_t}\right)^{-\varepsilon} c_t$$

where $\frac{P_t^{R,j}}{P_t}$ is the relative sectoral price. In both sectors perfectly competitive firms produce wholesale goods which are then sold to monopolistically competitive retail firms that are subject to price adjustment costs.

Our assumption that firms populate the informal economy follows La Porta and Shleifer (2008) whose cross-country analysis of informality is based on large World Bank surveys where 85% of informal firms have at least two employees in addition to the owner.[9] Our characterization of the informal economy is consistent with a well-known"stylized fact": firms operating in this sector have access to a relatively more labor intensive production technology (Amaral and Quintin, 2006; Koreshkova, 2006). Finally, we do not model financial frictions in the informal sector and, following Koreshkova (2006), we assume that households directly finance

[8] In an earlier version we incorporated tax distortions and the α_c value necessary to obtain the same relative share of the informal sector was negligible, implying that the existence of the informal sector could be motivated by tax distortions instead of preferences. Our simulation results were not affected by these different modelling choices. Results available upon request.

[9] By contrast, Fiess, Fugazza, and Maloney (2010) identify the informal sector with self-employed workers.

unofficial firms. Indeed La Porta and Shleifer (2008) report that about 75 percent of informal firms investments were with internal funds and 10.5 percent with help from the owner's family, suggesting that household financing is crucial for informal firms. Our characterization of informal firms neglects the role of retained profits and emphasizes the alternatives faced by households. In fact they can either finance informal firms or hold deposit at commercial banks, which are modeled as in Gertler and Karadi (2011).

3.1 Households

There is a continuum of households of measure $i \in (0,1)$. Each household incorporates a continuum of individuals, l workers and $(1-l)$ bankers. Households preferences are defined by:

$$U_t = E_t \sum_{k=o}^{\infty} \beta^k \left\{ \ln\left(c^i_{t+k} - bc_{t+k-1}\right) - \left(\frac{\chi \left(h^i_{t+k}\right)^{1+\phi} l^{i,o}_{t+k}}{1+\phi} \right) \right\} \tag{3}$$

where c^i is individual consumption, b defines consumption habits and l^i and h^i_t respectively are the number of employed individuals and their labor effort in the official and informal economy sectors.[10]

Following Zenou (2008) the labor market is characterized by search frictions in the official sector and by perfect competition in the unofficial sector.[11] Official sector employees earn a product real wage w^o_t. Individuals who are not hired in the official sector either take official sector unemployment status, or work in the unofficial sector. Unemployed individuals search for next-period hire in the official sector, therefore only unemployed individuals can enter a new match with an employer in the official sector. Unofficial sector employees earn the product real wage w^s_t. Following earlier contributions (Merz, 1995; Andolfatto, 1996), we assume that household members perfectly share the risk of sectoral employment and unemployment outcomes. Thus, individual consumption decisions are the same irrespective of the individual labor market status.

[10] We assume that bankers share consumption risk with remaining individuals in the household. In addition, they inelastically supply a unit of labor in each period.

[11] Other contributions assume a non-segmented, fully competitive labor market in the informal economy (Amaral and Quintin (2006) and Pratap and Quintin (2006)).

The representative household flow budget constraint is:

$$\begin{aligned} & c_t + \frac{P_t^{R,o}}{P_t} D_t + \frac{P_t^{R,s}}{P_t} I_t^s = \\ = \; & \frac{P_t^{R,o}}{P_t} w_t^o h^o l_t^o + \frac{P_t^{R,o}}{P_t} R_{t-1}^D D_{t-1} \\ & + \frac{P_t^{R,s}}{P_t} w_t^s h^s l_t^s + \frac{P_t^{R,s}}{P_t} \left(r_t^{k.s} - \delta \right) k_{t-1}^s + \frac{P_t^{R,o}}{P_t} \Pi_t^o + \frac{P_t^{R,s}}{P_t} \Pi_t^s \end{aligned} \tag{4}$$

where D are bank deposits, which yield the rate of return R_t^D, k^s and I_t^s are the capital stock and the amount of investment in the informal sector, $r^{k,s}$ is the return from capital investment in the informal economy and δ is the capital depreciation rate. Π^o and Π^s define sectoral profits.[12] Note that households choose investment in the informal sector, whereas official investment is chosen by official firms.

3.2 Labor market

Following Christiano, Trabandt, and Walentin (2011) and Zhang (2011), to facilitate model tractability we assume that employment agencies post vacancies in the official labor market at the official output cost f_{pv}^{EA} and bargain with workers both the official sector product wage rate w_t^o and the number of hours worked h^o. Subsequently they combine individual labor supplies into a labor input which is then transferred to official sector wholesale firms at the competitive price P_t^{EA}, defined in terms of official sector goods. New matches per unit of time are determined by a standard matching technology:

$$M_t = m \left(u_t \right)^{\varkappa} \left(V_t \right)^{1-\varkappa} \tag{5}$$

where V_t and u_t respectively define the number of vacancies in the official sector and unemployment, and m is a parameter that defines the efficiency of the matching technology. The probability that a vacancy z_t^V be filled therefore is:

$$z_t^V = \frac{M_t}{V_t} = m \left(\frac{u_t}{V_t} \right)^{\varkappa}.$$

[12] Following Gertler and Karadi (2011) Π_t^o incorporates profits from both official sector retail firms and banks, as well as transfers from individuals exiting the banking profession and to new bankers, as discussed below.

Similarly, the probability that an unemployed individual gets a job in the official sector, z_t^{un}, is:

$$z_t^{un} = \frac{M_t}{u_t} = m\left(\frac{V_t}{u_t}\right)^{1-\varkappa}$$

Official employment follows the law of motion:

$$l_t^o(s) = \rho^s l_{t-1}^o(s) + z_t^V V_t(s) \tag{6}$$

where ρ^s $(0 < \rho^s < 1)$ defines the exogenous probability that a match survives up to next period.

Employment agencies maximize discounted profits subject to (6), obtaining the following hiring condition:

$$\frac{f_{pv}^{EA}}{z_t^V} = \left(P_t^{EA} - w_t^o\right) h_t^o + \beta \frac{\pi_{t+1}^{R,o}\lambda_{t+1}}{\pi_{t+1}\lambda_t} \frac{f_{pv}^{EA}}{z_{t+1}^V} \rho^S \tag{7}$$

where $\frac{f_{pv}^{EA}}{z_t^V}$ defines the marginal cost of hiring a worker[13] and the r.h.s. of (7) is the marginal benefit, including both the price margin $(P_t^{EA} - w_t^o)$, and the discounted savings on posting a future vacancy, which are proportional to the match survival rate ρ^s.

The nominal wage and the number of hours are negotiated by workers and employment agencies within a Nash bargaining framework. We assume simultaneous bargaining over W and h.

The value of a new hire for the employment agency is:

$$v_t^{EA} = \left(P_t^{EA} - w_t^o\right) h_t^o + \beta \frac{\pi_{t+1}^{R,o}\lambda_{t+1}}{\pi_{t+1}\lambda_t} v_{t+1}^{EA} \rho^S$$

where v_t^{EA} is defined in official goods. The conditions that define the value for an individual of being employed and unemployed respectively are:

$$v_t^{lo} = \lambda_t \frac{P_t^{R,o}}{P_t} w_t^o h_t^o - \chi \frac{h_t^{o(1+\phi)}}{1+\phi} + \beta\left[\rho v_{t+1}^{lo} + (1-\rho) v_{t+1}^u\right] \tag{8}$$

$$v_t^u = \lambda_t \frac{P_t^{R,o}}{P_t} b^u + \beta\left[z_{t+1}^{un} v_{t+1}^{lo} + \left(1 - z_{t+1}^{un}\right) v_{t+1}^u\right] \tag{9}$$

where b^u defines the value of being unemployed in period t. Bosch and Esteban-

[13] We assume that $f_{pv}^{EA} V_t$ is purchased in the goods market, as such it enters the official sector aggregate resource constraint below.

Pretel (2012) point out that this value may capture elements such as the value of leisure, unemployment benefits and home production, which they treat as distinct from informal employment. Note that the option value of being employed in the unofficial sector does not enter (8) and (9) because we impose the stock equilibrium condition:

$$v_t^u = v_t^s \tag{10}$$

where

$$v_t^s = \lambda_t \frac{P_t^{R,s}}{P_t} w_t^s h_t^s - \chi_t \frac{h_t^{s(1+\phi)}}{1+\phi} + \beta v_{t+1}^s \tag{11}$$

defines the value to the individual of being employed in the unofficial sector.

Wages and hours are set to maximize the product:

$$\left(v_t^{EA}\right)^{1-\vartheta} \left(v_t^{lo} - v_t^u\right)^{\vartheta} \tag{12}$$

where ϑ identifies the relative bargaining power of each party.

Condition (12) is maximized by the following two FOCs:

$$w_t^o h_t^o = (1-\theta)\left(\chi \frac{h_t^{o(1+\phi)}}{\left(\frac{\lambda_t P_t^{R,o}}{P_t}\right)(1+\phi)} + b^u\right) + \theta\left\{P_t^{EA} h_t^o + \beta \frac{\lambda_{t+1}\pi_{t+1}^{R,o}}{\lambda_t \pi_{t+1}} z_{t+1}^{un} v_{t+1}^{ea}\right\}$$

and

$$\chi h_t^{o(\phi)} = P_t^{EA}$$

3.3 Banks

Official banks collect deposits from households and lend funds to official wholesale firms, who use them to purchase capital goods. There is an exogenous probability $\sigma_{(1-l)}$ that bankers continue to perform their role in the following period. In turn, with probability $(1-\sigma_{(1-l)})$ bankers exit the financial sector and become workers; therefore for each individual engaged in banking, activity is expected to last $(1-\sigma_{(1-l)})^{-1}$ periods.[14] Exiting bankers transfer their net worth to the household. The household provides new bankers with an initial endowment which is a fraction $\rho_{(1-l)}(1-\sigma_{(1-l)})^{-1}$ of last period loans.

[14] This assumption is typically made to prevent bankers from accumulating net worth up to the point where they would no longer need deposits to supply loans.

At the end of period t the *j - th* banker's balance sheet is given by:

$$q_t^o L_{j,t}^W = (D_{j,t+1} + NW_{j,t}) \left(\frac{p_t^o}{p_t} \right) \tag{13}$$

where $L_{j,t}^W$ is the amount of claims on firms, q_t^o is their relative price in terms of the consumption bundle (2), and $NW_{j,t}$ is the banker net worth at the end of period t. Bankers' net worth and bank deposits are defined in official goods, whose relative price price in terms of the consumption bundle is $\frac{p^o}{p}$.

The banker charges a gross return R_t^W on loans, and pays a gross real return R_{t-1}^D on households deposits. At the beginning of each period the banker may choose to divert a fraction ϕ of available funds from the bank portfolio because, by assumption, ϕ defines the unit cost households must bear to recover diverted funds. To ensure that depositors are willing to supply funds to bankers the discounted continuation value of a banker should be no less than the value of divertible funds. In fact the supply of deposits sets a limit to the bankers' leverage ratio

$$lev_t = \frac{q_t^o L_t^W}{\left(\frac{p_t^o}{p_t} \right) NW_t} = \frac{\eta_{j,t}}{\phi - v_{j,t}^k} \tag{14}$$

where v_t^k is the expected discounted marginal gain to the banker of expanding loans by a unit (holding net worth constant); η_t defines the expected discounted value of having another unit of net worth (holding assets constant). The leverage ratio allows bankers to earn a credit spread between earnings on loans and interests paid on liabilities which prevents bankers from diverting funds and induces them to accumulate wealth until they exits the market. The law of motion of the total net worth is:

$$NW_t = \sigma_{(1-l)} \left\{ ((R_t^W - R_{t-1}^D) lev_{t-1} + R_{t-1}^D \right\} \frac{NW_{t-1}}{\exp(\xi_t^o)} + \varrho_{(1-l)} q_{t-1}^o L_{t-1}^W \tag{15}$$

where $\varrho_{(1-l)} q_{t-1}^o L_{t-1}^W$ defines net worth endowments for new-born bankers and ξ_t^o is a *i.i.d.* net worth shock that initiates the crisis, as in Gertler and Karadi (2011).

3.4 Monetary policy

Monetary policy is assumed to follow a standard inflation-targeting rule with interest-rate smoothing, where i defines the steady state nominal interest rate

$$i_t = \left[i \left(\pi_t^o \right)^{\phi_\pi} \right]^{\rho_i} \left[i_{t-1} \right]^{1-\rho_i}$$

and the link between the nominal and the real interest rates is given by a standard Fisher equation:

$$1 + i_t = R_{t+1}^D E_t \pi_{t+1}^o$$

4 Results

We model a banking crisis as an adverse white noise shock to the bankers real net worth which causes an immediate 60% reduction of NW_t, broadly in line with the initial NW_t fall reported in Gertler and Karadi's (2011) crisis experiment. Right from the outset, it is important to emphasize that our focus is different from theirs, as we aim at characterizing the role of the informal economy in shaping labor market outcomes, instead of matching GDP losses recorded in specific episodes such as the 2007 Great Financial Crisis. Figures 6, 7 report impulse response functions of the relevant variables. Simulation of the shock in the one-sector economy shows that after 5 quarters GDP falls by little less than 3% and slowly recovers thereafter. This happens in spite of the interest rate cuts implemented by the Central Bank. The contraction of investment follows the same time pattern but is much sharper, reaching a minimum at about -20%. In the labor market the contraction triggers adjustment both in the intensive and in the extensive margin. Worked hours for employed individuals immediately fall. The contraction in official economic activity induces firms to post fewer vacancies, and therefore causes an increase in unemployment. Employment is gradually reduced and reaches a minimum at about -2%. These findings are broadly in line with recent theoretical studies (see for instance Toracchi, 2017).

The existence of an informal sector has important implications. Unemployed individuals now have an outside option - working in the informal sector - and the official labor market participation rate must ensure that condition $v_t^u = v_t^s$ holds. The policy of lower interest rates is an unambiguous demand stimulus for informal goods. If the participation rate remained constant, this would raise labor demand and real wages in the unofficial labor market, driving v_t^s above v_t^u. Adjustment in the official market participation rate prevents this outcome, determining a labor reallocation towards the informal economy that eventually disciplines informal wages and allows an increase in informal employment and production. Note that the in-

vestment gaps in the two sectors have opposite signs and drive sectoral capital accumulations away from steady state and in opposite directions. As a result, informal (official) economic activity expands (contracts) for a prolonged period. Indeed, it takes a long time to reverse the accumulation of capital in the informal sector. This, in turn, contributes to the persistence of the official sector slump we observe in the two-sector model. Note that product wages fall in both sectors for different reasons. In the official sector it happens due to lower labor demand, whereas in the informal sector it happens because the inflow of workers raises the labor supply. As a result inflation falls in both sectors, and the diverging growth rates of sectoral products bring about only a limited fall in the official goods relative price.

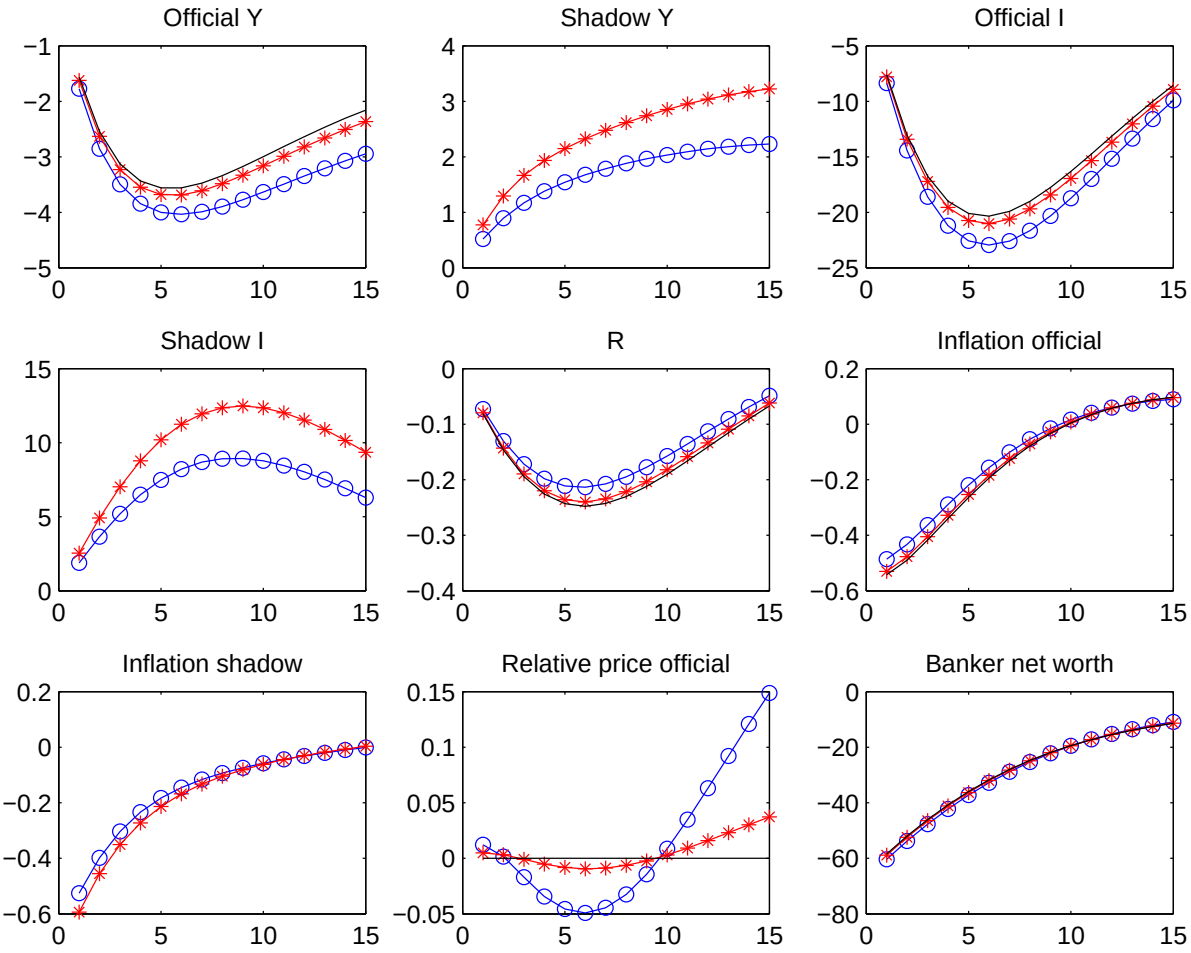
The labor reallocation mechanism which determines our results is driven by the initial dis-alignment of incentives to supply labor in the two sectors. The strength of the fall in the official employment and participation rates is essentially determined by the immediate adjustment in the informal capital/labor ratio which is necessary to adequately reduce informal wages.

The informal economy sector acts as a buffer which absorbs workers, and also as a crisis amplifier for the official economy. In fact, for a given financial shock, the ensuing contraction in the official economy is deeper and more persistent the larger the size of the unofficial sector. This occurs because when $\frac{y^s}{y^o}$ is relatively large, a greater labor reallocation is necessary to maintain $v_t^u = v_t^s$ after the shock.

5 Conclusions

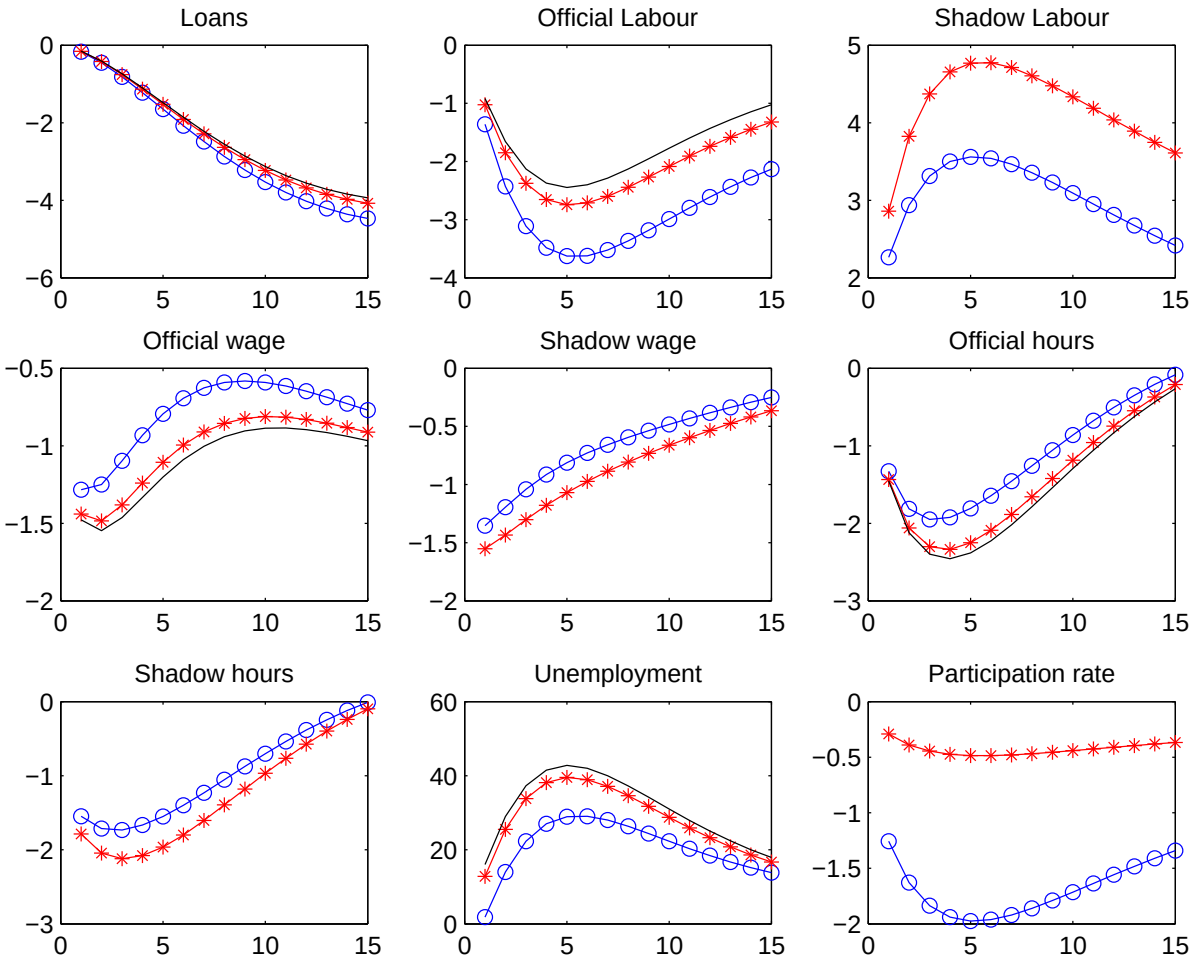
This paper investigates the effect of financial crises on the labor market participation rate. Our empirical analysis, based on a large sample of countries, suggests that financial crises are followed by a drop in the official market participation rate and by an increase in informal employment. To rationalize the evidence we analyze the labor market response in a two sector DSGE model that accounts for financial and labor market frictions. Our approach allows to deal with both the intensive and the extensive margin in employment adjustment. We find that financial crises imply a large reallocation effect of employment across the two sectors of the economy. As a result employment adjustment occurs mainly through the extensive margin.

Figure 6: Impulse responses to permanent shock to net worth.



Note: black line denotes IRF of the standard one sector model without the informal economy; starred red line denotes the two sector model when the share of the informal economy is 8%; dotted blue line denotes the two sector model when the share of the informal economy is 40%. Figures are percentage deviations from the steady state.

Figure 7: Impulse responses to permanent shock to net worth.



Note: black line denotes IRF of the standard one sector model without the informal economy; starred red line denotes the two sector model when the share of the informal economy is 8%; dotted blue line denotes the two sector model when the share of the informal economy is 40%. Figures are percentage deviations from the steady state.

References

Amaral, Pedro S. and Erwan Quintin. 2006. "A competitive model of the informal sector." *Journal of Monetary Economics* 53 (7):1541–1553.

Andolfatto, David. 1996. "Business Cycles and Labor-Market Search." *American Economic Review* 86 (1):112–32.

Blundell, Richard and Stephen Bond. 1998. "Initial conditions and moment restrictions in dynamic panel data models." *Journal of Econometrics* 87 (1):115–143.

Bosch, Mariano and Julen Esteban-Pretel. 2012. "Job creation and job destruction in the presence of informal markets." *Journal of Development Economics* 98 (2):270–286.

———. 2015. "The labor market effects of introducing unemployment benefits in an economy with high informality." *European Economic Review* 75 (C):1–17.

Boz, Emine, C. Bora Durdu, and Nan Li. 2015. "Emerging Market Business Cycles: The Role of Labor Market Frictions." *Journal of Money, Credit and Banking* 47 (1):31–72.

Breitung, J. and M.H. Pesaran. 2008. "Unit Roots and Cointegration in Panels." In *The Econometrics of Panel Data*, edited by L. Matyas and P. Sevestre. Springer.

Cerra, Valerie and Sweta Saxena. 2008. "Growth Dynamics: The Myth of Economic Recovery." *American Economic Review* 98 (1):439–57.

Christiano, Lawrence J., Mathias Trabandt, and Karl Walentin. 2011. "Introducing financial frictions and unemployment into a small open economy model." *Journal of Economic Dynamics and Control* 35 (12):1999–2041.

Colgiago, Andrea and Lorenza Rossi. 2014. "Firm entry, endogenous markups and the dynamics of the labor share of income." *Macroeconomic Dynamics* forthcoming.

Colombo, Emilio, Luisanna Onnis, and Patrizio Tirelli. 2016. "Shadow economies at times of banking crises: Empirics and theory." *Journal of Banking & Finance* 62:180 – 190.

Dell'Ariccia, Giovanni, Enrica Detragiache, and Raghuram Rajan. 2008. "The real effect of banking crises." *Journal of Financial Intermediation* 17 (1):89–112.

Dennis, Richard. 2009. "Consumption Habits in a New Keynesian Business Cycle Model." *Journal of Money, Credit and Banking* 41 (5):1015–1030.

Duval, Romain, Mehmet Eris, and Davide Furceri. 2011. "The Effects of Downturns on Labour Force Participation: Evidence and Causes." OECD Economics Department Working Papers 875, OECD Publishing.

Epstein, Brendan and Alan Finkelstein Shapiro. 2017. "Employment and firm heterogeneity, capital allocation, and countercyclical labor market policies." *Journal of Development Economics* 127 (C):25–41.

Erceg, Christopher J. and Andrew T. Levin. 2014. "Labor Force Participation and Monetary Policy in the Wake of the Great Recession." *Journal of Money, Credit and Banking* 46 (S2):3–49.

Fernández, Andrés and Felipe Meza. 2015. "Informal employment and business cycles in emerging economies: The case of Mexico." *Review of Economic Dynamics* 18 (2):381 – 405.

Fiess, Norbert M., Marco Fugazza, and William Maloney. 2010. "Informal self-employment and macroeconomic fluctuations." *Journal of Development Economics* 91 (2):211–226.

Garcia-Cicco, Javier, Roberto Pancrazi, and Martin Uribe. 2010. "Real Business Cycles in Emerging Countries?" *American Economic Review* 100 (5):2510–2531.

Gertler, Mark and Peter Karadi. 2011. "A model of unconventional monetary policy." *Journal of Monetary Economics* 58 (1):17–34.

Hobijn, Bart and Ayseg?l Sahin. 2009. "Job-finding and separation rates in the OECD." *Economics Letters* 104 (3):107–111.

Horvath, Jaroslav. 2017. "Business Cycles, Informal Economy, and Interest Rates in Emerging Countries." *Journal of Macroeconomics* .

Howard, Greg, Robert F. Martin, and Beth Anne Wilson. 2011. "Are recoveries from banking and financial crises really so different?" International Finance Discussion Papers 1037, Board of Governors of the Federal Reserve System (U.S.).

Koreshkova, Tatyana A. 2006. "A quantitative analysis of inflation as a tax on the underground economy." *Journal of Monetary Economics* 53 (4):773–796.

Kroszner, Randall S., Luc Laeven, and Daniela Klingebiel. 2007. "Banking crises, financial dependence, and growth." *Journal of Financial Economics* 84 (1):187–228.

La Porta, Rafael and Andrei Shleifer. 2008. "The Unofficial Economy and Economic Development." *Brookings Papers on Economic Activity* 39 (2 (Fall)):275–363.

Laeven, Luc and Fabian Valencia. 2008. "Systemic Banking Crises: A New Database." IMF Working Papers 08/224, International Monetary Fund.

———. 2010. "Resolution of Banking Crises: The Good, the Bad, and the Ugly." IMF Working Papers 10/146, International Monetary Fund.

Loayza, Norman V. and Jamele Rigolini. 2011. "Informal Employment: Safety Net or Growth Engine?" *World Development* 39 (9):1503–1515.

Meghir, Costas, Renata Narita, and Jean-Marc Robin. 2015. "Wages and Informality in Developing Countries." *American Economic Review* 105 (4):1509–1546.

Merz, Monika. 1995. "Search in the labor market and the real business cycle." *Journal of Monetary Economics* 36 (2):269–300.

Ozkan, F. Gulcin and Filiz D Unsal. 2012. "Global Financial Crisis, Financial Contagion, and Emerging Markets." IMF Working Papers 12/293, International Monetary Fund.

Pratap, Sangeeta and Erwan Quintin. 2006. "The Informal Sector in Developing Countries: Output, Assets and Employment." Working Papers RP2006/130, World Institute for Development Economic Research (UNU-WIDER).

Rajan, Raghuram G and Luigi Zingales. 1998. "Financial Dependence and Growth." *American Economic Review* 88 (3):559–86.

Reinhart, Carmen and Kenneth Rogoff. 2009. *This Time Is Different. Eight Centuries of Financial Folly*. Princeton University Press.

Restrepo-Echavarria, Paulina. 2014. "Macroeconomic volatility: The role of the informal economy." *European Economic Review* 70 (C):454–469.

Romer, Christina D. and David H. Romer. 1989. "Does Monetary Policy Matter? A New Test in the Spirit of Friedman and Schwartz." In *NBER Macroeconomics Annual 1989, Volume 4*, NBER Chapters. National Bureau of Economic Research, Inc, 121–184.

Rotemberg, Julio J. 1982. "Monopolistic Price Adjustment and Aggregate Output." *Review of Economic Studies* 49 (4):517–31.

Schmitt-Grohe, Stephanie and Martin Uribe. 2004. "Optimal fiscal and monetary policy under sticky prices." *Journal of Economic Theory* 114 (2):198–230.

Schneider, Friedrich, Andreas Buehn, and Claudio E. Montenegro. 2010. "Shadow economies all over the world : new estimates for 162 countries from 1999 to 2007." Policy Research Working Paper Series 5356, The World Bank.

Schneider, Friedrich G. and Andreas Buehn. 2007. "Shadow economies and corruption all over the world: revised estimates for 120 countries." *Economics - The Open-Access, Open-Assessment E-Journal* 1 (9 (Versio):1–53.

Toracchi, Federico. 2017. "How Do Credit Supply Conditions Affect the Labor Market? Estimating a New-Keynesian DSGE Model with Labor and Credit Market Frictions." Tech. Rep. 817, University of Oxford.

Ulyssea, Gabriel. 2010. "Regulation of entry, labor market institutions and the informal sector." *Journal of Development Economics* 91 (1):87 – 99.

Zenou, Yves. 2008. "Job search and mobility in developing countries. Theory and policy implications." *Journal of Development Economics* 86 (2):336–355.

Zhang, Yahong. 2011. "Financial Frictions, Financial Shocks and Labour Market Frictions in Canada." Discussion paper no. 2011-10, Bank of Canada.

Technical Appendix

A.1 Model details

A.1.1 Households

Households preferences are defined by:

$$U_t = E_t \sum_{k=o}^{\infty} \beta^k \left\{ \ln\left(c^i_{t+k} - bc_{t+k-1}\right) - \left(\frac{\chi \left(h^i_{t+k}\right)^{1+\phi} l^{i,o}_{t+k}}{1+\phi} \right) \right\} \tag{A.1}$$

where c^i is individual consumption, b defines consumption habits and l^i and h^i_t respectively are the number of employed individuals and their labor effort in the official and informal economy sectors.[15]

Household preferences over the goods produced in sector j of the economy are defined as follows:

$$c^j_t = \left(\int_0^1 c^j_t \left(z^j\right)^{\frac{\sigma^j - 1}{\sigma^j}} dz^j \right)^{\frac{\sigma^j}{\sigma^j - 1}} \tag{A.2}$$

and the associated retail price index is:

$$P^{Rj}_t = \left(\int_0^1 \left(P^{Rj}_t (z) \right)^{1-\sigma^j} dz \right)^{\frac{1}{1-\sigma^j}}$$

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

$$c_t\left(z^j\right) = \left(\frac{P^{Rj}_t \left(z^j\right)}{P^{Rj}_t} \right)^{-\sigma^j} c^j_t$$

Following Fernández and Meza (2015) and Restrepo-Echavarria (2014) the total consumption bundle is[16]

$$c_t = \left[(1-\alpha_c)^{\frac{1}{\varepsilon}} \left(c^o_t\right)^{\frac{\varepsilon-1}{\varepsilon}} + (\alpha_c)^{\frac{1}{\varepsilon}} \left(c^s_t\right)^{\frac{\epsilon-1}{\varepsilon}} \right]^{\frac{\varepsilon}{\varepsilon-1}} \tag{A.3}$$

and

$$P_t = \left[(1-\alpha_c) \left(P^{R,o}_t\right)^{1-\varepsilon} + \alpha_c \left(P^{R,s}_t\right)^{1-\varepsilon} \right]^{\frac{1}{1-\varepsilon}} \tag{A.4}$$

[15] We assume that bankers share consumption risk with remaining individuals in the household. In addition, they inelastically supply a unit of labor in each period.

[16] In an earlier version we incorporated tax distortions and α_c was calibrated at a negligible value. Our simulation results were not affected by these adjustments. Results available upon request.

defines the consumption price index. Demand functions for the sectoral consumption bundles are:

$$c_t^o = (1-\alpha_c)\left(\frac{P_t^{R,o}}{P_t}\right)^{-\varepsilon} c_t$$

$$c_t^s = \alpha_c\left(\frac{P_t^{R,s}}{P_t}\right)^{-\varepsilon} c_t$$

The representative household flow budget constraint is:

$$\begin{aligned} & c_t + \frac{P_t^{R,o}}{P_t} D_t + \frac{P_t^{R,s}}{P_t} I_t^s = \\ = \; & \frac{P_t^{R,o}}{P_t} w_t^o h^o l_t^o + b^u u_t + \frac{P_t^{R,o}}{P_t} R_{t-1}^D D_{t-1} \\ & + \frac{P_t^{R,s}}{P_t} w_t^s h^s l_t^s + \frac{P_t^{R,s}}{P_t}\left(r_t^{k.s} - \delta\right) k_{t-1}^s + \frac{P_t^{R,o}}{P_t}\Pi_t^o + \frac{P_t^{R,s}}{P_t}\Pi_t^s \end{aligned} \tag{A.5}$$

where D are bank deposits, which yield the rate of return R_t^D, k^s and I_t^s are the capital stock and the amount of investment in the informal sector, $r^{k,s}$ is the return from capital investment in the informal economy and δ is the capital depreciation rate. Π^o and Π^s define sectoral profits.[17] Note that households choose investment in the informal sector, whereas official investment is chosen by official firms.

The household marginal utility of consumption is:

$$\lambda_t = \frac{1}{(c_t - bc_{t-1})}.$$

The intertemporal Euler equations for deposits, D_t and for informal sector capital are:

$$\lambda_t = \beta E_t \frac{\pi_{t+1}^{R,o}\lambda_{t+1}}{\pi_{t+1}} R_t^D \tag{A.6}$$

$$1 = \beta E_t \frac{\lambda_{t+1}}{\lambda_t} \frac{[q_{t+1}^s(1-\delta) + \frac{P_{t+1}^{R,s}}{P_{t+1}} r_{t+1}^{k,s}]}{q_t^s} \tag{A.7}$$

Accumulation of k_t^s is driven by:

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

[17] Following Gertler and Karadi (2011) Π_t^o incorporates profits from both official sector retail firms and banks, as well as transfers from individuals exiting the banking profession and to new bankers, as discussed below.

where q_t^s is the informal sector relative price of capital, defined in terms of the consumption bundle (A.3), π_t,$\pi_t^{R,o}$ respectively define inflation rates for P_t, $P_t^{R,o}$ and $S\left(\frac{I_t^s}{I_{t-1}^s}\right) = \frac{\gamma_I}{2}\left(\frac{I_t^s}{I_{t-1}^s} - 1\right)^2$ investment adjustment costs.

The first order condition for investment decisions in the informal sector is:

$$\begin{aligned}\frac{P_t^{R,s}}{P_t} &= q_t^s\left\{1 - \gamma_I\left(\frac{I_t^s}{I_{t-1}^s} - 1\right)\frac{I_t^s}{I_{t-1}^s} - \frac{\gamma_I}{2}\left(\frac{I_t^s}{I_{t-1}^s} - 1\right)^2\right\} \\ &+\beta\frac{\lambda_{t+1}}{\lambda_t}q_{t+1}^s\gamma_I\left(\frac{I_{t+1}^s}{I_t^s} - 1\right)\left(\frac{I_{t+1}^s}{I_t^s}\right)^2\end{aligned}$$

A.1.2 Labor market

The labor market is perfectly competitive in the unofficial sector, but is characterized by matching frictions in the official sector. Following Christiano, Trabandt, and Walentin (2011) and Zhang (2011), to facilitate model tractability we assume that employment agencies post vacancies in the official labor market at the official output cost f_{pv}^{EA} and bargain with workers both the official sector product wage rate w_t^o and the number of hours worked h^o. Subsequently they combine individual labor supplies into a labor input which is then transferred to official sector wholesale firms at the competitive price P_t^{EA}, defined in terms of official sector goods.

A.1.2.1 Employment agencies

In the formal sector new matches per unit of time are determined by a standard matching technology:

$$M_t = m\left(u_t\right)^{\varkappa}\left(V_t\right)^{1-\varkappa} \tag{A.8}$$

where V_t and u_t respectively define the number of vacancies in the official sector and unemployment, and m is a parameter that defines the efficiency of the matching technology. The probability that a vacancy z_t^V be filled therefore is:

$$z_t^V = \frac{M_t}{V_t} = m\left(\frac{u_t}{V_t}\right)^{\varkappa}.$$

Similarly, the probability that an unemployed individual gets a job in the official sector, z_t^{un}, is:

$$z_t^{un} = \frac{M_t}{u_t} = m\left(\frac{V_t}{u_t}\right)^{1-\varkappa}$$

Real profits of the representative employment agency are:

$$\Pi^{EA} = \left(P_t^{EA} - w_t^o\right) l_t^o h_t^o - f_{pv}^{EA} V_t \tag{A.9}$$

Official employment follows the law of motion:

$$l_t^o(s) = \rho^s l_{t-1}^o(s) + z_t^V V_t(s) \tag{A.10}$$

where ρ^s $(0 < \rho^s < 1)$ defines the exogenous probability that a match survives up to next period.

The employment agency maximizes:

$$E_t \sum_{k=o}^{\infty} \beta \frac{\pi_{t+1}^{R,o}}{\pi_{t+1}} \frac{\lambda_{t+1}}{\lambda_t} \left[\left(P_t^{EA} - w_t^o\right) l_t^o h_t^o - f_{pv}^{EA} V_t\right]$$

subject to A.10 by optimally choosing the number of workers and the number of vacancies. The first order conditions are:

$$\frac{P_t^{R,o}}{P_t} \lambda_t \left(P_t^{EA} - w_t^o\right) h_t^o - \frac{P_t^{R,o}}{P_t} \lambda_t v_t^{EA} + \beta \frac{P_{t+1}^{R,o}}{P_{t+1}} \lambda_{t+1} v_{t+1}^{EA} \rho^S = 0$$

and:

$$f_{pv}^{EA} = v_t^{EA} z_t^V .$$

Combining the two, we obtain the the following hiring condition:

$$\frac{f_{pv}^{EA}}{z_t^V} = \left(P_t^{EA} - w_t^o\right) h_t^o + \beta \frac{\pi_{t+1}^{R,o} \lambda_{t+1}}{\pi_{t+1} \lambda_t} \frac{f_{pv}^{EA}}{z_{t+1}^V} \rho^S \tag{A.11}$$

where $\frac{f_{pv}^{EA}}{z_t^V}$ defines the marginal cost of hiring a worker[18] and the r.h.s. of (A.11) is the marginal benefit, including both the price margin $(P_t^{EA} - w_t^o)$, and the discounted savings on posting a future vacancy, which are proportional to the match survival rate ρ^s.

[18]We assume that $f_{pv}^{EA} V_t$ is purchased in the goods market, as such it enters the official sector aggregate resource constraint below.

A.1.2.2 Nash bargaining over wages and hours

The nominal wage and the number of hours are negotiated by workers and employment agencies within a Nash bargaining framework. We assume simultaneous bargaining over W and h.

The Bellman equation that describes the value of a new hire for the employment agency is:

$$v_t^{EA} = \left(P_t^{EA} - w_t^o\right) h_t^o + \beta \frac{\pi_{t+1}^{R,o} \lambda_{t+1}}{\pi_{t+1} \lambda_t} v_{t+1}^{EA} \rho^S$$

where v_t^{EA} is defined in official goods. The Bellman equations that describe the value for an individual of being employed and unemployed respectively are:

$$v_t^{lo} = \lambda_t \frac{P_t^{R,o}}{P_t} w_t^o h_t^o - \chi \frac{h_t^{o(1+\phi)}}{1+\phi} + \beta \left[\rho v_{t+1}^{lo} + (1-\rho) v_{t+1}^u\right] \tag{A.12}$$

$$v_t^u = \lambda_t \frac{P_t^{R,o}}{P_t} b^u + \beta \left[z_{t+1}^{un} v_{t+1}^{lo} + \left(1 - z_{t+1}^{un}\right) v_{t+1}^u\right] \tag{A.13}$$

where b^u defines the value of being unemployed in period t. Bosch and Esteban-Pretel (2012) point out that this value may capture elements such as the value of leisure, unemployment benefits and home production, which they treat as distinct from informal employment. Note that the option value of being employed in the unofficial sector does not enter (A.12) and (A.13) because we impose the stock equilibrium condition:

$$v_t^u = v_t^s \tag{A.14}$$

where

$$v_t^s = \lambda_t \frac{P_t^{R,s}}{P_t} w_t^s h_t^s - \chi_t \frac{h_t^{s(1+\phi)}}{1+\phi} + \beta v_{t+1}^s \tag{A.15}$$

defines the value to the individual of being employed in the unofficial sector.

Wages and hours are set to maximize the product:

$$\left(v_t^{EA}\right)^{1-\vartheta} \left(v_t^{lo} - v_t^u\right)^{\vartheta} \tag{A.16}$$

where ϑ identifies the relative bargaining power of each party.

The foc with respect to wages and hours respectively are:

$$(1-\theta)\left(v_t^{ea}\right)^{-\theta}\frac{\partial v_t^{ea}}{\partial w_t^o}\left(v_t^{lo}-v_t^u\right)^{\theta}=-\theta\left(v_t^{ea}\right)^{1-\theta}\left(v_t^{lo}-v_t^u\right)^{\theta-1}\frac{\partial\left(v_t^{lo}-v_t^u\right)}{\partial w_t^o}=$$

$$=\quad(1-\theta)\left(\chi\frac{h_t^{o(1+\phi)}}{\left(\frac{\lambda_t P_t^{R,o}}{P_t}\right)(1+\phi)}+b^u\right)+\theta\left\{P_t^{EA}h_t^o+\beta\frac{\lambda_{t+1}\pi_{t+1}^{R,o}}{\lambda_t\pi_{t+1}}z_{t+1}^{un}v_{t+1}^{ea}\right\}$$

$$\begin{aligned}(1-\theta)\left(v_t^{ea}\right)^{-\theta}\frac{\partial v_t^{ea}}{\partial h_t^o}\left(v_t^{lo}-v_t^u\right)^{\theta} &= -\theta\left(v_t^{ea}\right)^{1-\theta}\left(v_t^{lo}-v_t^u\right)^{\theta-1}\frac{\partial\left(v_t^{lo}-v_t^u\right)}{\partial w h_t^o}=\\ -\theta\left(v_t^{ea}\right)\frac{\partial\left(v_t^{lo}-v_t^u\right)}{\partial h_t^o} &= (1-\theta)\frac{\partial v_t^{ea}}{\partial h_t^o}\left(v_t^{lo}-v_t^u\right)\\ -\theta\left(v_t^{ea}\right)\lambda_t\left(\frac{P_t^{R,o}}{P_t}w_t^o-\chi h_t^{o(\phi)}\right) &= (1-\theta)\left(P_t^{EA}-w_t^o\right)\left(v_t^{lo}-v_t^u\right)\end{aligned}$$

Since, $\frac{\theta}{(1-\theta)}\left(v_t^{ea}\right)\frac{\lambda_t P_t^{R,o}}{P_t}=\left(v_t^{lo}-v_t^u\right)$ we get:

$$\chi h_t^{o(\phi)}=P_t^{EA}$$

also note that Nash bargaining implies

$$-\frac{\frac{\partial\left(v_t^{lo}-v_t^u\right)}{\partial h_t^o}}{\frac{\partial v_t^{ea}}{\partial h_t^o}}=(1-\theta)\frac{\left(v_t^{lo}-v_t^u\right)}{\theta\left(v_t^{ea}\right)}$$

$$-\frac{\left(\frac{\partial\left(v_t^{lo}-v_t^u\right)}{\partial w_t^o}\right)}{\frac{\partial v_t^{ea}}{\partial w_t^o}}=\frac{\partial v_t^{ea}}{\partial w_t^o}(1-\theta)\frac{\left(v_t^{lo}-v_t^u\right)}{\theta\left(v_t^{ea}\right)}$$

that is:

$$\frac{\frac{\partial\left(v_t^{lo}-v_t^u\right)}{\partial h_t^o}}{\frac{\partial v_t^{ea}}{\partial h_t^o}}=\frac{\left(\frac{\partial\left(v_t^{lo}-v_t^u\right)}{\partial w_t^o}\right)}{\frac{\partial v_t^{ea}}{\partial w_t^o}}$$

A.1.3 Banks

Official banks lend funds to official wholesale firms, who use them to purchase capital goods. There is an exogenous probability $\sigma_{(1-l)}$ that bankers continue to perform their role in the following period. In turn, with probability $(1-\sigma_{(1-l)})$ bankers exit the financial sector and become workers; therefore for each individual engaged in

banking, activity is expected to last $(1-\sigma_{(1-l)})^{-1}$ periods.[19] Exiting bankers transfer their net worth to the household. The household provides new bankers with an initial endowment which is a fraction $\rho_{(1-l)}(1-\sigma_{(1-l)})^{-1}$ of last period loans.

At the end of period t the *j - th* banker's balance sheet is given by:

$$q_t^o L_{j,t}^W = (D_{j,t+1} + NW_{j,t}) \left(\frac{p_t^o}{p_t}\right) \tag{A.17}$$

where $L_{j,t}^W$ is the amount of claims on firms, q_t^o is their relative price in terms of the consumption bundle (A.3), and $NW_{j,t}$ is the banker net worth at the end of period t. Bankers' net worth and bank deposits are defined in official goods, whose relative price price in terms of the consumption bundle is $\frac{p^o}{p}$.

The banker charges a gross return R_t^W on loans, and pays a gross real return R_{t-1}^D on households deposits. A credit spread arises as difference between earnings on assets and interests paid on liabilities in presence of imperfect capital market: the banker will only fund projects with an expected return of no less than the discounted cost of borrowing. Assuming that the discount factor of the banker between time t and $t+i$ is the household's intertemporal marginal rate of substitution, the following participation constraint must hold:

$$E_t \beta \frac{\pi_{t+i}^{R,o} \lambda_{t+i}}{\pi_{t+i} \lambda_t} (R_{t+i+1}^W - R_{t+i}^D) \geq 0 \qquad i \geq 0$$

So the banker accumulates wealth until he exits the market.

The evolution of the banker's real net worth is:

$$NW_{j,t+1} = (R_t^W - R_{t-1}^D) \frac{q_t^o}{\left(\frac{p_t^o}{p_t}\right)} L_{j,t}^W + R_{t-1}^D NW_{j,t}$$

A credit spread arises as difference between earnings on assets and interests paid on liabilities in presence of imperfect capital market: the banker will only fund projects with an expected return of no less than the discounted cost of borrowing. Assuming that the discount factor of the banker between time t and $t+i$ is the household's intertemporal marginal rate of substitution, the following participation con-

[19] This assumption is typically made to prevent bankers from accumulating net worth up to the point where they would no longer need deposits to supply loans.

straint must hold:

$$E_t \beta \frac{\pi^{R,o}_{t+i} \lambda_{t+i}}{\pi_{t+i} \lambda_t} (R^W_{t+i+1} - R^D_{t+i}) \geq 0 \qquad i \geq 0$$

So the banker accumulates wealth until he exits the market. Therefore he will maximize the discounted value of expected terminal wealth, $V_{j,t}$.

$$V_{j,t} = E_t \sum_{i=0}^{\infty} \left(1 - \sigma_{(1-h)}\right) \sigma_{(1-h)} \beta^{i+1} \frac{\pi^{R,o}_{t+i+1} \lambda_{t+i+1}}{\pi_{t+i+1} \lambda_{t+i}} \left[(R^W_{t+i} - R^D_{t+i-1}) \frac{q^o_{t+i}}{\left(\frac{p^o_{t+i}}{p_{t+i}}\right)} L^W_{j,t+i} + R^D_{t+i-1} NW_{j,t+i} \right]$$

At the beginning of each period the banker may choose to divert a fraction ϕ of available funds from the bank portfolio because, by assumption, ϕ defines the unit cost households must bear to recover diverted funds. To ensure that depositors are willing to supply funds to bankers the following incentive constraint must be satisfied:

$$V_{j,t} \geq \phi \frac{q^o_t}{\left(\frac{p^o_t}{p_t}\right)} L^W_{j,t} \tag{A.18}$$

i.e. the discounted value of expected terminal wealth $V_{j,t}$ should not be less than the value of divertible funds.

Following Gertler and Karadi (2011) the present discounted value of net worth at the end of the period takes the following form:

$$V_{j,t} = v^k_{j,t} \frac{q^o_t}{\left(\frac{p^o_t}{p_t}\right)} L^W_{j,t} + \eta_{j,t} NW_{j,t} \tag{A.19}$$

$$\eta_{j,t} = E_t \left\{ \left(1 - \sigma_{(1-l)}\right) + \beta \frac{\pi^{R,o}_{t+1} \lambda_{t+1}}{\pi_{t+1} \lambda_t} \sigma_{(1-l)} \eta_{j,t+1} \frac{NW_{j,t+1}}{NW_{j,t}} \right\}$$

$$v^k_{j,t} = E_t \left\{ \beta \frac{\pi^{R,o}_{t+1} \lambda_{t+1}}{\pi_{t+1} \lambda_t} \left(1 - \sigma_{(1-l)}\right) \left((R^W_{t+1} - R^D_t) + \beta \frac{\pi^{R,o}_{t+1} \lambda_{t+1}}{\pi_{t+1} \lambda_t} \sigma_{(1-l)} v^k_{j,t+1} \frac{\frac{q^o_{t+1}}{\left(\frac{p^o_{t+1}}{p_{t+1}}\right)} L^W_{j,t+1}}{\frac{q^o_t}{\left(\frac{p^o_t}{p_t}\right)} L^W_{j,t}} \right) \right\}$$

where v^k_t is the expected discounted marginal gain to the banker of expanding non-financial claims by a unit (keeping net worth constant), η_t defines the expected discounted value of having another unit of net worth (holding assets constant) and the banker's leverage ratio

$$lev_{j,t} = \frac{\eta_{j,t}}{\phi - v^k_{j,t}}$$

limits the banker's access to households deposits, so that the incentive constraint (A.18) is satisfied. Summing across the portfolios of each individual bank in the market we obtain the relationship between the outstanding stock of loans and the aggregate net worth of banks

$$\frac{q_t^o}{\left(\frac{p_t^o}{p_t}\right)} L_t^W = lev_t NW_t$$

The net worth of existing bankers, NW_t^e, evolves according to:

$$NW_t^e = \sigma_{(1-l)} \left\{ (R_t^W - R_{t-1}^D) lev_{t-1} + R_{t-1}^D \right\} NW_{t-1}^e$$

New born-bankers are endowed with $\frac{\varrho_{(1-l)}}{\left(1-\sigma_{(1-l)}\right)} L_{t-1}^W$. Hence, the law of motion of the total net worth is:

$$NW_t = \sigma_{(1-l)} \left\{ ((R_t^W - R_{t-1}^D) lev_{t-1} + R_{t-1}^D \right\} \frac{NW_{t-1}}{\exp\left(\xi_t^o\right)} + \varrho_{(1-l)} q_{t-1}^o L_{t-1}^W \tag{A.20}$$

where ξ_t^o defines a *i.i.d.* net worth shock, as in Gertler and Karadi (2011).

A.1.4 Firms

In each sector j (o, s), perfectly competitive (flex-price) firms produce wholesale (intermediate) goods $I^{W,j}$ and sell them to retail producers R, j that differentiate products and are subject to price adjustment costs.

A.1.4.1 Wholesale producers

Wholesale producers have access to the production technology:

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

where y_t^j, k_t^j, h_t^j respectively define sector-specific output, capital and labor inputs.

Informal firms As discussed above, informal firms hire factor inputs directly from households. Their factor demands are:

$$w_t^s = (1-\alpha^s)\left(\frac{k_{t-1}^s}{h_t^s l_t^s}\right)^{\alpha^s} \tag{A.21}$$

and

$$r_t^{k,s} = \alpha^s \left(\frac{k_{t-1}^s}{h_t^s l_t^s}\right)^{-(\alpha^s-1)}. \tag{A.22}$$

Intermediate goods are sold to final goods producers at

$$p_t^{I^W,s} = \left(\frac{r_t^{k,s}}{\alpha^s}\right)^{\alpha^s}\left(\frac{w_t^s}{(1-\alpha^s)}\right)^{1-\alpha^s}$$

where $p_t^{I^W,s}$ defines the price of informal intermediate goods in terms of the informal retail price.

Official firms and capital goods producers At the beginning of each period official firms use funds borrowed from banks to finance their capital acquisition from capital goods producers to be used for production. After production, undepreciated capital is sold back to capital goods producers. Their profits in terms of the consumption bundle are

$$\Pi_t^{I^W,o} = y_t^o \frac{p_t^{I^W,o}}{p_t} + q_t^o\left(1-\delta\right)k_{t-1}^o - R_t^W q_{t-1}^o k_{t-1}^o - \frac{p_t^{I^W,o}}{P_t} P_t^{EAW} h_t^o l_t^o$$

Intermediate firms' capital demand is such that

$$\frac{\left\{r_t^{k,o}\left(\frac{p_t^{I^W,o}}{p_t}\right) + q_t^o\left(1-\delta\right)\right\}}{q_{t-1}^o} = R_t^W \tag{A.23}$$

where $r_t^{k,o} = \alpha^o\theta_t^o\left(\frac{k_{t-1}^o}{h_t^o l_t^o}\right)^{-(\alpha^o-1)}$ defines the marginal productivity of capital. Demand for the labor bundle is

$$P_t^{EAW} = (1-\alpha^o)\left(\frac{k_{t-1}^o}{h_t^o l_t^o}\right)^{\alpha^o} \tag{A.24}$$

Official intermediate goods are sold to final goods producers at

$$p_t^{I^W,o} = \left(\frac{r_t^{k,o}}{\alpha^o}\right)^{\alpha^o} \left(\frac{P_t^{EAW}}{(1-\alpha^o)}\right)^{1-\alpha^o}$$

At the end of each period capital goods producers purchase undepreciated capital from intermediate firms and obtain from retail firms the final goods devoted to investment in order to assemble the capital goods which are then sold to the wholesale firms. Capital accumulation is subject to:

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

where

$$S\left(\frac{I_t^o}{I_{t-1}^o}\right) = \frac{\gamma_I}{2}\left(\frac{I_t^o}{I_{t-1}^o} - 1\right)^2$$

defines investment adjustment costs.

Their expected discounted profits in terms of the consumption bundle are:

$$E_t \sum_{i=0}^{\infty} \beta^i \frac{\lambda_{t+i}}{\lambda_t} \left[q_t^o k_t^o - q_t^o\,(1-\delta)\, k_{t-1}^o - \frac{p_t^{I^W,o}}{p_t} I_t^o\right]$$

and the first order condition for their maximization problem is:

$$\begin{aligned} \frac{p_t^{I^W,o}}{p_t} &= q_t^o \left\{1 - \gamma_I\left(\frac{I_t^o}{I_{t-1}^o} - 1\right)\frac{I_t^o}{I_{t-1}^o} - \frac{\gamma_I}{2}\left(\frac{I_t^o}{I_{t-1}^o} - 1\right)^2\right\} \\ &\quad + \beta \frac{\lambda_{t+1}}{\lambda_t} q_{t+1}^o \gamma_I \left(\frac{I_{t+1}^o}{I_t^o} - 1\right)\left(\frac{I_{t+1}^o}{I_t^o}\right)^2 \end{aligned} \tag{A.25}$$

A.1.4.2 Retail producers

Retail producers turn intermediate goods into differentiated retail products. We assume a sticky price specification based on Rotemberg (1982) quadratic cost of nominal price adjustment:

$$\frac{\varphi}{2}\left(\pi_t^{Rj} - 1\right)^2 \tag{A.26}$$

where $\varphi \geq 0$ is a measure of price stickiness, $\pi_t^{Rj} = \frac{P_t^{Rj}}{P_{t-1}^{Rj}}$ denotes the sectoral gross inflation rate.

In a symmetrical equilibrium the price adjustment rule satisfies:

$$\left(\frac{(1-\sigma^j)}{\sigma^j} + p_t^{I^W,j}\right)\frac{\sigma^j}{\varphi} + \beta\frac{\pi_{t+1}^j\lambda_{t+1}}{\pi_{t+1}\lambda_t}\frac{y_{t+1}^j}{y_t^j}\left[\left(\pi_{t+1}^{Rj}-1\right)\left(\pi_{t+1}^{Rj}\right)\right] = \left(\pi_t^{Rj}-1\right)\pi_t^{Rj} \quad \text{(A.27)}$$

the sectoral price index is determined as

$$P_t^{R,j} = P_{t-1}^{R,j}\pi_t^{Rj}$$

The inflation rate for the price index of the price index of the consumption bundle (A.4) is:

$$\pi_t = \frac{P_t}{P_{t-1}}$$

A.1.5 Market clearing

$$y_t^o = c_t^o + I_t^o + \frac{\varphi}{2}y_t^o\left(\pi_t^{R,o}-1\right)^2 + f_{pv}^{EA}V_t \quad \text{(A.28)}$$

$$y_t^s = c_t^s + I_t^s + \frac{\varphi}{2}y_t^s\left(\pi_t^s-1\right)^2 \quad \text{(A.29)}$$

A.1.6 Labor resource constraint

The labor resource constraint is:

$$l = l_t^o + l_t^s + u_t \quad \text{(A.30)}$$

A.1.7 Monetary policy rule

Monetary policy is assumed to follow a standard inflation-targeting rule with interest-rate smoothing, where i defines the steady state nominal interest rate

$$i_t = \left[i\left(\pi_t^o\right)^{\phi_\pi}\right]^{\rho_i}\left[i_{t-1}\right]^{1-\rho_i}$$

and the link between the nominal and the real interest rates is given by a standard Fisher equation:

$$1 + i_t = R^D_{t+1} E_t \pi^o_{t+1}$$

A.1.8 Calibration

The agency problem in the banking sector is parameterized as in Gertler and Karadi (2011). The fraction of funds that can be diverted, ϕ, is set at 0.381: the survival rate of banker, $\sigma_{(1-l)}$, is 0.975, the proportional transfer to new bankers, $\varrho_{(1-l)}$, is 0.002. These values allow to obtain in steady state a spread of one hundred basis points, a leverage ratio of 4 and 10 years as the average horizon for bankers.

Parameters characterizing the official economy and households preferences are fairly standard. The values chosen for the household subjective discount factor, $\beta = 0.99$, the capital income share $\alpha^o = 0.34$, the capital depreciation rate, $\delta = 0.02$, follow the literature (see Fernández and Meza, 2015). The consumption habits parameter $b = 0.6$ falls in the range considered in Dennis (2009). The degree of price stickiness, $\varphi = 120$ is taken from Ozkan and Unsal (2012),[20] to the best of our knowledge, there is no evidence about nominal rigidities in the unofficial sector. We therefore take as benchmark the values adopted for the degree of price stickiness in the official sector. The price-elasticity parameter $\sigma^o = 6$ is taken from Schmitt-Grohe and Uribe (2004). The elasticity of substitution between official and informal consumption bundles, is set at 5, similarly to Epstein and Finkelstein Shapiro (2017). Turning to firms operating in the informal economy, to capture the relatively low capital intensity in their production function we have chosen the capital share parameter, $\alpha^s = 0.28$, as in Koreshkova (2006); we have also assumed that firms operating in the unofficial retail sector have limited market power, $\sigma^s = 20$. The steady-state relative capital labor ratio $\frac{k^o/h^o l^o}{k^s/h^s l^s}$ is 1.58. Parameters $\phi_\pi = 1.5$, $\rho_i = 0.9$ characterize the monetary policy rule.

Labor market parameters are selected as follows. Hobijn and Sahin (2009) find that monthly separation rates range between 2 and 0.7%. We therefore set $\rho^s = 0.96$, implying a 4% quarterly separation rate. We calibrate m, f^{EA}_{pv} to obtain a job finding

[20] We also experimented with a very low degree of stickiness, $\varphi^o = 4.37$, taken from Schmitt-Grohe and Uribe (2004). Our results were only marginally affected.

rate[21] $z^{un} = 0.7$ and a vacancy filling rate $z^V = 0.9$, as in Colgiago and Rossi (2014).[22] These values are also broadly in line with the calibration in Boz, Durdu, and Li (2015) who refer to the Mexican economy. We set $b^u = 0.5w^o$ as in Bosch and Esteban-Pretel (2015). The Nash bargaining parameter ϑ is assigned value 0.5, which is standard in this literature. Parameter $\varkappa$ in (A.8) also takes the standard value of 0.5.

Finally we close the model by calibrating α_c in order to set the steady state value of the informal economy relative size, $\frac{y^s}{y^o}$. Schneider and Buehn (2007) document the large dispersion of this ratio across different countries, where developing countries are typically characterized by a relatively large share of the informal economy. Following Colombo, Onnis, and Tirelli (2016) we have therefore chosen two "representative" calibrations. By setting $\frac{y^s}{y^o} = 8\%$ we match the sample average for advanced economies whereas $\frac{y^s}{y^o} = 40\%$ is a value common to several low income countries, Correspondingly the ratios $\frac{l^s}{l^o}$ are 12% and 58%. We calibrate two values of χ (1.7 and 1.8) in (A.1) to obtain in both steady state hours $h^o = 1$, $h^s = 0.9974$. Table A.1 summarizes all the parameters values.

A.2 Empirical analysis

GDP and investment are taken from the World Bank WDI (both are in real terms PPP adjusted). Regarding labor market data, it is well known that reasonably long cross-country comparable time series of labor market variables are limited to advanced economies. To maximize coverage we used two different data set. The first one is the recently released KILM dataset by the ILO. Its main advantage is the width of the coverage including 170 countries; the disadvantage is the depth of the time series available as observations start only from 1990. The ILO dataset is also the basis of data on the participation rate included in the World Bank WDI. The second one is taken from the OECD labor market statistics which are available only for OECD countries but for most countries to go back to 1970.

The ILO-KILM dataset has collected and organized available estimates on informal employment, measured through surveys either at household or at establishment level. Information is however scattered as only for few countries such esti-

[21] Hobijn and Sahin (2009) document that monthly job-finding rates in the OECD seem to range between 2.6% and56%.

[22] This implies that official labor market tightness, $\frac{z^{un}}{z^V}$ in steady state is about 80%. Bosch and Esteban-Pretel (2015) choose a tightness index of 1, but they clarify that model dynamics are not affected by such choice.

Table A.1: Parameter values

Parameter	Value	Description
β	0.99	Household subjective discount factor
σ^o	6	price-elasticity of demand for a differentiated good, official
σ^s	20	price-elasticity of demand for a differentiated good, informal
φ^o, φ^s	120	degree of price stickiness
α^o	0.34	capital income share
α^s	0.28	capital income share
δ	0.02	depreciation rate
$\sigma_{(1-l)}$	0.975	Banker's survival rate
ϕ	0.381	Fraction of divertible funds
ε	5	elasticity of substitution between official and informal consumption bundles
ρ^χ	0.3	financial shock autocorrelation
ρ^s	0.96	Survival probability of a match
ϕ^π	1.5	Taylor parameter
b	0.6	External habit parameter
ϑ	0.5	Nash bargaining parameter
$\varkappa$	0.5	Matching technology parameter
z^{un}	0.7	Job finding rate
z^V	0.9	Vacancy filling rate
ρ^s	0.96	Labour market separation rate

mates are available and in several cases a there is not a proper time series but few isolated observations. This dataset does not lend itself to a proper econometric analysis. We have used it for the descriptive statistics in the introduction considering only countries for which a sufficient time series was available around episodes of banking crises.

An alternative approach to measuring informal employment follows Loayza and Rigolini (2011) which use as a proxy the percentage of the active labor force that is self-employed. As pointed out in La Porta and Shleifer (2008) the definition of self-employment does not include unpaid family workers whose contribution to informal production is probably high. Further, it is quite obvious that self-employment can be high for structural reasons which are not related to the informal economy. By contrast, the cyclical evolution of the self-employed workers' share is likely to exhibit a strong correlation with the informal economy share, even though it does not account for intensive margin effects. Data on self employment are derived from the ILO and the World Bank (WDI) and are available for a large panel of countries starting from 1980.

Data on banking crises are taken from Laeven and Valencia (2010, 2008), who

Table A.2: Panel stationarity test

Variable	Level	Growth
Participation rate (Kilm)	4.200	-20.451***
Unemployment rate (Kilm)	-0.209	-31.510***
Participation rate (OECD)	-0.912	-15.556***
Unemployment rate (OECD)	0.316	-12.159***
Share self employed	1.068	-16.469***

build on the early work by Caprio and Klingebiel (1996). More specifically Laeven and Valencia (2010) focus on systemic banking crises excluding distress events that affected isolated banks.[23]

A.2.1 Panel stationarity tests

The autoregressive model underlying impulse responses reported in section 2 of the paper is estimated using variables in growth rates given the trending nature of most macroeconomic variables. In this section we report the Im-Pesaran-Shin panel unit root test we have conducted on the data. table A.2 reports the results. The first column refers to the level of the variable, the second one to its growth rate. In all cases we cannot reject the null of non stationarity in levels, while we always reject it in growth rates.

A.2.2 Regression results

This section contains the tables from the regression results used to generate the impulse responses of section 2 and present the instrument validity tests. All regressions implement the Blundell and Bond (1998) system GMM estimator; robust standard errors apply Windmeijer's finite sample correction.

The tables report the Hansen test for instrument validity. The Hansen test is robust, but weakened by many instruments. In order to deal with this problem we collapse the instruments as suggested by Roodman (2009). In all the cases the Hansen test, cannot reject the null hypothesis that the full set of orthogonality conditions is valid. The Arellano–Bond test for autocorrelation (not reported in the statistics) re-

[23] More precisely the starting year of the crises is identified by a) deposit runs, defined as a monthly percentage decline in deposits in excess of 5 percent, b) the introduction of deposit freezes or blanket guarantees, and c) liquidity support or central bank interventions, defined as the ratio of monetary authorities' claims on banks as a fraction of total deposits of "at least 5% and at least double the ratio compared to the previous year".

jects the null hypothesis of first order serial correlation and does not reject the null of no second-order serial correlation in the first-differenced error terms.

Overall the tests suggest that the instruments used are valid and that the error correlation is of no concern.

Table A.3: Participation rate and financial crises

	All countries	High Income
$Part_{L1}$	0.084*	0.130**
	(0.046)	(0.060)
$Part_{L2}$	0.043	0.023
	(0.039)	(0.044)
$Part_{L3}$	0.032	-0.002
	(0.050)	(0.054)
$Crisis$	-0.005**	-0.005**
	(0.002)	(0.002)
$Crisis_{L1}$	-0.004	-0.005
	(0.003)	(0.003)
$Crisis_{L2}$	-0.004**	-0.005***
	(0.002)	(0.002)
N. obs	1038	795
N. count.	35	23
Hansen test	10.65	7.22
Hansen p.	0.30	0.61

Note: system GMM OLS estimates, robust standard errors in brackets, Windmeijer finite sample correction applied, collapsed instruments. Time dummies included but not reported. Hansen test for overid. restrictions. * denotes significance at 0.1 level, ** at 0.05, ** at 0.01.

A.2.3 Robustness checks

The analyses developed in section 2 of the paper and in the previous section look at the relationship between banking crises and each variable separately, neglecting that macroeconomic variables are jointly determined in equilibrium. In order to shed light on this issue we have analyzed the joint response of the participation rate and GDP following a banking crisis. We have done so through a panel-VAR that takes into account the interrelations between the relevant variables. Residuals are orthogonalized with a Choleski decomposition that relies on variables ordering for allocating any correlation between residuals. These orderings are consistent with the assumptions of the theoretical model and posit that a financial crisis affects the following variables contemporaneously, as well as with a lag, while GDP growth and the participation rate affect the previous variables only with a lag. Estimation is con-

Table A.4: Participation rate and financial crises

	All countries	High Income	Non High Income
$Part_{L1}$	0.229***	0.291***	0.216***
	(0.039)	(0.063)	(0.053)
$Part_{L2}$	0.100***	0.066	0.110***
	(0.028)	(0.041)	(0.035)
$Part_{L3}$	0.098***	0.071	0.076**
	(0.025)	(0.047)	(0.031)
$Crisis$	-0.004***	-0.001	-0.004**
	(0.001)	(0.002)	(0.002)
$Crisis_{L1}$	-0.000	-0.001	-0.001
	(0.002)	(0.004)	(0.002)
$Crisis_{L2}$	-0.001	-0.001	-0.002
	(0.002)	(0.005)	(0.002)
N. obs	3606	1039	2567
N. count.	168	49	119
Hansen test	4.73	8.36	5.92
Hansen p.	0.45	0.14	0.31

Note: system GMM OLS estimates, robust standard errors in brackets, Windmeijer finite sample correction applied, collapsed instruments. Time dummies included but not reported. Hansen test for overid. restrictions. * denotes significance at 0.1 level, ** at 0.05, ** at 0.01.

Table A.5: Unemployment rate and financial crises

	All countries	High Income
$Unem_{L1}$	0.435***	0.353***
	(0.052)	(0.049)
$Unem_{L2}$	-0.095**	-0.005
	(0.046)	(0.055)
$Unem_{L3}$	-0.005	-0.011
	(0.026)	(0.032)
$Crisis$	0.053	0.054
	(0.041)	(0.041)
$Crisis_{L1}$	0.288***	0.254***
	(0.047)	(0.049)
$Crisis_{L2}$	-0.007	0.056
	(0.030)	(0.034)
N. obs	1038	795
N. count.	35	23
Hansen test	6.33	4.27
Hansen p.	0.71	0.89

Note: system GMM OLS estimates, robust standard errors in brackets, Windmeijer finite sample correction applied, collapsed instruments. Time dummies included but not reported. Hansen test for overid. restrictions. * denotes significance at 0.1 level, ** at 0.05, ** at 0.01.

Table A.6: Unemployment rate and financial crises

	All countries	High Income	Non High Income
$Unem_{L1}$	-0.050	0.038	-0.154***
	(0.058)	(0.082)	(0.053)
$Unem_{L2}$	-0.060	-0.169***	-0.075**
	(0.067)	(0.043)	(0.035)
$Unem_{L3}$	0.011	0.224***	-0.049*
	(0.054)	(0.019)	(0.029)
$Crisis$	0.030	0.042	0.028
	(0.026)	(0.044)	(0.034)
$Crisis_{L1}$	0.136***	0.148**	0.086**
	(0.037)	(0.068)	(0.042)
$Crisis_{L2}$	0.077***	0.086***	0.059**
	(0.022)	(0.023)	(0.027)
N. obs	3442	992	2450
N. count.	168	49	119
Hansen test	10.43	2.87	7.61
Hansen p.	0.06	0.72	0.18

Note: system GMM OLS estimates, robust standard errors in brackets, Windmeijer finite sample correction applied, collapsed instruments. Time dummies included but not reported. Hansen test for overid. restrictions. * denotes significance at 0.1 level, ** at 0.05, ** at 0.01.

Table A.7: Self employment rate and financial crises

	All countries	High-income	Non high-income
$Selfemp_{L1}$	-0.067	-0.090	-0.063
	(0.044)	(0.073)	(0.061)
$Selfemp_{L2}$	-0.159***	-0.064	-0.157**
	(0.042)	(0.056)	(0.065)
$Selfemp_{L3}$	-0.029	-0.018	-0.024
	(0.032)	(0.060)	(0.044)
$Crisis$	0.003	-0.009	0.015
	(0.008)	(0.006)	(0.018)
$Crisis_{L1}$	0.030*	0.017	0.039
	(0.015)	(0.014)	(0.037)
$Crisis_{L2}$	0.014*	0.012	0.021
	(0.008)	(0.008)	(0.016)
N. obs	1563	682	881
N. count.	97	26	71
Hansen test	26.55	16.12	27.06
Hansen p.	0.60	0.97	0.57

Note: system GMM OLS estimates, robust standard errors in brackets, Windmeijer finite sample correction applied, collapsed instruments. Time dummies included but not reported. Hansen test for overid. restrictions. * denotes significance at 0.1 level, ** at 0.05, ** at 0.01.

ducted by GMM and the panel fixed-effects are removed using forward orthogonal deviation (Abrigo and Love, 2015).

Panel-VAR analysis allows also to provide an additional robustness check. Equation (1) assumes that the crisis is a "contemporaneously exogenous" event with respect economic activity (GDP, participation rate etc.). However if crises are the result of weak economic activity, their impact would occur through the lagged effect and our results would be biased upward. Panel-VAR analysis assumes that variables affect each other only with a lag and therefore excludes the contemporaneous effect of financial crises.

The figures A.1-A.2 show a strong negative impact of financial crises on both participation rate and GDP. On the other side GDP growth has a positive impact of the participation rate. There is no sign of reverse causality with GDP growth or the participation rate effecting banking crises.[24]

[24] Note that these figures are not directly comparable with those of section 2 as they represent the effect of a 1 standard deviation shock of the relevant variables which are expressed in growth rates. The intuition is however the same. Banking crises have a temporary effect on the growth rate of the participation rate and of GDP, therefore they have a permanent effect on the level of the same variables.

Figure A.1: Panel VAR, Kilm dataset

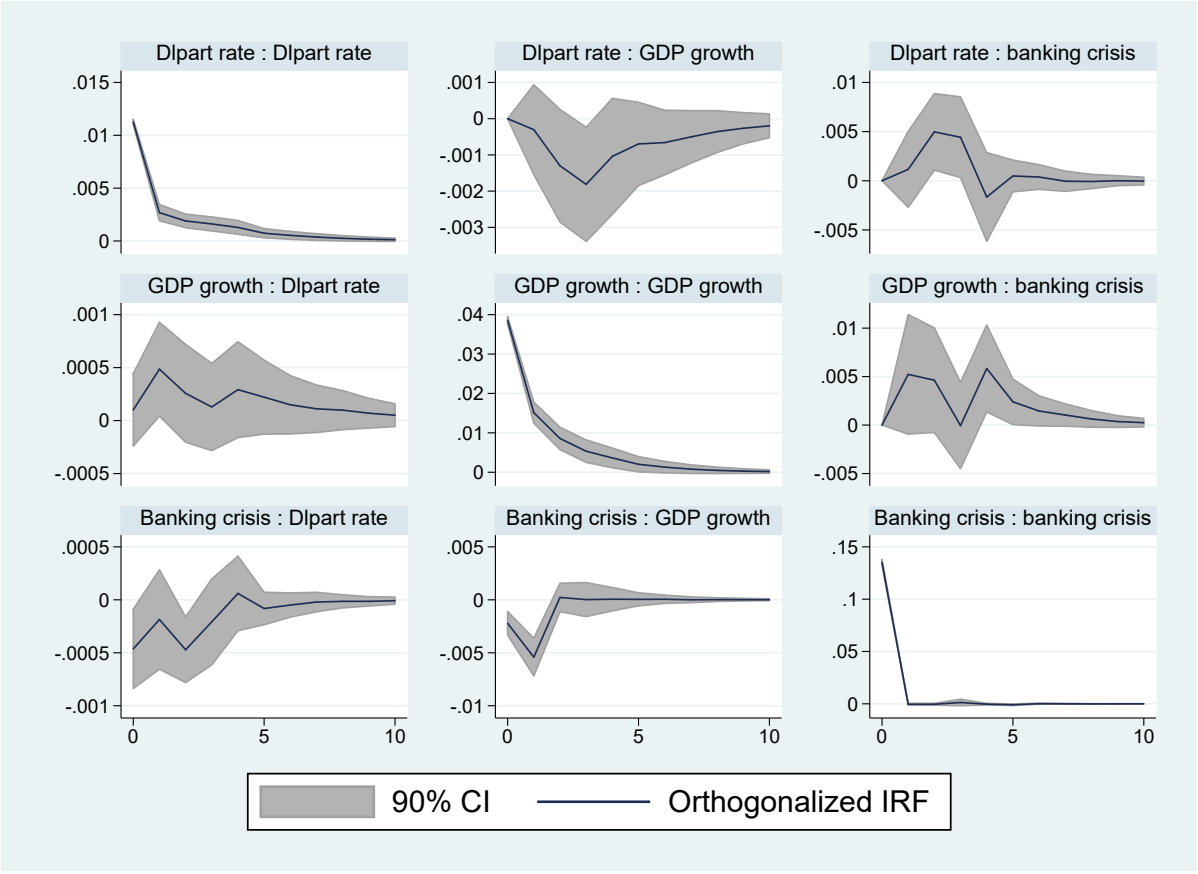
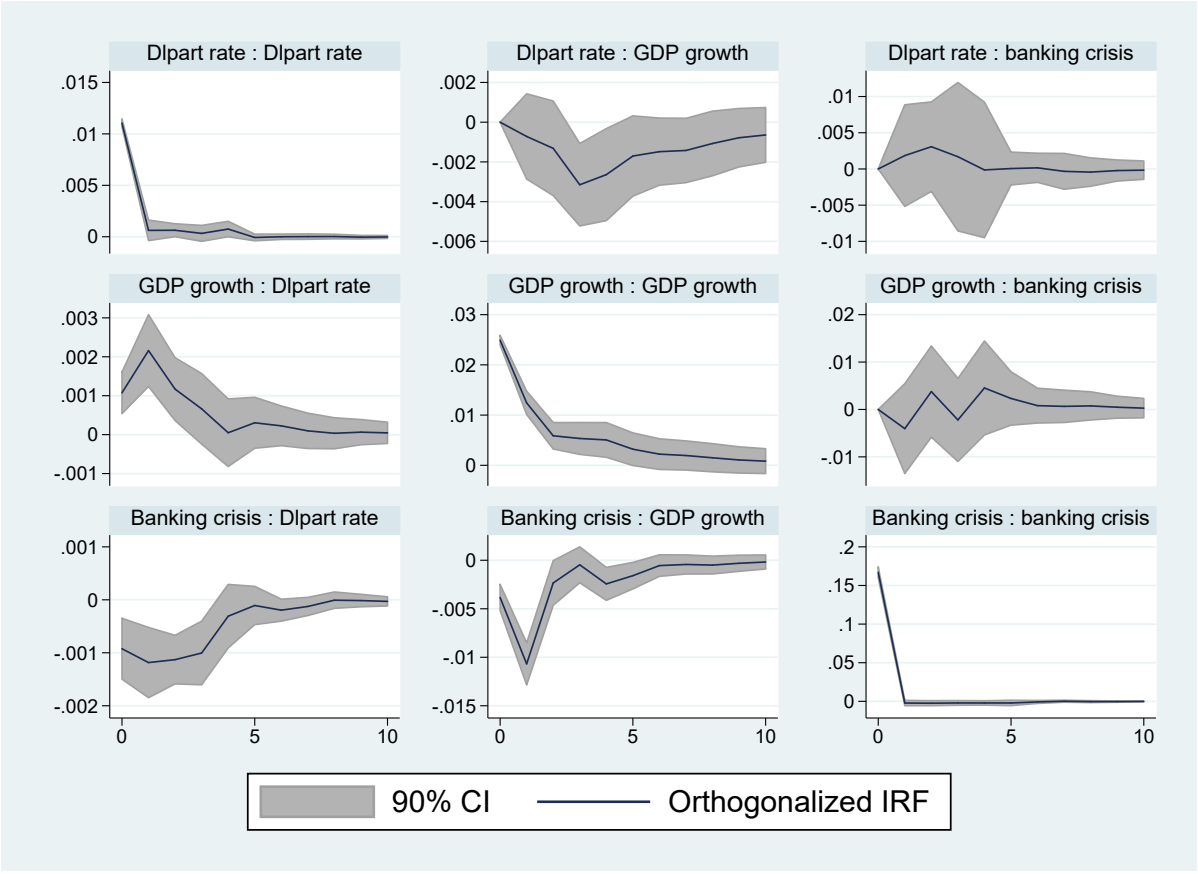


Figure A.2: Panel VAR, Oecd dataset



Appendix References

Abrigo, Michael R.M. and Inessa Love. 2015. "Estimation of Panel Vector Autoregression in Stata: a Package of Programs." Mimeo, University of Hawaii.

Blundell, Richard and Stephen Bond. 1998. "Initial conditions and moment restrictions in dynamic panel data models." *Journal of Econometrics* 87 (1):115–143.

Caprio, Gerard Jr. and Daniela Klingebiel. 1996. "Bank insolvencies : cross-country experience." Policy Research Working Paper Series 1620, The World Bank.

La Porta, Rafael and Andrei Shleifer. 2008. "The Unofficial Economy and Economic Development." *Brookings Papers on Economic Activity* 39 (2 (Fall)):275–363.

Laeven, Luc and Fabian Valencia. 2010. "Resolution of Banking Crises: The Good, the Bad, and the Ugly." IMF Working Papers 10/146, International Monetary Fund.

Loayza, Norman V. and Jamele Rigolini. 2011. "Informal Employment: Safety Net or Growth Engine?" *World Development* 39 (9):1503–1515.

Roodman, David. 2009. "A note on the theme of too many instruments." *Oxford Bulletin of Economics and Statistics* 71:135–158.