Financial crises, unemployment and the endogenous participation rate

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Abstract

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. We rationalize this evidence building a DSGE model which accounts for financial and labour market frictions and for an informal sector of the economy. We analyse employment fluctuations along both the intensive and the extensive margin. 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.

Keywords: Financial crises, matching frictions, endogenous participation

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1 Introduction

Financial crises are special: they 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), with obvious adverse implications for labor market conditions. For instance, Erceg and Levin (2014) forcefully argue that the financial crisis accounts for the major part of the decline in the U.S. labor force participation rate observed after 2007.

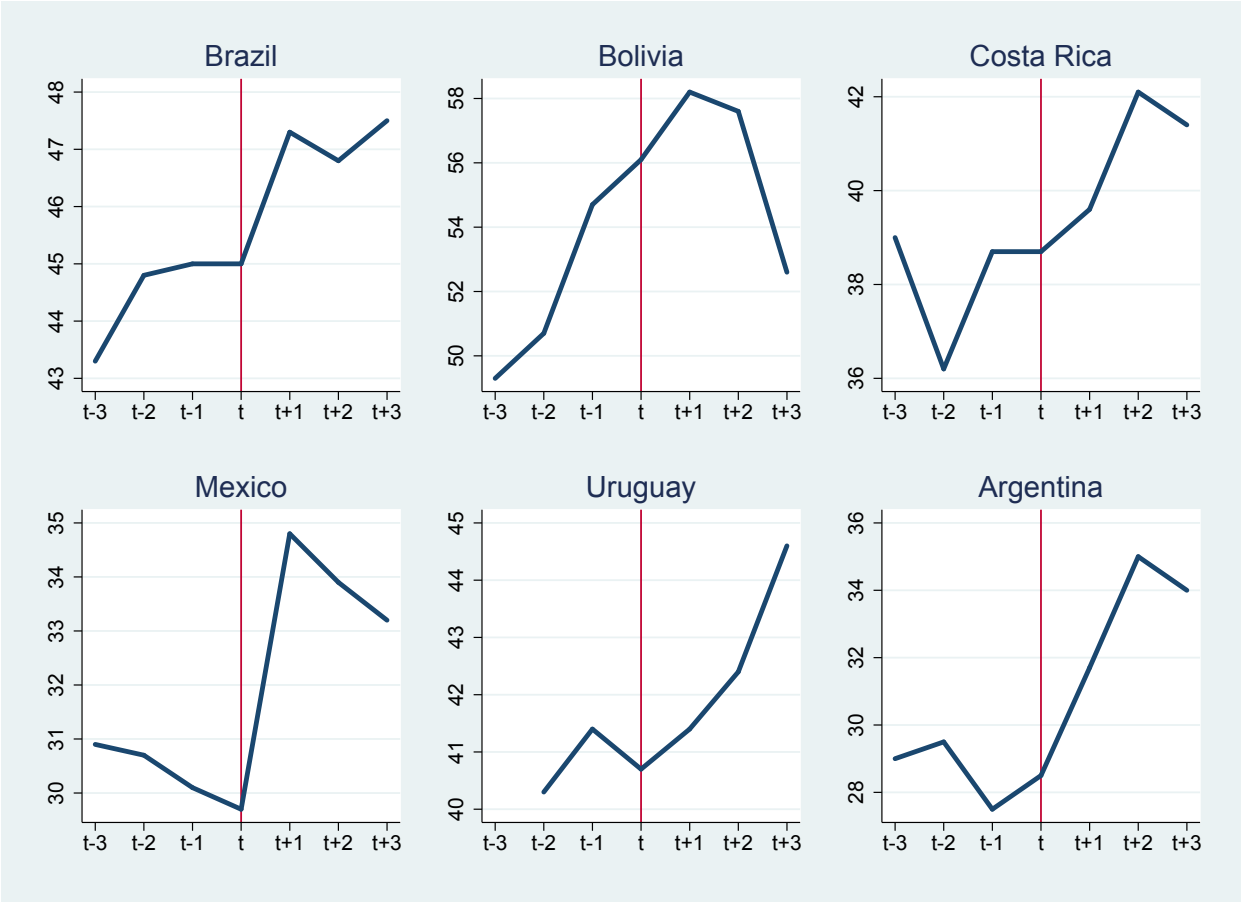
Furthermore, as shown by Colombo, Onnis, and Tirelli (2016), financial crises act as a large asymmetric shock leading to a strong reallocation of economic activity between the official economy and the shadow economy. This suggests that financial crises might have important implications for the labour market, and in particular for the participation rate and for the informal labor market. Colombo, Onnis, and Tirelli (2016) show that the share of self employed increases following banking crises, but this is an admittedly rough proxy for the informal employment. International Labour Office (2015) provides an estimate of informal employment which is available only for a small number of countries and for a limited time span. Figure 1 shows that crises were associated to an increase in informal employment for all the episodes of banking crises and countries included in the dataset.

In this paper we provide empirical evidence and a theoretical rationalization of the labor force participation rate in the aftermath of a financial crisis. Based on a large panel of countries, our analysis shows that financial crises are associated to a significant drop in the participation rate. To the best of our knowledge, this is the first contribution documenting the endogenous labor force participation response to financial crises.

Our theoretical contribution relies on a two-sector DSGE model that accounts for both the official and the shadow economy, whose existence is entirely motivated by tax distortions. The official labor market is charaterized by search and matching frictions and by Nash bargaining over wages and hours. The official labor market participation rate is endogenous and driven by an optimal choice between being employed in the shadow economy and searching for a job in the official sector. In this version of the model the crisis is captured by two complementary shocks. The first one is a standard risk premium shock, as defined Smets and Wouters (2007) and an investment-specific shock. In fact, as argued in Justiniano, Primiceri, and Tambalotti (2011) investment specific shocks may be interpreted as a proxy for more fundamental disturbances to the functioning of the financial sector. Both shocks imply that the shadow economy acts as a buffer which softens the unemployment increase, and the participation rate unambiguously falls.

Right from the outset, we emphasize that this latter result critically hinges on the hypothesis that substitutability between official and shadow economy goods does not fall below a critical threshold. This allows to emphasize the relative merit of explicitly modelling the shadow economy instead of assuming home production. Our approach follows a long-standing tradition in public economics, that broadly sees the shadow economy sector as the consequence of agents attempt to escape taxation. In this framework, official- and unofficial-sector goods are natural substitutes. By contrast, home production models neglect this issue and typically assume separability (see for instance Campolmi and Gnocchi (2016)). This causes a counterfactual result: the participation rate should increase following a financial

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.

crisis. Erceg and Levin (2014) manage to avoid this result by neglecting search and matching frictions and assuming exogenous adjustment costs of moving labor between the market and home production sectors.

The remainder of the paper is structured as follows: section 2 presents the empirical evidence, section 3 describes the model, section presents the results, section 5 concludes.

2 Empirical evidence

In this section we present some empirical evidence about labour market dynamics in the aftermath of financial crises.

There is a large and documented drop in the US participation rate following the financial crisis. Erceg and Levin (2014), Aaronson et al. (2014) and Council of Economic Advisers (2014) show that a large part (approximately 1/3) of the drop in the participation rate is not explained by standard factors such as the ageing of the population, historical trends or patterns of previous recessions.

The drop in the US participation rate is usually opposed to the rise observed in Europe following the crisis (see (European Central Bank, 2015)). However at a closer inspection the rise in European participation rate is due to the strong growth in Germany and Spain. On the contrary participation rate did not rise in France, UK and while it decreased substantially in Italy, Ireland and Portugal. These trends occurred notwithstanding the fact that the crisis in Europe has been accompanied by several pension reforms that determined a generalised increase in retirement age that have a natural positive effect on participation.

We generalise this anedoctical evidence by conducting an empirical investigation of the behaviour of the participation rate during and in the aftermath of banking crises. It is well known that acquiring cross-country comparable time series of labour market variables is very difficult as the only reliable data available is restricted to advanced economies for which - with the exception of 2008 - there are almost no cases of banking crises. We use for our estimates the KILM data set recently assembled by the ILO which provides comparable data on key labour market variables for approximately 170 countries from 1990 to 2015. Following Colombo, Onnis, and Tirelli (2016); Cerra and Saxena (2008); Romer and Romer (1989) we estimate the following autoregressive model:

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

where $Lpart_{i,t}$ is the log of the participation rate in country i at time t, DBC is a dummy variable for the presence of a banking crisis. The number of lags of both the dependent variable and the crisis dummy have been chosen to maximise the informativeness of the model considering the constraint posed by the limited short time period.[1]

As standard in dynamic panel models we estimate (1) with system GMM (Blundell and Bond, 1998) which is particularly suited for cases where the dependent variable (as ours) is highly persistent, when adding a level equation in addition to the difference equation improves the validity of instruments. All estimates include time dummies, report standard

[1]The results are robust to changes in the lag distribution.

errors robust to heteroskedasticity and autocorrelation within individual units. The system GMM and collapse the number of instruments following the suggestion of Roodman (2009).

Regarding banking crises we adopt the well known classification by Laeven and Valencia (2010), who focus on systemic banking crises excluding distress events that affected isolated banks.[2] Defining banking crises is often controversial, due to the lack of a consensual definition and the need of a certain degree of discretionary judgement. Our choice is justified by the widespread use of the classification in the empirical literature.

Table 1 shows that overall the participation rate decreases following a banking crisis. This result holds overall but are stronger for the group of emerging and developing countries.

Table 1: Participation rate and financial crises

	All countries	High Income	Non High Income
L. lpart rate	1.315***	1.370***	1.303***
	(0.051)	(0.065)	(0.061)
L2. lpart rate	-0.153***	-0.295***	-0.127**
	(0.049)	(0.068)	(0.057)
L3. lpart rate	-0.088***	-0.056	-0.095***
	(0.030)	(0.074)	(0.034)
bank	-0.003*	-0.002	-0.004*
	(0.002)	(0.002)	(0.002)
L. bank	-0.003	-0.004	-0.002
	(0.002)	(0.004)	(0.003)
L2. bank	-0.004**	-0.004	-0.005**
	(0.002)	(0.005)	(0.002)
N. obs	3770	1086	2684
N. count.	168	49	119
Hansen test	9.79	8.59	4.24
Hansen p.	0.20	0.28	0.75

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.

In table 2 we estimated (1) on the log of unemployment rate. Confirming previous empirical evidence the unemployment (with a lag) increases following financial crisis.

Regarding the contribution of the shadow economy the bulk of the literature focussed on estimating the size of the shadow economy in terms of economic activity (i.e. as fraction of GDP). In this case the evidence provided by Colombo, Onnis, and Tirelli (2016) clearly shows that there is a significant increase of the shadow economy following banking crises.

The evidence in the labour market is more difficult to gather as it is difficult to measure

[2]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".

Table 2: Unemployment rate and financial crises

	All countries	High Income	Non High Income
L.lun rate	0.850***	1.057***	0.708***
	(0.043)	(0.131)	(0.050)
L2. lun rate	0.002	-0.186***	0.034
	(0.040)	(0.070)	(0.044)
L3. lun rate	0.099**	0.137	0.035
	(0.048)	(0.103)	(0.041)
bank	0.017	0.062	-0.005
	(0.026)	(0.044)	(0.034)
L. bank	0.123***	0.186**	0.077**
	(0.036)	(0.078)	(0.036)
L2. bank	0.078***	0.082**	0.054**
	(0.020)	(0.037)	(0.025)
N. obs	3606	1039	2567
N. count.	168	49	119
Hansen test	10.50	12.25	6.58
Hansen p.	0.16	0.15	0.47

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.

the size of the shadow labour market even with indirect methods. Some authors use the share of self employed as a proxy for informal employment albeit this represents a very rough proxy.[3]

Indeed the ILO dataset provides for the first time an estimate of the size of informal employment constructed by collecting and integrating various sources in several developing countries. The data is available only for a subset of countries and periods with respect to the full KILM dataset, preventing a fully fledged statistical analysis. However it is possible to use this data for revealing qualitative evidence. Figure 1 shows the evolution of informal employment around episodes of banking crises for the countries included in the dataset.

From the figure it is clear that in all the countries considered informal employment rises following a banking crisis.[4]

[3]Indeed Colombo, Onnis, and Tirelli (2016) show that the share of self employed increase following banking crises.

[4]The figure reports the share of informal employment, using data on the number of person informal employment would yield identical results.

3 The model

Our model is a standard DSGE model that incorporates search and matching frictions in the labour market as well as labour force participation decisions.[5]. Differently from all the other contributions in the literature ours is a two sectors model that accounts for both the official (o) and the underground (s) economy. In both sectors perfectly competitive firms produce wholesale goods which are then sold to monopolistically competitive retail firms. Retail prices are sticky.

Following Zenou (2008) the labour market is characterised by search frictions in the official sector of the economy and by perfect competition in the unofficial sector.[6] There is a representative household, who has a large family structure. A fraction of the members in the household are employed in the official sector, the rest are either unemployed or employed in the unofficial sector. Employed individuals inelastically supply one unit of labor. In line with Zenou (2008), only unemployed individuals can enter a new match with an employer in the official sector. We do not explicitly model flows between unemployment and employment in the informal sector, but we impose a stock equilibrium condition where in each period the outside option of an individual employed in the unofficial sector is equal to the value attached to unemployment status.

Consumption purchases are subject to monetary transaction costs that motivate a demand for money[7]:

$$s(v), \quad s'(v) > 0 \text{ for } v > v^* \tag{2}$$

where v^j defines sectoral money velocity. The features of $s(v^j)$ are such that a satiation level of money balances ($v^* > 0$) exists where the transaction cost vanishes and, simultaneously, a finite demand for money is associated to a zero nominal interest rate. Following Schmitt-Grohe and Uribe (2004) the transaction cost is parameterized as follows:

$$s(v) = Av + \frac{B}{v} - 2\sqrt{AB} \tag{3}$$

The government finances an exogenous stream of expenditures by levying distortionary taxes and by printing money.

3.1 Preferences

There is a continuum of mass 1 of households who gather a continuum of mass one of family members characterised by the lifetime utility:

$$U_t^i = E_t \sum_{k=o}^{\infty} \beta^k \left\{ \ln\left(c_{t+k}^i\right) - \chi \frac{h_t^{i(1+\phi)}}{1+\phi} l^i \right\}$$

[5]The literature on this field has expanded rapidly during recent years: Gertler and Trigari (2009), Arseneau and Chugh (2008, 12), Faia (2009) and Erceg and Levin (2014) are notable examples.

[6]Other contributions assume a non-segmented, fully competitive labour market (Amaral and Quintin (2006) and Pratap and Quintin (2006)). This assumption is supported by Maloney (1999, 2004) and Pratap and Quintin (2006) who provide evidence against labour market segmentation

[7]See Sims (1994), Guerron-Quintana (2009).

where χ is a parameter that regulates the disutility of work and ϕ defines the Frisch elasticity. Households members consume and, for each sector, own the firms, hold physical capital, and choose their investment. Following earlier contributions (Merz, 1995; Andolfatto, 1996), we assume that household members perfectly share the risk of sectoral employment and unemployment outcomes. As a result consumption and investment decisions are identical across individuals.Their flow budget constraint is:[8]

$$\begin{aligned} & c_t\left(1+s(v_t)\right)+\frac{P_t^{R,o}}{P_t}k_t^o+\frac{P_t^{R,s}}{P_t}k_t^s+\frac{M_t-M_{t-1}}{P_t}+\frac{\frac{B_t}{R_t}-B_{t-1}}{P_t}= \\ = \; & \left(1-\tau_t^w\right)\frac{P_t^{R,o}}{P_t}w_t^o h^o l_t^o+\frac{P_t^{R,o}}{P_t}b_t^u u_t+\frac{P_t^{R,o}}{P_t}\left(1+\left(1-\tau_t^k\right)r_t^{k.o}-\left(1-\tau_t^k\right)\delta\right)k_{t-1}^o \quad (4) \\ & +\frac{P_t^{R,s}}{P_t}w_t^s h^s l_t^s+\frac{P_t^{R,s}}{P_t}\left(1+r_t^{k.s}-\delta\right)k_{t-1}^s+\frac{P_t^{R,o}}{P_t}\Pi_t^o+\frac{P_t^{R,s}}{P_t}\Pi_t^s \quad (5) \end{aligned}$$

where B_t is a nominally riskless government bond that pays one unit of currency in period $t+1$ and R_t is the gross nominal interest rate. Then we define a number of sectoral variables: the retail price $P_t^{R,j}$, the capital stock k_t^j, the return on capital $r_t^{k.j}$, profits Π_t^j, the product wage w_t^j, the number of employed individuals l_t^j. Fiscal variales are defined as follows: τ^c is a consumption tax, τ_t^w and τ_t^k are the labor- and capital- income tax rates, t_t denotes real fiscal transfers, b^u is the unemployment subsidy defined in terms of the official sector consumption bundle.

Household preferences over the goods produced in the economy are defined as follows.

$$c_t^j=\left(\int_0^1 c_t^j\left(z^j\right)^{\frac{\sigma^j-1}{\sigma^j}}dz^j\right)^{\frac{\sigma^j}{\sigma^j-1}} \quad (6)$$

and the associated price index is

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

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

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

The total consumption bundle is

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

and

$$P_t=\left[\left(1-\alpha_c\right)\left(\left(P_t^{R,o}\left(1+\tau^c\right)\right)\right)^{1-\varepsilon}+\left(\alpha_c\right)\left(P_t^{R,s}\right)^{1-\varepsilon}\right]^{\frac{1}{1-\varepsilon}} \quad (8)$$

[8]We drop the superscript i.

defines the consumption price index. Demand functions for the sectoral consumption bundles are:[9]

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

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

In aggregate terms:

$$P_t c_t = P_t^{R,o} c_t^o (1+\tau^c) + P_t^{R,s} c_t^s$$

3.2 Labour market

Following Zenou (2008) individuals who are not hired in the official sector either take official sector unemployment status, that earns them the (real) unemployment subsidy, $\frac{P_t^{R,o}}{P_t} b^u$, and allows ongoing search for next-period hire in the official sector, or employment in the unofficial sector at the competitive real wage rate $\frac{P_t^{R,s}}{P_t} w_t^s$,[10] where b^u, w_t^s denote real variables in terms of the official and unofficial sectoral price deflators.

Following Christiano, Trabandt, and Walentin (2011) and Zhang (2011), to facilitate model tractability we assume that employment agencies post vacancies in the official labour 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 labour supplies into a labour input which is supplied to official sector wholesale producers at the competitive price P_t^{EA}, defined in terms of official sector goods. In the formal sector new matches per unit of time are determined by a standard matching technology

$$M_t^o = m^o (u_t)^{\varkappa} (V_t)^{1-\varkappa}$$

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

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

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

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

[9] In the official sector the consumption tax drives a wedge between the retail price set by firms and the corresponding consumption price.

[10] Note that w_t^j, b, p_t^{EA}, f_{pv}^{EA} denote real variables in terms of the consumption price index (8).

Both probabilities are taken as given by employment agencies and household members. Real profits of the representative employment agency are defined as follows:

$$\Pi^{EA} = \left(P_t^{EA} - \frac{W_t^o}{P_t^o} \right) l_t^o h_t^o - f_{pv}^{EA} V_t - \frac{Z}{2} \left(\frac{W_t^o}{W_{t-1}^o} - 1 \right)^2 l_t^o \tag{9}$$

where $W_t^o = P_t^o w_t^o$ define nominal wages. Note that eq (9) includes a (Rotemberg type) cost for adjusting nominal wages which allow us to model wage stickiness.[11]

Employment follows the law of motion:

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

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

Employment agencies maximise (9) subject to (10) obtaining the following hiring condition:

$$\frac{f_{pv}^{EA}}{z_t^V} = \left(P_t^{EA} - w_t^o \right) h_t^o - \frac{Z}{2} \left(\frac{w_t^o}{w_{t-1}^o \pi_t^o} - 1 \right)^2 + \beta \frac{\pi_{t+1}^o \lambda_{t+1}}{\pi_{t+1} \lambda_t} \frac{f_{pv}^{EA}}{z_{t+1}^V} \rho^S \tag{11}$$

where $\frac{f_{pv}^{EA}}{z_t^V}$ defines the marginal cost of hiring a worker[12] and the r.h.s. of (11) the marginal benefit, including both the price margin $P_t^{EA} - w_t^o$, the wage adjustment cost, and the discounted savings on posting a future vacancy, which are proportional to the match survival rate ρ^s.

3.2.1 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.[13] We assume simultaneous bargaining over W and h.[14]

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

$$v_t^{EA} = \left(P_t^{EA} - \frac{W_t^o}{P_t^o} \right) h_t^o - \frac{Z}{2} \left(\frac{W_t^o}{W_{t-1}^o} - 1 \right)^2 + \beta \frac{\pi_{t+1}^o \lambda_{t+1}}{\pi_{t+1} \lambda_t} v_{t+1}^{EA} \rho^S$$

where v_t^{EA} is defined in official goods while in nominal terms $V_t^{ea} = P_t^o v_t^{EA}$

[11] This specification is fairly common in the literature (Arseneau and Chugh, 2012) and is equivalent up to a first order approximation to a Calvo specification with the advantage of being computationally easier.

[12] 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.

[13] In our framework bargaining occurs over nominal wages for wage stickiness to have a bite. Note that in the absence of wage adjustment costs bargaining over nominal wages is equivalent to bargaining over real ones.

[14] Alternative specifications as right to manage or right to work would yield similar results (see Arseneau and Chugh (2012)).

Analogously the Bellman equations that describe the value for an individual of being employed and unemployed are:

$$v_t^{lo} = (1-\tau_t^w)\,\lambda_t p_t^o w_t^o h_t^o - \chi_t \frac{h_t^{o(1+\phi)}}{1+\phi} + \beta\left[\rho v_{t+1}^{lo} + (1-\rho)\,v_{t+1}^u\right] \tag{12}$$

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

Note that the option value of being employed in the unofficial sector does not enter (16) because we impose the stock equilibrium condition:

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

where

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

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

Note that all values above are defined in utils, while in nominal terms: $V_t^{lo} = \frac{v_t^{lo}}{\lambda_t} P_t$ and $V_t^u = \frac{v_t^u}{\lambda_t} P_t$.

Wages and hours are set to maximise the product:

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

where ϑ identifies the relative bargaining power of each party.

Nash bargaining implies that 16 is maximised by:

$$\frac{\varpi_t}{(1-\varpi_t)}\left(P_t^{EA} h_t^o - w_t^o h_t^o - \frac{Z}{2}\left(\frac{w_t^o}{w_{t-1}^o \pi_t^o} - 1\right)^2 + \beta \frac{\lambda_{t+1}}{\lambda_t} \frac{f_{pv}^{EA}}{z_{t+1}^V} \frac{\pi_{t+1}^o}{\pi_{t+1}} \rho\right) =$$

$$(1-\tau_t^w)\,w_t^o h_t^o - \chi_t \frac{h_t^{o(1+\phi)}}{(1+\phi)\,\lambda_t p_t^o} - b + \beta \frac{\lambda_{t+1}}{\lambda_t} \frac{\varpi_{t+1}}{(1-\varpi_{t+1})} \frac{\pi_{t+1}^o}{\pi_{t+1}} \left(\rho - z_{t+1}^{un}\right) \frac{f_{pv}^{EA}}{z_{t+1}^V}$$

$$-\vartheta \frac{(1-\varpi_t)}{\varpi_t}\left((1-\tau_t^w)\,w_t^o - \frac{\chi_t \left(h_t^o\right)^{\phi}}{\lambda_t p_t^o}\right) = (1-\vartheta)\left(P_t^{EA} - w_t^o\right)$$

where

$$\varpi_t = \frac{\vartheta}{\vartheta - (1-\vartheta)\,\frac{\partial V_t^{ea}}{\partial W_t^o} \Big/ \frac{\partial\left(V_t^{lo} - V_t^u\right)}{\partial W_t^o}}$$

3.3 Firms

In each sector $j\,(o, s)$, perfectly competitive (flex-price) firms produce wholesale goods Ij and sell them to retail producers Rj that differentiate products and are subject to price rigidity.

3.3.1 Wholesale producers

Wholesale producers have access to the production technology:

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

where y_t^j, k_t^j, h_t^j respectively define sector-specific output, capital and labour inputs, and θ_t^j captures a sectoral productivity shock, which displays the following time path:

$$\theta_t^o = \rho^\theta \theta_{t-1}^o + \xi_t^o; \quad \xi_t^o \text{ i.i.d.}$$

Factor demands are:

$$w_t^s = (1-\alpha^s)\, \theta_t^s \left(\frac{k_t^s}{h_t^s l_t^s}\right)^{\alpha^s} \tag{17}$$

$$P_t^{EA} = (1-\alpha^o)\, \theta_t^o \left(\frac{k_t^o}{h_t^o l_t^o}\right)^{\alpha^o} \tag{18}$$

$$r_t^j = \alpha^j \theta_t^j \left(\frac{k_t^j}{h_t^i l_t^j}\right)^{-\left(1-\alpha^j\right)} \tag{19}$$

Intermediate sector real marginal costs, mc_t^{Ij}, are:

$$mc_t^{I,o} = \left(\frac{r_t^o}{\alpha^o}\right)^{\alpha^o} \left(\frac{\left(P_t^{EA}\right)}{(1-\alpha^o)}\right)^{1-\alpha^o} \tag{20}$$

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

3.3.2 Retail producers

Retail producers turn intermediate goods into differentiated retail products. They are subject to a fixed production costs fc^j such that their profits are zero in steady state. We assume a sticky price specification based on Rotemberg (1982) quadratic cost of nominal price adjustment:

$$\frac{\varphi}{2}\left(\pi_t^{Rj} - 1\right)^2 \tag{21}$$

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:

$$\left(\frac{(1-\sigma^j)}{\sigma^j} + mc_t^{I,j}\right)\frac{\sigma^j}{\varphi} + \beta\left[\left(\frac{\lambda_{t+s}}{\lambda_t}\right)\frac{y_{t+1}^j}{y_t^j}\left(\pi_{t+1}^{Rj} - 1\right)\left(\pi_{t+1}^{Rj}\right)\right] = \left(\pi_t^{Rj} - 1\right)\pi_t^{Rj} \tag{22}$$

where $\frac{P_t^{Ij}}{P_t^{Rj}}$ defines real marginal costs in terms of the sectoral retail price. Consumption price inflation is:

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

3.4 Households decisions

The intertemporal Euler equation is:

$$\lambda_t = \beta E_t \left(\lambda_{t+1} \frac{R_t}{\pi_{t+1}} \right) \tag{23}$$

where

$$\lambda_t = \frac{u_c\left(c_t\right)}{1 + s(\frac{c_t}{m_t}) + \frac{c_t}{m_t} s'(\frac{c_t}{m_t})} \tag{24}$$

In condition (24) the monetary transaction cost introduces a wedge between the marginal utility of consumption, $u_c\left(c_t\right) = \frac{1}{c_t - b c_{t-1}}$, and the marginal utility of wealth, λ_t^u, where $m_t = \frac{M_t}{P_t}$.

Households portfolio equilibrium requires that capital demand is driven by:

$$\lambda_t = \beta E_t(\lambda_{t+1}[(1-\delta) + r_{t+1}^{k,s}]) \tag{25}$$

and

$$\lambda_t = \beta E_t(\lambda_{t+1}[(1-\tau_{t+1}^k) r_{t+1}^{ko} + \delta \tau_{t+1}^k + (1-\delta)])$$

the implicit money demand function is $s(v) = Av + \frac{B}{v} - 2\sqrt{AB}; 1 - \frac{1}{R_t} = s'(v_t)\left(v_t\right)^2$

$$1 - \frac{1}{R_t} = s'(v_t)\left(v_t\right)^2 \tag{26}$$

3.5 Government

The government supplies an exogenous, stochastic[15] and unproductive amount of public good g_t (defined in terms of the official sector good) and unemployment benefits. Government financing is obtained through an income tax, money creation and issuance of one-period, nominally risk free bonds. The government flow budget constraint is then given by

$$\frac{B_{t-1}}{P_t^o} + g_t + b_t^u u_t = \left(\tau_t^w w_t^o h_t^o l_t^o \ + \tau_t^k \left(r_t^{ko} - \delta\right) k_{t-1}^o + c_t^o \tau^c\right) + \frac{M_t - M_{t-1}}{P_t^o} + \frac{B_t}{R_t P_t^o} + \tau_t^{LS} \tag{27}$$

where τ_t^{LS} defines lump sum taxes.

[15] We assume that the logarithm of government consumption is normal and i.i.d.

3.6 Capital accumulation

Sectoral capital accumulation is driven by

$$k_t^o = (1-\delta)\, k_{t-1}^o + y_t^o - c_t^o\,(1+s(v_t)) - g_t - \frac{\xi_p}{2} y_t^o\,(\pi_t^o - 1)^2 - f_{pv}^{EA} V_t \tag{28}$$

$$k_t^s = (1-\delta)\, k_{t-1}^s + y_t^s - c_t^s\,(1+s(v_t)) - \frac{\xi_p}{2} y_t^s\,(\pi_t^s - 1)^2 \tag{29}$$

3.7 Labor resource constraint

Finally, the labour resource constraint is:

$$1 - u_t = l_t^o + l_t^s \tag{30}$$

3.8 Calibration

Parameters characterising 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 $\alpha^o = 0.36$, the capital depreciation rate, $\delta = 0.02$, follow the literature. The degree of price stickiness, $\varphi^o = 4.37$, and the price-elasticity parameter $\sigma^o = 6$ are taken from Schmitt-Grohe and Uribe (2004). The elasticity of substitution between official and shadow consumption bundles, is set at 1.5 as in Batini et al. (2011). Turning to firms operating in the shadow 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, $\sigma^s = 20$. 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.[16]

Labour market parameters are selected as follows. Hobijn and Sahin (2009) find that monthly separation rates in OECD countries range between 2 and 0.7%. We therefore set $\rho^s = 0.95$, implying a 5% quarterly separation rate. Following Colgiago and Rossi (2014) we calibrate m, f_{pv}^{EA} to obtain a job finding rate[17] $z^{un} = 0.7$ and a vacancy filling rate $z^V = 0.9$, and we set $b^u = 0.4w^o$ parametrised to the US economy. The Nash bargaining parameter ϑ is assigned value 0.5, which is standard in this literature.

Finally we close the model by calibrating α_c at the value that would imply a near-zero value of the shadow economy if the official one was untaxed. The tax rates are chosen to match those of the US economy: consumption tax $\tau^c = 0.077$, capital tax $\tau^k = 0.184$, labour tax $\tau^w = 0.154$, debt to gdp ratio 60% and government spending is set to 16% of gdp.

With those tax rates the size of the shadow economy raises to 8.5% which is around the consensus estimate for the US (Schneider and Buehn, 2007).

[16] On theoretical grounds it is not obvious that the proportional output cost associated to price revisions should be different across the two sectors. We also experimented with $\varphi^s = 2.18$, and our results were entirely confirmed.

[17] Hobijn and Sahin (2009) document that monthly job-finding rates in the OECD seem to range between 56% and 2.6%.

4 Results

The figures report impulse response functions following relevant shocks. We have analysed the effects of investment and risk premium shocks. Investment shock is modelled as asymmetric (i.e. affecting only the official economy). Unless where variables are already defined as percentages, impulse responses are calculated as percentage deviation from the steady state values. The dashed line in the figure describes the behaviour of the one sector (official) economy while the continuous line identifies the behaviour of the two sector (official and shadow) economy. Following the investment shock, the increase in official output shock determines an increase in employment and wages in the official economy (the latter traded with less hours in the bargaining framework). The widening gap between the value of being employed and the value of being unemployed, as a consequence employment is reallocated from the shadow to the official economy magnifying the official employment response and increasing wages in the shadow economy too. Asymmetric investment shocks are therefore associated with an increase in the participation rate. Risk premium shock has a similar effect.

Note that we obtain large variation in employment and in unemployment without assuming unrealistically high values of preference for leisure (typical of models with work-leisure choice) or unrealistically high productivity of home activities (typical of models with home production).

5 Conclusions

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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. In order to rationalise the evidence we analyse search and matching frictions, wage and price stickiness within a two sector DSGE model that accounts for both the official and the shadow economy. Our approach allows to deal with both the intensive and the extensive margins 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.

References

Aaronson, Stephanie, Tomaz Cajner, Bruce Fallick, Felix Galbis-Reig, Christopher Smith, and William Wascher. 2014. "Labor Force Participation: Recent Developments and Future Prospects." *Brookings Papers on Economic Activity* 49 (2 (Fall)):197–275.

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.

Arseneau, David M. and Sanjay K. Chugh. 2008. "Optimal fiscal and monetary policy with costly wage bargaining." *Journal of Monetary Economics* 55 (8):1401–1414.

———. 2012. "Tax Smoothing in Frictional Labor Markets." *Journal of Political Economy* 120 (5):926 – 985.

Batini, Nicoletta, Paul Levine, Emanuela Lotti, and Bo Yang. 2011. "Informality, Frictions and Monetary Policy." School of Economics Discussion Papers 0711, School of Economics, University of Surrey.

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

Campolmi, Alessia and Stefano Gnocchi. 2016. "Labor market participation, unemployment and monetary policy." *Journal of Monetary Economics* 79 (C):17–29.

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.

Council of Economic Advisers. 2014. "The Labor Force Participation Rate Since 2007: Causes and Policy Implications." Tech. rep., CEA.

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

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.

European Central Bank. 2015. "Recent Developments on the Labour Force Participation Rate in the Euro Area." Monthly bullettin july 2015, ECB.

Faia, Ester. 2009. "Ramsey monetary policy with labor market frictions." *Journal of Monetary Economics* 56 (4):570–581.

Gertler, Mark and Antonella Trigari. 2009. "Unemployment Fluctuations with Staggered Nash Wage Bargaining." *Journal of Political Economy* 117 (1):38–86.

Guerron-Quintana, Pablo A. 2009. "Money demand heterogeneity and the great moderation." *Journal of Monetary Economics* 56 (2):255–266.

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

International Labour Office. 2015. "KILM dataset."

Justiniano, Alejandro, Giorgio Primiceri, and Andrea Tambalotti. 2011. "Investment Shocks and the Relative Price of Investment." *Review of Economic Dynamics* 14 (1):101–121.

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.

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.

Maloney, William. 1999. "Does Informality Imply Segmentation in Urban Labor Markets? Evidence from Sectoral Transitions in Mexico." *World Bank Economic Review* 13 (2):275–302.

———. 2004. "Informality Revisited." *World Development* 32 (7):1159–1178.

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

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.

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.

Roodman, David. 2009. "A note on the theme of too many instruments." *Oxford Bulletin of Economics and Statistics* 71:135158.

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 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.

Sims, Chris. 1994. "A simple model for study of the determination of the price level and the interaction of monetary and fiscal policy." *Economic Theory* 4:381–399.

Smets, Frank and Rafael Wouters. 2007. "Shocks and Frictions in US Business Cycles: A Bayesian DSGE Approach." *American Economic Review* 97 (3):586–606.

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.

Figure 2: Risk premium shock

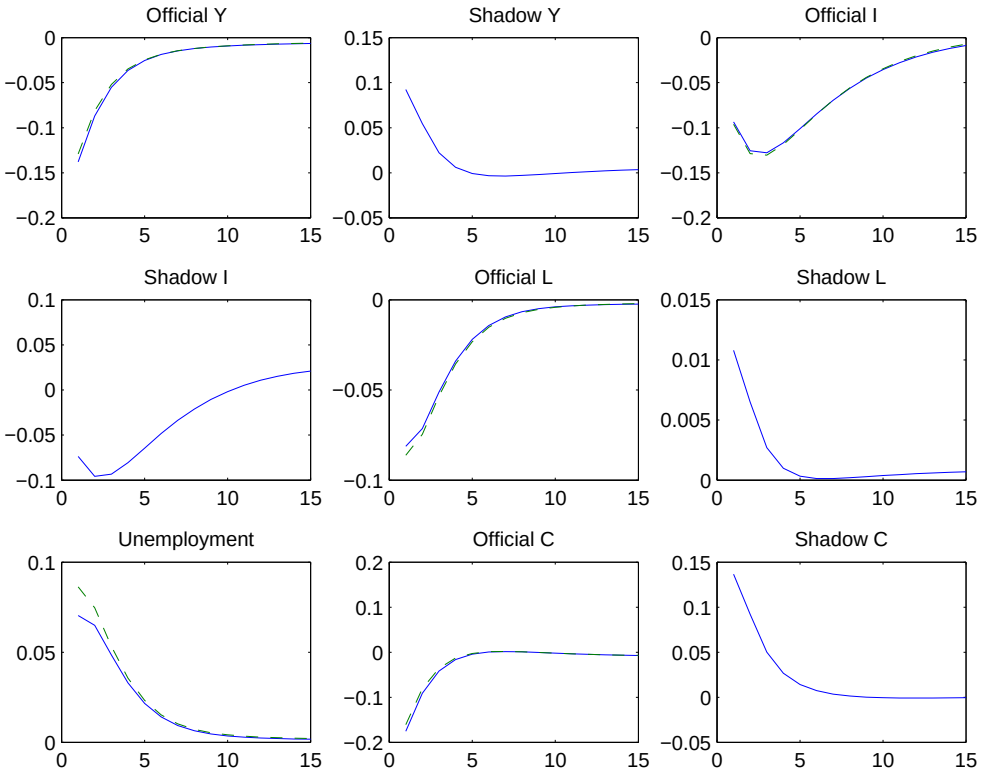

Figure 3: Risk premium shock

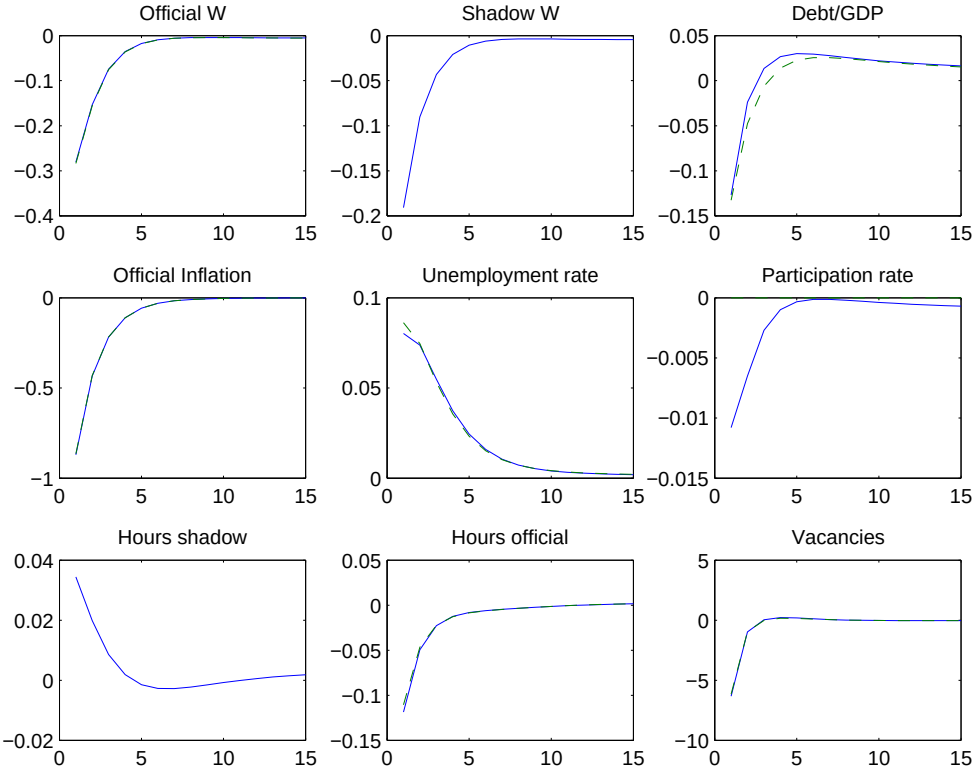

Figure 4: Investment shock: asymmetric

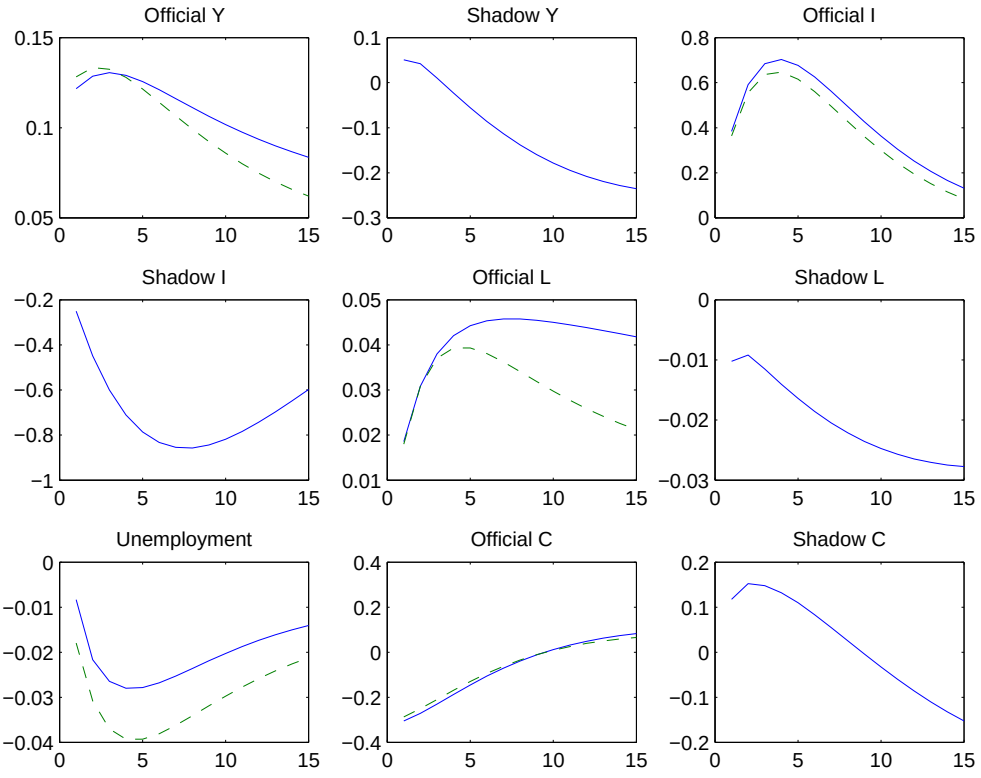

Figure 5: Investment shock: asymmetric