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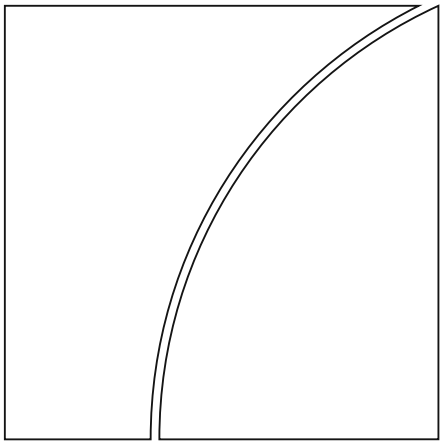

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Financial inclusion and optimal monetary policy

by Aaron Mehrotra and James Yetman

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Keywords: financial inclusion; optimal monetary policy; limited asset market participation

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Financial inclusion and optimal monetary policy

By Aaron Mehrotra and James Yetman[1]

Abstract

Limited access to the formal financial sector is a common feature of the economic environment in many emerging market and developing economies. In this paper, we examine how the level of financial inclusion affects welfare-maximising monetary policy. Our theoretical framework is based on Galí, López-Salido and Vallés (2004). In this model, only financially included households are able to borrow and save to smooth consumption in the face of income volatility. We show that optimal monetary policy implies a positive relationship between the share of financially included households and the ratio of output volatility to inflation volatility. We find strong empirical support for the model's predictions using a broad cross-country dataset on financial inclusion. The empirical results are driven primarily by central banks with a high degree of autonomy in their monetary policy decisions, who might be most likely to set monetary policy optimally.

JEL classification: E52, O23, G21.

Keywords: financial inclusion; optimal monetary policy; limited asset market participation

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Table of Contents

1. Introduction

Limited access by households to the formal financial sector is a common feature of the economic environment in many emerging market and developing economies. Data from the World Bank suggest that 50% of adults globally did not have an account at a formal financial institution in 2011, based on a survey of households in 148 economies (Demirguc-Kunt and Klapper, 2012). Financially excluded households have incomplete access to instruments that facilitate saving and borrowing. As a consequence, changes in policy interest rates may only have a limited direct effect on their intertemporal consumption decisions.

There is a growing theoretical literature examining how the presence of financially excluded households affects monetary policy. The previous research has discussed the implications of financial exclusion for the parameters in the central bank's policy rule and model stability (eg Gali et al, 2004; Bilbiie, 2008; Colciago, 2011); the effectiveness of monetary policy (eg di Bartolomeo and Rossi, 2007) and the implications for the choice of price index used as the central bank's target (Anand and Prasad, 2012).

In this paper, we examine the implications of different degrees of financial inclusion for optimal monetary policy. Our contributions to the literature are two-fold. First, we focus explicitly on the consequences of limited financial inclusion on macroeconomic *outcomes*, defined in terms of output and inflation volatility, when monetary policy maximises social welfare. Second, we provide empirical evidence supporting the model's predictions, using a broad cross-country dataset on financial inclusion.

As with much of the related literature, our model is based on Galí et al (2004). The model contains the following agents. There are two types of consumers. Those who are financially included save and accumulate capital, varying the accumulation rate in response to shocks in order to smooth consumption. In contrast, financially excluded consumers earn only wage income, and consume all of their income each period. Then there are monopolistically competitive firms who use labour and capital, both rented from consumers, to produce differentiated final goods. Finally, there is a monetary authority that sets interest rates to maximise the weighted sum of the welfare of included and excluded households, where the weights are equal to the share of each type of consumer in the economy.

Given that our model assumes that the financially excluded consume *all* of their disposable income each period, we are taking an extreme position on the effect of borrowing constraints. However, even with limited access to formal financial institutions, there are various ways for the financially excluded to mitigate the associated constraints. As an example, savings could be accumulated in the form of nonfinancial assets, including land and jewellery. In agricultural environments, livestock and other income generating assets could be traded strategically to allow for consumption smoothing (eg Rosenzweig and Wolpin, 1993). Alternatively, financially excluded farmers could adjust their labour supply in response to shocks so as to affect consumption levels (eg Jayachandran, 2006).

There are also alternative sources of borrowing that may be used to smooth consumption. Even if loans did not originate in the formal financial sector, informal lenders, friends and family can act as important sources of funds (eg Banerjee and Duflo, 2007). Moreover, survey data from the World Bank show that one of the main

reasons given by those who do not have a bank account is that a family member already has one. Thus, non-account holders may be financially included at the level of the household, even if not at the level of the individual. Also important in alleviating the constraints of financial exclusion has been the rapid increase in the use of mobile money, perhaps most prominently in Sub-Saharan Africa. This has allowed consumers to perform financial transactions with mobile phones in a reliable and cost-efficient manner, at times without an account at a formal financial institution.[2]

Such qualifiers notwithstanding, we argue that the model provides a good proxy of an economy where some agents are financially excluded. Savings in the form of assets other than cash may not help to smooth consumption much if there are large negative shocks to the economy (eg Besley, 1995). Moreover, in many economies there appears to be a sizeable share of the population that does not save, either by formal or informal means. Data from the World Bank suggest that 69% of adults in low and middle income countries did not save by *any* means in the previous year, including through asset accumulation or by placing cash under a mattress. And even if informal lenders were to provide credit to those consumers who are excluded from the formal financial system, the interest rates set by such lenders may be prohibitively high. Such interest rates may also display no obvious pass-through from the interest rates set by the central bank to maximise welfare.[3]

A key result of our model is that, conditional on optimal monetary policy, the ratio of output volatility to inflation volatility should be increasing in the share of financially included consumers. Underlying this result is that different types of consumers respond differently to shocks. Financially included consumers are able to adjust their savings and investment decisions to partially insulate their consumption from output volatility, while excluded consumers cannot. But inflation represents a deadweight loss, driving a wedge between aggregate output and aggregate consumption that affects both the included and excluded consumers. Optimal monetary policy therefore increasingly focuses on stabilising inflation – even at the expense of somewhat greater output volatility – as the degree of financial inclusion rises and more consumers are able to mitigate the negative welfare effects stemming from increased output volatility. We are able to show that it is primarily the change in optimal monetary policy that drives the changing relationship between output and inflation volatility. In contrast, if the central bank were to follow a simple Taylor-type rule (with fixed parameters), then there would be little variation in the ratio of output volatility to inflation volatility as the level of financial inclusion changes.

We test the implication that the ratio of output volatility to inflation volatility should be increasing in the share of financially included consumers using data for over 130 economies, across a broad range of income levels, from the World Bank's Global Findex database on financial inclusion. Based on cross-sectional data, we find strong support for the model's predictions using different proxies for financial

[2] This expansion of mobile banking also has important implications in the regulatory sphere (see eg Caruana, 2014; Sriram et al., 2012).

[3] At the same time, even if we regard those with accounts at formal financial institutions as "financially included", in reality many bank accounts may be dormant with few banking transactions. Thus, the extent of financial exclusion could be even larger than the simple numbers of account ownership suggest (eg Subbarao, 2012).

inclusion. These results are driven primarily by central banks with a high degree of autonomy in their monetary policy decisions, who might be most likely to set monetary policy optimally.[4]

The paper is structured as follows. Section 2 provides a brief review of the related literature. Section 3 outlines the theoretical model and characterises optimal policy. In Section 4, we provide empirical evidence supporting the model's predictions, before concluding.

2. Related literature

There is a growing literature discussing how the presence of financially excluded households may influence the design of monetary policy. One strand of the research addresses the broader implications of financial exclusion for economic policy. For example, Prasad (2013) provides a comprehensive discussion of the challenges posed by a lack of access to financial markets, and stresses the importance of focusing on distributional effects when some households lack the ability to insure against risks. Hannig and Jansen (2010) discuss the potential trade-offs and synergies between financial inclusion and financial stability. Filardo et al (2014) focus on monetary policy in emerging Asian economies and discuss how financial inclusion is likely to change the role of monetary and credit aggregates in the conduct of policy in that region.

Another strand of the literature is predominantly theoretical in nature.[5] It incorporates financially excluded consumers into otherwise standard New Keynesian models with sticky prices and examines the various implications for monetary policy. Galí et al (2004) label such agents "rule-of-thumb" consumers, who neither save nor borrow but instead simply consume their labour income. The authors show how the existence of such consumers influences the economy under different monetary policy rules. An important result is that the range of parameter values for which a Taylor-type rule yields dynamic stability and uniqueness depends critically on the share of households with access to financial markets. If the policy rule responds to contemporaneous values of output and inflation, then a greater response to inflation is required in order to generate a unique solution the smaller is the portion of financially included households. And if the policy rule is forward looking, a sufficiently large share of hand-to-mouth consumers may result in no locally unique equilibrium at all. In this paper we use a version of the model in Galí et al (2004) to examine how optimal monetary policy varies with the presence of financially excluded households.

Many subsequent papers build on Galí et al (2004) and provide insights on the sensitivity of their results. One key reason why monetary policy rules may become

[4] The classification of central bank independence follows the indices computed in Siklos (2008).

[5] In addition to the papers summarised here, see Anand and Prasad (2012) who develop a theoretical model to examine the implications of financial exclusion for the choice of the price index used as the central bank's target. Their model departs from those summarised here in that financially excluded consumers work in a flexible-price "food" sector, whereas included consumers work in a sticky-price "non-food" sector. Also, while households consume goods produced in both sectors, there is a minimum subsistence level of food that all households must consume.

destabilising as the level of financial inclusion falls is that excluded consumers are not directly affected by interest rates, rendering monetary policy less effective. However, Di Bartolomeo and Rossi (2007) argue that a low level of financial inclusion does not reduce monetary policy effectiveness by as much as one might expect since consumption demand is more income-sensitive for excluded households than included households. Monetary policy affects the consumption of included households, and hence the incomes of excluded households, creating an indirect policy channel that the authors label a Keynesian effect.

Such a Keynesian effect is at work in Bilbiie's (2008) examination of monetary policy in a framework with limited financial market participation. In his model, if the portion of financially excluded households is sufficiently high then the "Taylor principle", that nominal policy interest rates should respond more than one-for-one to changes in the inflation rate, may even become inverted. In such a case, optimal policy entails a passive monetary policy rule. His model differs from Galí et al (2004) in a number of respects, including abstracting from physical capital accumulation. Despite the differences in models, Bilbiie (2008) shows theoretically that optimal monetary policy implies a higher relative weight on output stability in the central bank's loss function the greater is the share of households without access to financial markets, consistent with the results we present below.

Other papers also focus on the implications of financially excluded households for model stability. Ascari et al (2011) and Colciago (2011) show that the presence of sticky wages helps to restore the Taylor principle as a key factor of determinacy, instead of requiring either a stronger monetary response to inflation (Galí et al, 2004) or a weaker one (Bilbiie, 2008). Finally, Motta and Tirelli (2010) show that Bilbiie's inverted Taylor principle argument returns if habit persistence is included in the utility function, even in the presence of sticky wages.

In our model, we assume that labour income is flexible. Our results may be sensitive to this assumption, as in some of the papers discussed above. However, we believe that our choice in this regard is the appropriate one for the set of economies that we study. We are focusing on a wide cross-section of countries, many of which have large informal and/or agricultural sectors where entrepreneurial activity (and therefore flexible labour income) is likely to predominate.[6] In addition, working in the informal sector is likely to be highly correlated with exclusion from the financial sector in these economies. Indeed, Demirguc-Kunt and Klapper (2012) document that there is a significant difference in formal account ownership – a common proxy for financial inclusion – between rural and urban areas. In the Middle East and North Africa, urban inhabitants are twice as likely to have a formal account as are rural inhabitants. In contrast to the diverse set of economies that we focus on, sticky wages may be a more important issue when studying the impact of financial inclusion in advanced economies, where financial exclusion and sticky labour income are more likely to coincide.

[6] See, for example, the discussion in Maloney (2004).

3. Model

The model is based on Galí et al (2004).[7] Households have a utility function given by:

$$U(C,L)=\frac{1}{1-\sigma}(CL^{\nu})^{1-\sigma}\ , \tag{1}$$

where $\sigma>0$, $\nu>0$. There are two kinds of households: those that have access to the financial market for one-period bonds and own capital goods that they rent to firms (indexed by o, for "optimising") and those that simply consume their full labour income every period, or are "rule of thumb" households (indexed by r).

For optimising households, their budget constraint is given by:

$$P_t(C_t^o+I_t^o)+R_t^{-1}B_{t+1}=W_tN_t^o+R_t^kK_{t-1}^o+B_t+D_t\ , \tag{2}$$

where P is the price level, C is consumption, I is investment, B is holdings of one-period bonds that yield a gross nominal interest rate of R, K is capital holdings, R^k is the rental rate on capital goods rented to firms by optimising households and D is the dividend stream of firms. We further assume that households have an endowment of one unit of time each period, so $L_t^o+N_t^o=1$. The evolution of capital follows:

$$K_t^o=(1-\delta)K_{t-1}^o+I_t^o\ , \tag{3}$$

where δ is the depreciation rate and the timing convention for capital reflects the period in which the variable is determined. Financially included households hold wealth in the form of capital, the rate of accumulation of which can be varied to smooth consumption relative to income. From the solution to the optimising households' problem, we get:

$$\frac{C_t^o}{L_t^o}=\frac{1}{\nu}\frac{W_t}{P_t}\ , \tag{4}$$

$$1=\beta R_tE_t\left[\left(\frac{C_t^o}{C_{t+1}^o}\right)^{\sigma}\left(\frac{L_{t+1}^o}{L_t^o}\right)^{\nu(1-\sigma)}\left(\frac{P_t}{P_{t+1}}\right)\right], \tag{5}$$

$$1=\beta\left[E_t\left(\frac{C_t^o}{C_{t+1}^o}\right)^{\sigma}\left(\frac{L_{t+1}^o}{L_t^o}\right)^{\nu(1-\sigma)}\left(\frac{R_{t+1}^k}{P_{t+1}}+(1-\delta)\right)\right]. \tag{6}$$

For rule-of-thumb households, who do not have access to financial markets, their budget constraint is simply:

$$P_tC_t^r=W_tN_t^r\ , \tag{7}$$

[7] Here we briefly outline the key elements of the paper. A more complete technical appendix is available on request from the authors.

where $L_t^r + N_t^r = 1$. Optimal behaviour then implies:

$$L^r = \frac{\nu}{1+\nu}, \tag{8}$$

$$C_t^r = \frac{1}{1+\nu}\frac{W_t}{P_t}. \tag{9}$$

Given a portion λ of households who do not have access to financial markets, aggregation implies:

$$N_t = \lambda(1-L_t^r) + (1-\lambda)(1-L_t^o), \tag{10}$$

$$C_t = \lambda C_t^r + (1-\lambda)C_t^o, \tag{11}$$

and aggregate investment and capital are given by $I_t = (1-\lambda)I_t^o$; $K_t = (1-\lambda)K_t^o$.

Final goods firms aggregate up intermediate goods $X_{j,t}$ to produce final good Y_t:

$$Y_t = \left(\int_0^1 {X_{j,t}}^{(\varepsilon-1)/\varepsilon} dj \right)^{\varepsilon/(\varepsilon-1)}, \tag{12}$$

where zero profits imply that:

$$P_t = \left(\int_0^1 {P_{j,t}}^{(1-\varepsilon)} dj \right)^{1/(1-\varepsilon)}, \tag{13}$$

so that demand for intermediate good j is given by:

$$X_{j,t} = \left(P_{j,t} / P_t \right)^{-\varepsilon} Y_t. \tag{14}$$

Intermediate goods are produced using Cobb-Douglas production technology:

$$X_{j,t} = A_t {K_{j,t-1}}^{\alpha} {N_{j,t}}^{1-\alpha}, \tag{15}$$

where A is productivity and profit maximisation implies that:

$$\frac{K_{j,t-1}}{N_{j,t}} = \frac{\alpha}{1-\alpha}\left(\frac{W_t}{R_t^k}\right); MC_t = \frac{V_t}{\Phi A_t}\left(\frac{R_t^k}{P_t}\right)^{\alpha}\left(\frac{W_t}{P_t}\right)^{1-\alpha}, \tag{16}$$

where MC is the real marginal cost, V is a marginal cost shock and $\Phi = \alpha^{\alpha}(1-\alpha)^{1-\alpha}$.

Firms face quadratic price adjustment costs as in Rotemberg (1982), and set prices $\{P_{j,t+k}\}_{k=0}^{\infty}$ to maximise:

$$\sum_{k=0}^{\infty}\beta^{k}E_{t}\left\{\frac{\Lambda_{t+k}}{\Lambda_{t}}\left[\begin{array}{c}X_{j,t+k}(P_{j,t+k}-P_{t+k}MC_{t+k})\\-\frac{\phi}{2}\left(\frac{P_{j,t+k}}{P_{j,t+k-1}}-1\right)^{2}P_{t+k}Y_{t+k}\end{array}\right]\right\}, \tag{17}$$

where $\Lambda_{t,t+k}$ is the stochastic discount factor. Optimal price setting then implies that aggregate price dynamics follow:

$$\begin{aligned}&(1-\varepsilon)+\varepsilon MC_{t}-\phi\left(\frac{P_{t}}{P_{t-1}}-1\right)\frac{P_{t}}{P_{t-1}}\\&+\beta\phi E_{t}\left[\frac{\Lambda_{t+1}}{\Lambda_{t}}\left(\frac{P_{t+1}}{P_{t}}-1\right)\left(\frac{P_{t+1}}{P_{t}}\right)^{2}\frac{Y_{t+1}}{Y_{t}}\right]=0.\end{aligned} \tag{18}$$

Since all firms price identically, aggregation is trivial ($N_{t}=N_{j,t}$; $K_{t}=K_{j,t}$; $Y_{t}=X_{j,t}$), and market clearing implies that:

$$Y_{t}\left[1-\frac{\phi}{2}\left(\frac{P_{t}}{P_{t-1}}-1\right)^{2}\right]=C_{t}+I_{t}. \tag{19}$$

In addition, we add persistent shocks to either productivity ($A_{t}=A_{t-1}^{\rho}\exp(u_{t})$) or marginal cost ($V_{t}=V_{t-1}^{\rho}\exp(u_{t})$) and redefine variables from nominal to real terms ($w_{t}=\frac{1}{\nu}\frac{W_{t}}{P_{t}}$; $r_{t}^{k}=\frac{R_{t}^{k}}{P_{t}}$; $(1+\pi_{t})=\frac{P_{t}}{P_{t-1}}$).

Monetary policy, characterised by the interest rate on one-period bonds, R_{t}, is set optimally to maximise aggregate welfare, defined as a weighted sum of the welfare of included and excluded consumers, where the weights are given by their respective shares in society:

$$E_{t}\sum_{k=0}^{\infty}\Big[(1-\lambda)U(C_{t+k}^{o},L_{t+k}^{o})+\lambda U(C_{t+k}^{r},L_{t+k}^{r})\Big]. \tag{20}$$

This is maximised subject to the constraints given by the above equations.[8] We then verify that a steady state exists and use second-order approximations to the equations to solve for the model dynamics.[9]

Our calibration for the model is given in Table 1. In general, the parameters are drawn from Galí et al (2003, 2004). For example, the preference parameter of

[8] Full details of the solution to the Ramsey problem are available on request.

[9] We use second order approximations in part because our model has a distorted steady state. But it also offers other advantages, for example allowing us to address the effect of marginal cost shocks. In log-linearised models, the optimal monetary policy typically fully offsets marginal cost shocks, so that they are not an interesting object of study.

$\nu = 0.69$ is consistent with their other parameter choices. One exception is our choice of the relative risk aversion parameter, σ, which we set to 2.0, as is common elsewhere.[10] Also, because we have assumed Rotemberg pricing, we require a cost-of-price-adjustment parameter, ϕ. We choose 75, in the middle of the range of estimates for US data from Ireland (2001).

Calibration

Table 1

Parameter	Value	Description
δ	0.025	Depreciation rate
α	1/3	Elasticity of output with respect to capital
β	0.99	Discount factor
ν	0.69	Leisure preference parameter
σ	2	Relative risk aversion
ε	6	Elasticity of substitution among intermediate goods
ϕ	75	Cost of price adjustment
ρ	0.90	Shock persistence
σ_u	0.01	Standard deviation of shock term

Source: Authors.

We compute the dynamics based on a second-order approximation of the model equations about the steady-state values of the variables. Except in cases of low levels of financial inclusion (less than around 15-25%, depending on the precise parameterisation), a steady state exists and the model is dynamically stable. We then compute impulse responses for the case of $\lambda = 0.5$, when 50% of consumers are financially included and the remainder are excluded, to highlight why the level of financial inclusion is likely to affect optimal monetary policy.

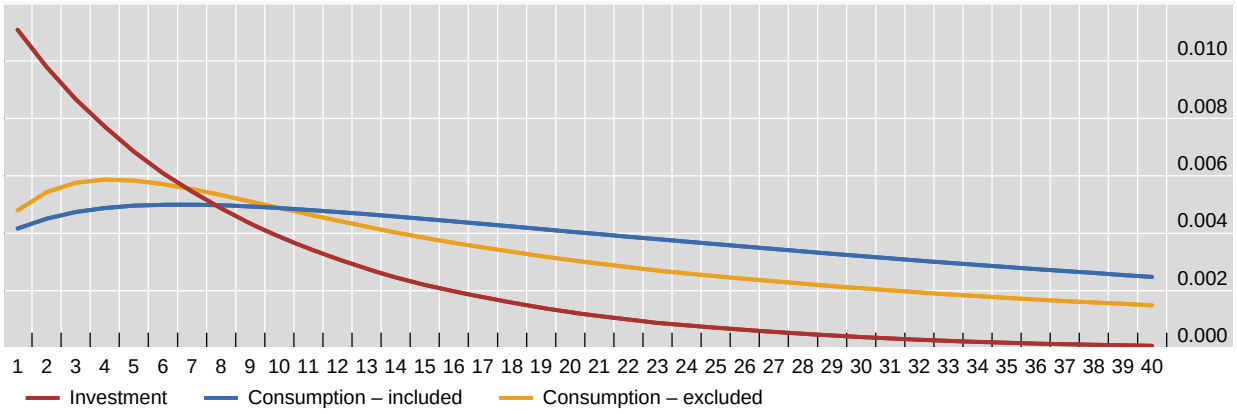
Graph 1 displays the impulse responses for consumption, investment and leisure in the case of a productivity shock. Optimising consumers, who are financially included, respond to a persistent productivity shock by reducing their leisure so as to increase their wage income, which is used to fund an increase in both investment and consumption. As a result of the increase in investment, their initial increase in consumption is smaller than for financially excluded consumers in the near term, but is more persistent.

The ability of included consumers to smooth their consumption through time changes both the underlying dynamics of the economy, and the optimal monetary policy response to this. Graph 2 graphs the impulse responses for output, inflation and the nominal policy rate for three different levels of financial inclusion: $\lambda \in \{0.25, 0.50, 0.75\}$.

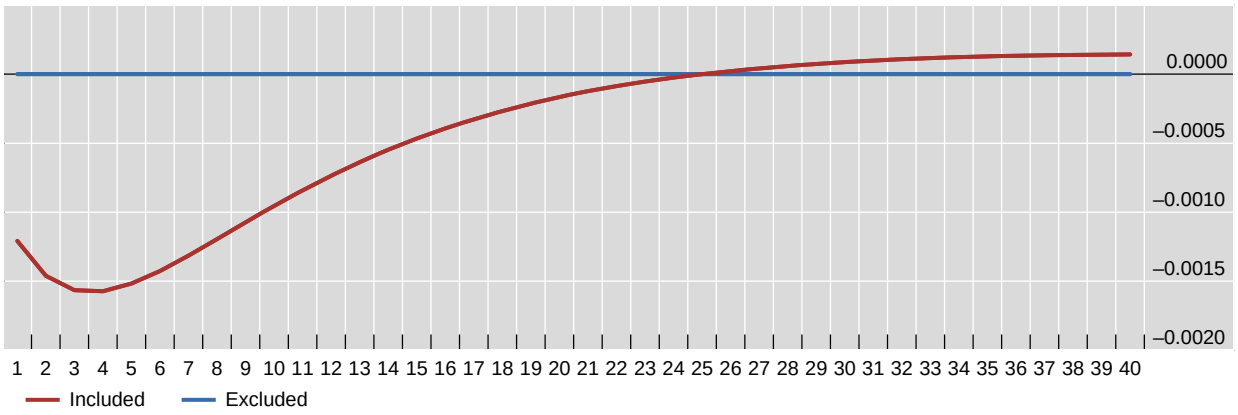
[10] Galí et al (2004) consider values of 1 and 5 for this parameter. For low levels of risk aversion, for example $\sigma = 1$ (when the utility function reduces to logs), the benefits from being able to smooth consumption by accessing financial markets are reduced and optimal policy from the point of view of financially included households varies little from that for financially excluded households. Other studies using $\sigma = 2$ include Anand and Prasad (2012), Aguiar and Gopinath (2007) and Schmitt-Grohe and Uribe (2007).

Impulse responses to productivity shock, λ = 0.5 Graph 1

Consumption and investment



Leisure



Source: Authors' calculations

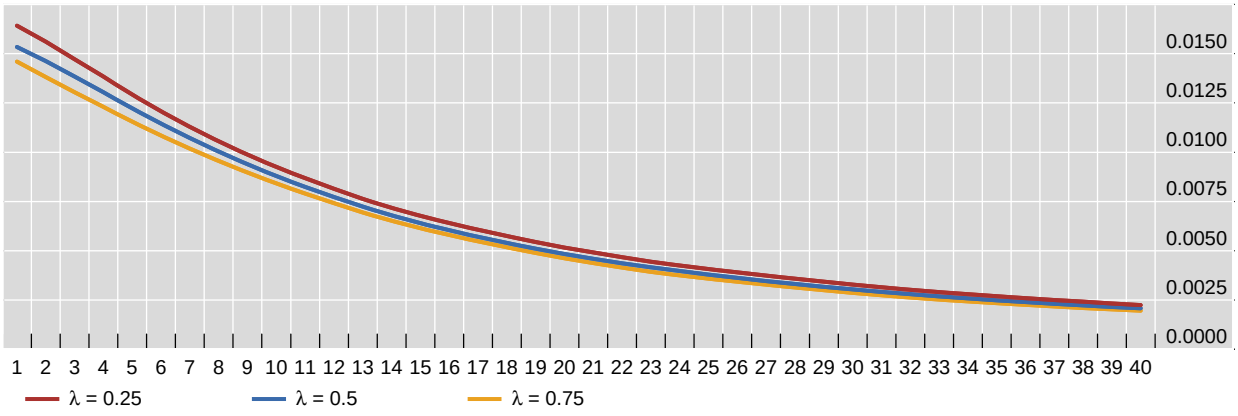
The top panel of Graph 2 shows that financial inclusion has a small impact on the sensitivity of output to a positive productivity shock. The greater is the level of financial inclusion (ie the lower is the level of λ) the greater is the increase in the capital stock, and therefore the larger is the increase in output, for a given productivity shock. The effects on inflation are more markedly different. In all cases, a positive productivity shock is deflationary. But with a high degree of inclusion, the spike in investment demand substantially offsets the deflationary effects of a productivity shock in the short term.

The inflation and output effects illustrated in the top two panels of Graph 2 reflect not just the changed dynamics in the economy, but also the optimal monetary policy response to them. We already know from the existing literature cited in Section 2 that optimal policy is likely to vary in important ways as the degree of financial inclusion changes. At the very least, the set of policy rules for which our model economy is dynamically stable will be critically dependent on the value of λ. The bottom panel of Graph 2 shows that we can say more than that. The degree to which policy rates should be cut in response to a positive productivity shock is decreasing in the share of the population that is financially included. Indeed, in the highest case we present here ($\lambda = 0.25$ so that 75% of consumers

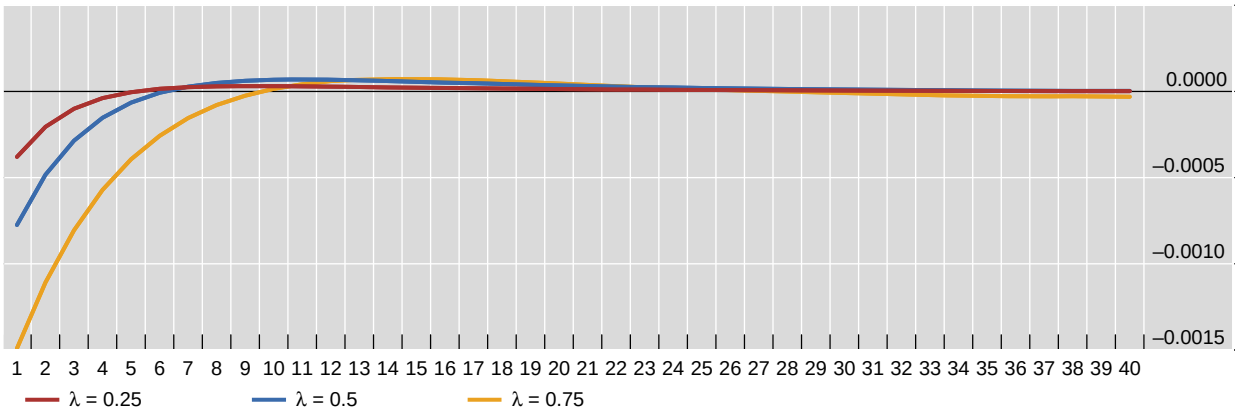
are financially included), optimal policy entails a modest tightening of policy in response to a positive productivity shock.

Impulse responses to productivity shock — Graph 2

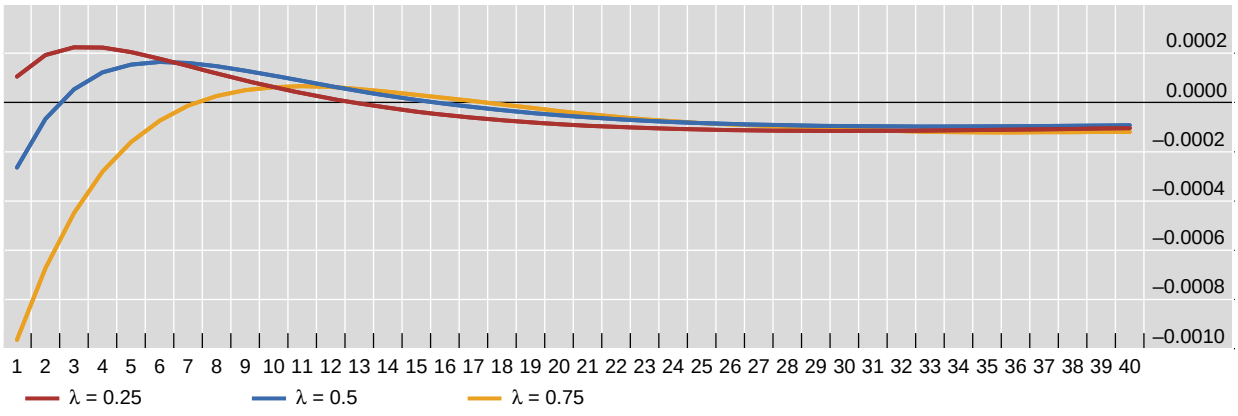
Output



Inflation



Policy rate



Source: Authors' calculations

To be able to compare our theoretical model results with the data, we require comparable measures of inflation and output. Our empirical evidence is based on

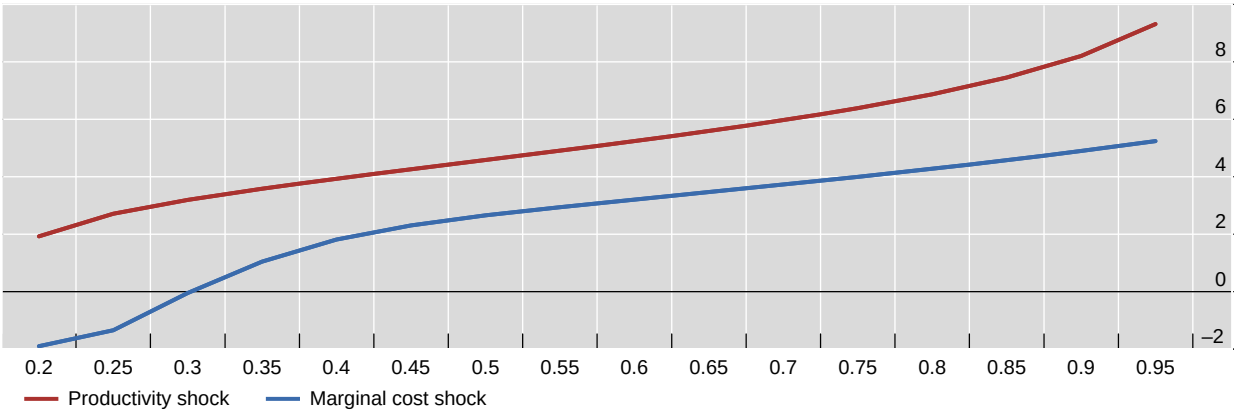
annual data, whereas our model calibration is based on quarterly data. Further, output in our model is measured in units (versus logs). We therefore examine the variance of the following transformed measures of output and inflation:

$$\tilde{Y}_t = 100 \sum_{k=0}^{3} \ln Y_{t-j} \,, \tag{21}$$

$$\tilde{\pi}_t = 100 \sum_{k=0}^{3} \pi_{t-j} \,. \tag{22}$$

Graph 3 displays the optimal ratio between the variances of output and inflation as the degree of financial inclusion varies, as a monotonically increasing function. (Note that the horizontal axis is defined in terms of $(1-\lambda)$, so that the level of financial inclusion is increasing as we move from left to right).

Optimal ratio of output: inflation variances — Graph 3



Note: The vertical axis displays the ratio of output volatility to inflation volatility, in logarithms. The horizontal axis displays the share of consumers who are financially included (1-λ).

Source: Authors' calculations.

Financial inclusion affects the volatility of output and inflation in a number of different ways. The first is via changes in the dynamics of the economy, even without any changes in the monetary policy rule. The model cannot always be solved with the same policy rule across a wide range of levels of inclusion for reasons of dynamic instability or lack of uniqueness, as discussed extensively in the existing literature and summarised in section 2. From experimenting with rules of the form $r_t = 1/\beta + \gamma\pi_t$ for $\gamma > 1.0$ we find that, in response to a productivity shock, higher levels of inclusion lead to declines in the volatility of both output and inflation. But both decline at around the same rate, so that the ratio between output and inflation volatility is approximately unchanged. Thus the increase in the ratio of output to inflation volatility seen in Graph 3 is primarily the result of changes in the monetary policy rule.

Our results based on simple monetary policy rules also indicate why we might expect optimal monetary policy to be sensitive to the degree of financial inclusion. Our simulations indicate that the correlation between output and inflation is declining in the level of financial inclusion. In practical terms, that means that the

trade-off between output and inflation volatility, and therefore the optimal monetary policy response to shocks, will vary with the degree of financial inclusion.

So how should monetary policy change in the face of growing financial inclusion? Both output and inflation volatility are costly to social welfare. Financially included consumers are able to adjust their savings and investment decisions to partially insulate their consumption from output volatility. Meanwhile inflation represents a deadweight loss, driving a wedge between aggregate output and aggregate consumption that impacts on both financially included and excluded consumers. Optimal monetary policy therefore increasingly focuses on stabilising inflation – even at the expense of somewhat greater output volatility – as the degree of financial inclusion rises and more consumers are able to mitigate the negative welfare effects of increased output volatility.

Put another way, there is an inherent difference between financially included and excluded consumers. Financially included households are able to smooth their consumption over time, by adjusting their rate of capital accumulation, even as income and output fluctuate, but are less able to insure away welfare losses due to volatile prices. Therefore their welfare is maximised when monetary policy stabilises prices, even at the expense of somewhat more volatile output. For financially excluded households, the results are reversed. Being unable to insure away the welfare costs of volatile income, which feed directly into volatile consumption, they prefer outcomes that stabilise output, even at the expense of more volatile inflation.[11] Not surprisingly, therefore, the policy rule that maximises a weighted sum of welfare moves from one that largely stabilises output at the expense of inflation when financially excluded consumers are most numerous, to one that embraces greater output volatility but pins inflation tightly down when included consumers dominate.

We can further illustrate the factors at work here in the following way. We repeat our analysis allowing for two values of λ: the true value, which drives the underlying dynamics of the economy, and λ^P which is the value in the central bank's objective function (equation 20). The results in Graph 3 are for the special case of $\lambda = \lambda^P$. We consider two alternatives: fixing $\lambda^P = 0.5$ while varying λ; and fixing $\lambda = 0.5$ while varying λ^P. The former shows the effect of changes in the underlying dynamics of the economy plus the optimal monetary policy response to them, ignoring the compositional change between consumer types, while the latter illustrates the effect of a compositional change, keeping the underlying dynamics of the economy unchanged.

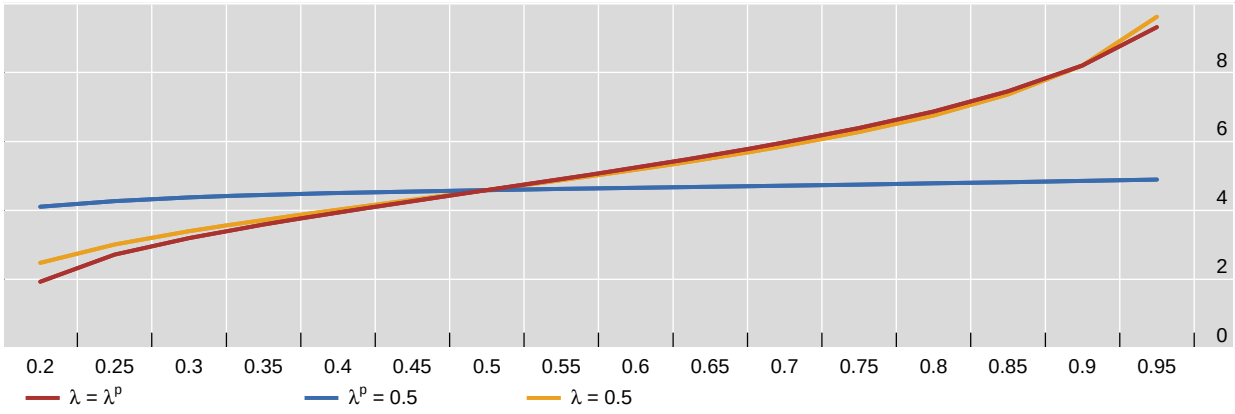
The results are given in Graph 4 for productivity shocks (top panel) and marginal cost shocks (bottom panel). In both cases the effects reinforce each other, with the relationships monotonically increasing in the degree of financial inclusion.

[11] On the surface, this result would seem to run counter to one rationale given for central banks to pursue price stability. It is sometimes argued that inflation represents a tax that affects the poorer part of the population in particular, as they have limited possibilities to hedge against inflation and high inflation tends to erode their savings (see eg Easterly and Fischer, 2001). But in our framework, the financially excluded have *no* savings and hence are affected only to a limited extent by more volatile inflation.

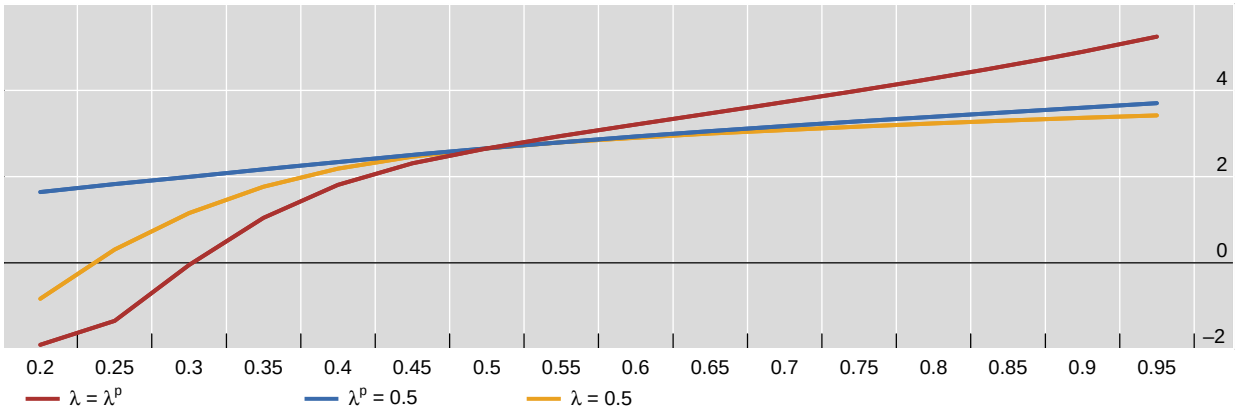
Decomposition of change in variance ratio

Graph 4

Productivity shocks



Marginal cost shocks



Note: The vertical axis displays the ratio of output volatility to inflation volatility, in logarithms. The horizontal axis displays the share of consumers who are financially included (1-λ), and/or the weight of financially included consumers in the central bank's loss function (1-λ^p). The line labelled "λ=λ^p" corresponds to the case where both coefficients change as we move from left to right. The line labelled "λ^p=0.5", illustrates the case where only (1-λ) increases as we move from left to right, corresponding to a case where monetary policy responds optimally to underlying changes in the structure of the economy but ignores changes in the composition of the population. The line labelled "λ=0.5" illustrates the case where only (1-λ^p) increases as we move from left to right, corresponding to a case where the underlying structure of the economy is unchanged and the change in outcomes purely reflects an increasing relative weight on the welfare of included consumers in the central bank's objective function.

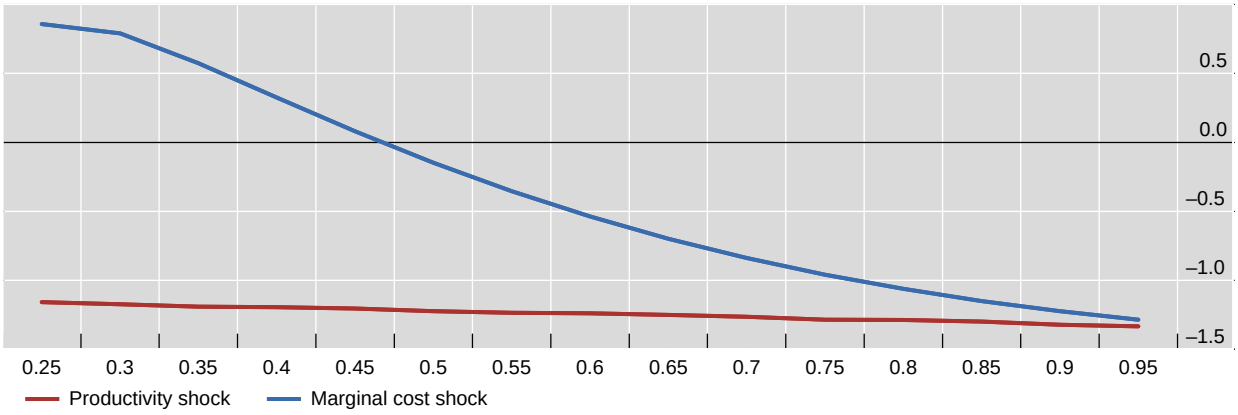
Source: Authors' calculations.

We can illustrate one other prediction of the model by focusing on the relative volatility of consumption and output. Since financially included households are able to smooth consumption in the face of output volatility, we would expect overall consumption volatility to fall relative to output volatility the more financially included households there are. We illustrate this in Graph 5. In fact, for our base calibration, output (consumption) volatility increases (decreases) monotonically with the level of financial inclusion once more than 25% of households are included ($\lambda \leq 0.75$) with either marginal cost or productivity shocks.

There are other empirical implications of the model that could, in principle, also be tested. For example, we could focus on the volatility of the policy rate. However, the mix of policy instruments used by central banks varies considerably across

jurisdictions, making their comparison difficult. Similarly, we could examine the variances of output and inflation individually, instead of their ratio. But emerging market economies, which are likely to have larger shares of financially excluded households, tend to have more volatile output and inflation (Fraga, Goldfajn and Minella, 2004). Perhaps these economies are subject to larger shocks than others on average, or the lack of financial development (which is likely to be correlated with the share of financially excluded households) changes the shock transmission process in ways that increase volatility. Focusing on the ratio of the variances, instead of their levels, allows us to avoid these potentially complicating factors.

Optimal ratio of consumption:output variances — Graph 5



Note: The vertical axis displays the ratio of consumption volatility to output volatility. The horizontal axis displays the share of consumers who are financially included (1-λ).

Source: Authors' calculations.

4. Empirical evidence

In what follows, we test three predictions from the theoretical model. First, using panel data, we examine whether the responses of the economy to productivity shocks vary at different levels of financial inclusion in a way that is consistent with the impulse responses of our theoretical model. Second, in a cross-section, we test whether the ratio of output to inflation volatilities increases in the degree of financial inclusion in an economy. Finally, we test whether the volatility of consumption declines relative to the volatility of output as financial inclusion increases.

In order to test the first prediction, we estimate panel VAR models for two different groups of economies with lower and higher levels of financial inclusion, respectively.[12] The vector of endogenous variables is defined as $[\Delta(y/l), y, \pi, i]$, where $\Delta(y/l)$ denotes the growth in labour productivity (in per cent), y is output, π is the

[12] We use the panel VAR code by Love and Zicchino (2006)

inflation rate and i is the nominal deposit rate.[13] The economies are divided into two groups based on our benchmark indicator for financial inclusion from the World Bank's Global Findex Database (Demirguc-Kunt and Klapper, 2012), ie the share of population above the age of 15 that had an account in a formal financial institution in 2011.[14] We split our sample based on the mean value (47%) for this variable. Annual data are used for the estimation, with the longest available sample running from 1980 to 2012, although for many economies the samples are substantially shorter due to data availability. The sample split results in 1441 yearly observations for the group with a higher degree of financial inclusion (55 economies) and 1080 observations for the group with a lower level of inclusion (47 economies).

In order to account for cross-sectional heterogeneity, we include fixed effects, by means of forward-mean differencing (ie Helmert procedure; see Arellano and Bover, 1995). This approach is important from the point of view of orthogonality between the transformed variables and the lagged regressors. Estimation then uses lagged dependent variables as instruments and a generalised method of moments (GMM) estimator. One yearly lag is included for all variables. Identification is achieved using contemporaneous restrictions, in particular the Choleski decomposition of the variance covariance matrix. Our ordering of the variables implies that productivity growth is the most "exogenous" of the four included variables. Finally, 90% confidence intervals for the impulse responses are computed by means of Monte Carlo simulations, with 1,000 replications.

Graph 6 shows the responses of output, inflation and interest rates to a 1 percentage point shock in labour productivity growth in period 1. In line with the predictions of the theoretical model, the negative impact on both inflation and the interest rate appear to be substantially stronger in economies with a lower level of financial inclusion.[15] Given the broad confidence intervals, the difference between the two groups is limited in a statistical sense, but there is a substantial difference in terms of the point estimates. The impacts on output are more quantitatively similar across the two groups of economies, again in line with the theoretical model, even if the estimated impact is slightly smaller for economies with a higher degree of inclusion (versus slightly bigger in the model impulse response).

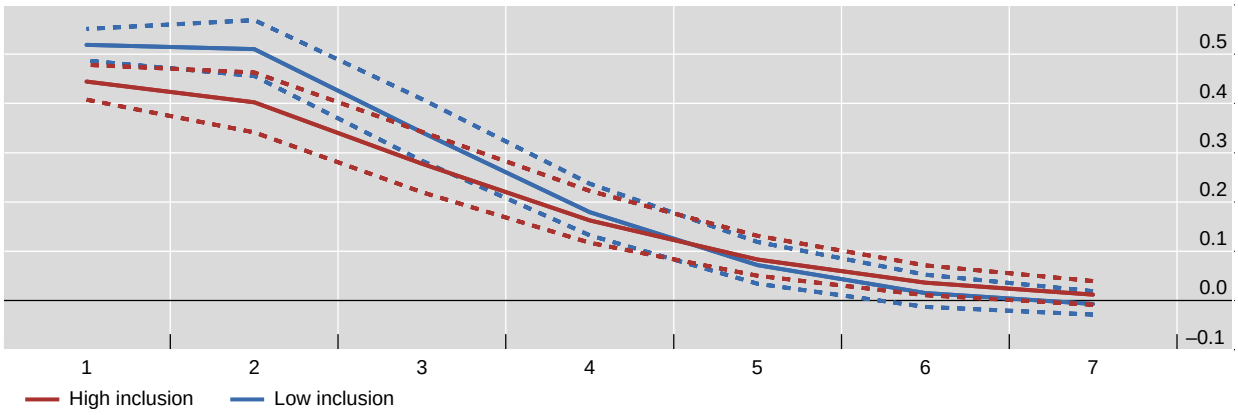
[13] The source for data on output and inflation is the IMF WEO database, while labour productivity and the interest rate data are from the World Bank Development Indicators database. As the impulse responses in the theoretical model capture deviations from steady state, we use an output gap as a measure of output in the VAR. This is computed using data on real GDP and extracting the cyclical component of output by the conventional Hodrick-Prescott (HP) filter, with a smoothing parameter of 100. The HP filter is applied to the data starting in 1980 where possible, or else as early as data availability allows. Inflation is defined as the average annual change in consumer prices. Labour productivity growth is the annual percentage change in GDP per person employed, with GDP expressed in terms of 1990 US dollars and adjusted for purchasing power parity, in order to take account of differences in relative prices across economies.

[14] A formal financial institution is defined as "a bank, credit union, post office, cooperative or microfinance institution." The data are based on interviews with adults in 148 economies.

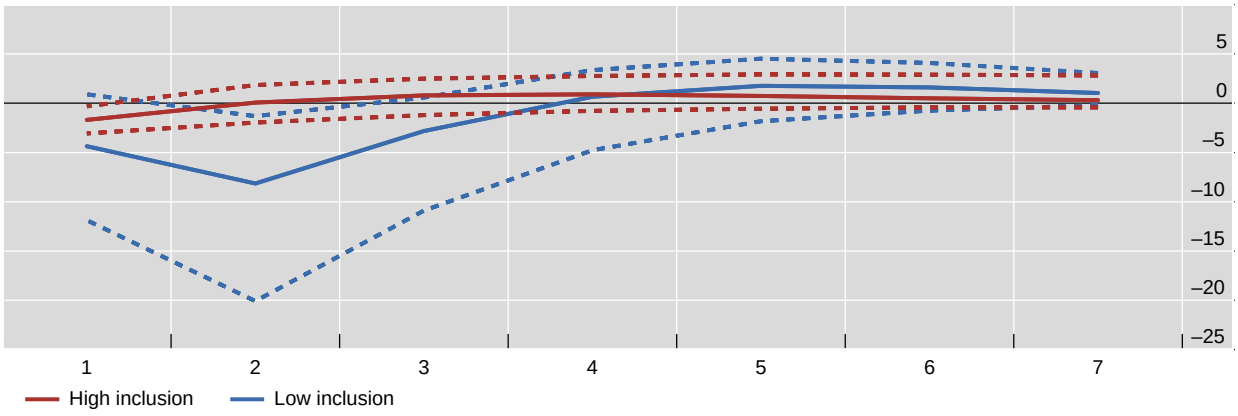
[15] The results are qualitatively very similar when a lending rate is used instead of the deposit rate, albeit with a lower statistical significance.

Estimated impulse responses to productivity shock Graph 6

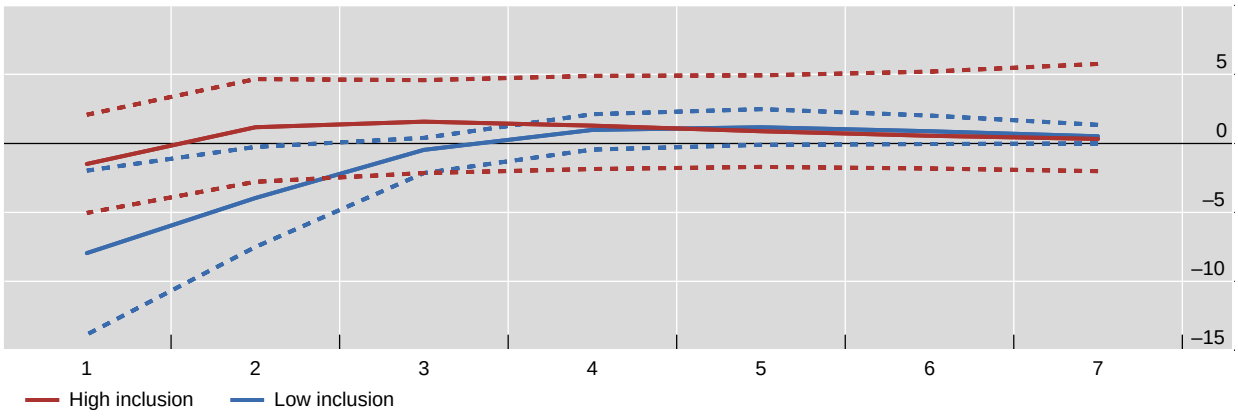
Output



Inflation



Deposit interest rate



Note: Dotted lines are 90% confidence bands.

Source: Authors' calculations

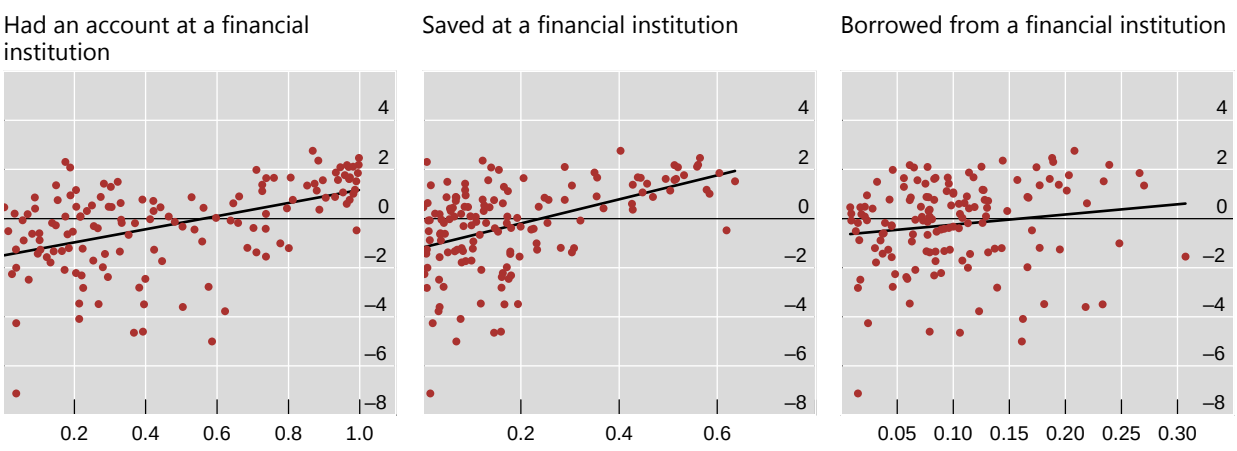
In order to test the second prediction from the theoretical model, we evaluate whether the relationship of the ratio of output to inflation volatility is related to the degree of financial inclusion, across a large cross-section of economies. Here we

include all economies where annual data on real GDP and average CPI inflation are available from 2000 onwards and for which data on financial inclusion are available in the Global Findex database. This yields a group of approximately 140 economies, depending on the exact measure of financial inclusion considered. The ratio of volatilities is then computed as a ratio of the variances of the output gap to inflation based on the 13 annual observations for 2000-12.

The left-hand panel of Graph 7 shows cross-sectional evidence on the relationship between financial inclusion – using our benchmark measure of account ownership – and the (logarithm of the) ratio of output volatility to inflation volatility. We plot the degree of financial inclusion on the x-axis, with 1 indicating that 100% of the adult population is financially included by our chosen measure. Graph 7 shows that the ratio of output volatility to inflation volatility generally increases in our sample as the share of financially included consumers increases, as in our theoretical model.[16]

However, it is possible that some households have an account primarily as a means of making and receiving payments rather than saving. We therefore examine how robust our finding of a positive association between inclusion and the ratio of output volatility to inflation volatility is by examining other measures of financial inclusion. The ability to inter-temporally smooth consumption depends on the ability to save and either run down those savings or borrow in response to shocks. We next consider each of these separately.

Ratio of output–inflation variances and financial inclusion, alternative measures — Graph 7



Note: The vertical axes show the ratio of output gap volatility to inflation volatility during 2000–12, in logarithms. The horizontal axes show the share of adults that had an account at a formal financial institution in 2011 (left panel), the share of adults who saved money (middle panel) or share of adults who borrowed money (right panel) at a formal financial institution during the preceding 12 months. Greece, an outlier, is excluded.

Sources: World Bank, *Global Financial Inclusion Database*; Authors' calculations.

In the middle panel of Graph 7, we address the savings dimension, using data from the Global Findex database on the share of adults who reported having saved money at a formal financial institution during the preceding 12 months. For this

[16] The upward trend also obtains if real GDP in logarithms is used for computing the variance ratio. This could be especially relevant for emerging economies that experience low frequency volatility in output. See eg Aguiar and Gopinath (2007).

measure, the regional averages vary from 5% in the Middle East and North Africa to 28% in East Asia and the Pacific. In terms of income groups, the share is 45% in the high income countries and 12% in the low income countries for a 22% average worldwide. Again, the analysis unveils a positive relationship between the ratio of variances and the degree of financial inclusion.

In our underlying theoretical model, savings are necessary and sufficient for households to smooth their consumption in response to shocks. Financially included households maintain a stock of savings in the form of the capital stock. In response to a negative shock, our representative included household can reduce its rate of saving to below that required to maintain the capital stock in order to smooth consumption.

In the real world, without a representative financially included household, some households are likely to borrow to smooth consumption instead of running down their savings. Thus, we consider the share of adults who report having borrowed money from a formal financial institution in the previous 12 months as a measure of financial inclusion. The results are reported in the right-hand panel of Graph 7. In this case, the degree of financial inclusion is clearly lower, with the regional averages ranging from 5% (both for Sub-Saharan Africa and for the Middle East and North Africa) to 9% (for East Asia and the Pacific). While the relationship between financial inclusion and the variance ratio is clearly weaker when a measure of borrowing is used, the cross-plot again suggests a positive relationship between the two variables.[17]

Table 2 investigates the relationships more formally, estimating cross-sectional models where the log of the ratio of output gap:inflation variances is regressed on a measure of financial inclusion. Table 2 suggests that, in these simple cross-sectional regressions, the coefficient on the financial inclusion variable is statistically significant at least at the 10% level with all three different proxies of financial inclusion: account ownership, saving and borrowing during the past 12 months. The adjusted R squared is highest in the model where financial inclusion is proxied by the ownership of an account at a formal financial institution (Model 1), while the fit is weakest when loans are used (Model 3).[18]

The theoretical model offered evidence that the positive relationship between the ratio of output volatility to inflation volatility and financial inclusion is largely due to changes in the optimal monetary policy response of the central bank to shocks. We have reported empirical evidence consistent with this relationship, but not on the underlying mechanism. One possibility is that more independent central banks are more likely to pursue optimal policy, as they may place less weight on the objectives of the fiscal authority (see Walsh, 2008, for example). To explore this

[17] Note that we might expect increased financial inclusion to be associated with reduced volatility of both inflation and output for reasons unrelated to monetary policy, such as financial market development or reduced vulnerability to some shocks. In Graph A1 in the annex, we show simple cross-plots between account ownership as a proxy for financial inclusion and output volatility, and financial inclusion and inflation volatility, respectively. While there is a negative association between financial inclusion and the individual volatilities, this is very weak and statistically insignificant.

[18] Greece is excluded from Graph 5 and all results reported in Tables 2, 3, A1 and A2, as it is an outlier with a ratio of variances exceeding 35 (3.6 in log terms). The adjusted R squared values fall with the inclusion of Greece, but the financial inclusion variable remains statistically significant at the 1% level in Models 1-2 and the 10% level in Model 3.

possibility, we estimate the model with our benchmark indicator of financial inclusion but split the sample based on the degree of central bank independence. To obtain a proxy for the latter, we use the index of "independence/autonomy in day-to-day monetary policy decisions" by Siklos (2008). We first estimate the model only for those economies with central banks that have a high level of autonomy, whether constitutionally mandated or otherwise, and then only for economies where central banks have little autonomy.[19] We find that the degree of financial inclusion is strongly (and significantly) correlated with the log of the variances ratio in economies with more autonomous central banks (Model 4) but not in economies where central banks have low levels of autonomy (Model 5).

Estimation results, cross section

Table 2

	Dependent variable is log of variance ratio				
	(1)	(2)	(3)	(4)	(5)
Financial inclusion variable	Account ownership	Savings in past year	Loans in past year	Account ownership, more autonomous central banks	Account ownership, less autonomous central banks
Coefficient on financial inclusion	2.679***	4.901***	4.160*	2.771***	0.549
	(0.419)	(0.784)	(2.371)	(0.431)	(1.523)
Adj R squared	0.224	0.214	0.015	0.341	–0.043
N	139	142	141	79	22

Source: The table shows the β_1 coefficients of cross-sectional regressions of the type: Log(Variance ratio) = β_1 * financial inclusion+c. *, ** and *** denote statistical significance at 10%, 5% and 1% levels respectively. Standard errors are in parentheses. Intercepts are not shown. Greece, an outlier, is excluded. The variance ratio is computed as the ratio of the variance of the output gap to the variance of inflation over 2000–12. The variables for financial inclusion are from the Global Findex Database. The degree of autonomy of central banks is from Siklos, P L (2008): "No single definition of central bank independence is right for all countries", *European Journal of Political Economy* 24(4), 802–816. "More autonomous" is defined as central banks with values of 0.75 or 1 in the "AUT" category that measures independence/autonomy in making day-to-day monetary policy decisions; "less autonomous" 0.5 or 0 in the same category.

We conduct various robustness tests and report these in Table 3 and Tables A1 and A2 in the Appendix. All regressions in the remainder of the paper are conducted for the more autonomous central banks, consistently with the previous results regarding the impact of central bank autonomy on the relationship between the variance ratio and financial inclusion. First, we deal with potential endogeneity. The estimates in Table 2 are based on the implicit assumption that causality runs from the degree of financial inclusion to the variance ratio, which is in line with the theoretical model. However, one could imagine potential reverse causality from the variance ratio to financial inclusion as well. For example, a high or volatile inflation rate could make the population reluctant to hold bank accounts or to save, especially if nominal interest rates are not adjusted fully to the prevailing inflation rate in the economy. In Model 6 in Table 3, we report the results from an instrumental variables regression, where financial inclusion is instrumented by

[19] The economies with a high degree of central bank autonomy/independence have values of 0.75 or 1.00 in the Siklos (2008) index; low autonomy central banks have values of 0 or 0.5.

regulatory quality. [20] The quality of institutions more broadly has been found to be an important determinant of financial development in Allen et al (2014). In this two-stage regression, the coefficient on financial inclusion proxied by account ownership is again positive and statistically significant.[21] We continue to use this instrument for the financial inclusion variables in the remainder of the paper.[22]

Estimation results, account ownership

Table 3

	(6)	(7)	(8)	(9)	(10)
	Dependent variable is log of variance ratio				
Account ownership	3.480***	3.667***	3.505***	2.771***	2.987**
	(0.537)	(1.192)	(0.540)	(0.431)	(1.129)
Credit-to-GDP		-0.001		-0.002	0.001
		(0.005)		(0.005)	(0.005)
Energy imports, share of GDP			-0.021	-0.020	-0.036
			(0.032)	(0.035)	(0.032)
Adjustment for crises	No	No	No	No	Excluding only crisis years from variance ratio
Adj R squared	0.318	0.268	0.311	0.253	0.345
N	79	76	79	76	76

Source: All estimations are two stage least squares estimations, where regulatory quality is used to instrument for the financial inclusion variable. Other right-hand side variables are used as their own instruments. Only more autonomous central banks are included (see note to Table 2). *, ** and *** denote statistical significance at 10%, 5% and 1% levels respectively. Standard errors are in parentheses. Intercepts are not shown. Greece, an outlier, is excluded. The variance ratio is computed as the ratio of the variance of the output gap to the variance of inflation over 2000–12. The variables for financial inclusion are from the Global Findex Database.

Next, we explore the importance of financial depth. While the coefficient on credit-to-GDP is positive and statistically significant if included on its own as a right-hand side variable, the significance disappears when a proxy for financial inclusion is also included (Model 7). This suggests that our results are driven by financial inclusion as opposed to simply financial depth.

While the observed outcomes for inflation and output are assumed to result from optimal monetary policy in the face of various shocks, explicitly controlling for some larger shocks may be pertinent. In Models 8 and 9, we control for the economies' vulnerability to global commodity price fluctuations by including the

[20] Regulatory quality "reflects perceptions of the ability of the government to formulate and implement sound policies and regulations that permit and promote private sector development". We use the value for 2011 reported in the Worldwide Governance Indicators database. See also Kaufmann et al (2010).

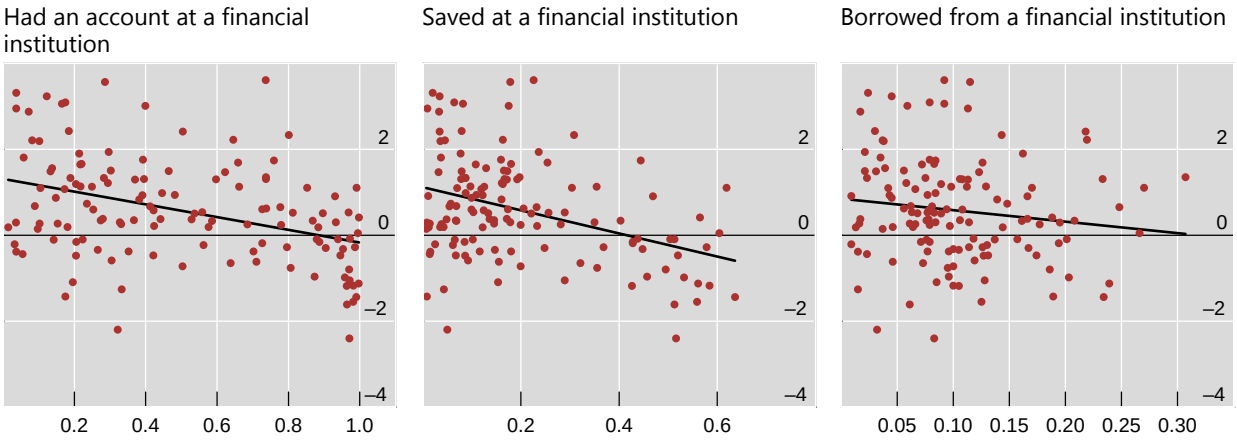
[21] We can reject the null hypothesis of weak instruments using the criterion of either Stock et al (2002) or Stock and Yogo (2005)

[22] Another way to deal with potential endogeneity resulting from high inflation rates would be to estimate the model only for economies with inflation below the sample median (4.68 during 2000-12). This adjustment also results in a statistically significant coefficient on the financial inclusion variable.

share of energy imports in GDP.[23] And in Model 10, we adjust the computation of the variance ratio by excluding the years of banking, currency and sovereign debt crises, using the database by Laeven and Valencia (2012). In these regressions as well, the financial inclusion variable obtains a statistically significant positive coefficient.

Tables A1 and A2 report identical regressions to those presented above for two other proxies for financial inclusion, saving and borrowing at a formal financial institution, respectively. The borrowing variable in Table A2 is adjusted to include the ownership of credit cards, which is a particularly important form of borrowing in the high-income economies.[24] In all regressions reported in Tables A1 and A2, the relationship between the variance ratio and the financial inclusion variable remains robust.

Ratio of consumption–output variances and financial inclusion, alternative measures Graph 8



Note: The vertical axes show the ratio of consumption gap volatility to output gap volatility during 2000–12, in logarithms. The horizontal axes show the share of adults that had an account at a formal financial institution in 2011 (left panel), the share of adults who saved money (middle panel) or share of adults who borrowed money (right panel) at a formal financial institution during the preceding 12 months. Republic of Congo and Zambia, two outliers, are excluded.

Sources: IMF, *World Economic Outlook*; World Bank, *Global Financial Inclusion Database*; Authors' calculations.

The final empirical evidence we examine is whether the volatility of consumption declines relative to the volatility of output as financial inclusion increases. The results are given in Graph 8 and accord with the prediction of the model for all three measures of financial inclusion examined. An increase in the level of financial inclusion is associated with a decline in the level of consumption volatility relative to output volatility.

[23] Based on trade data from UNCTAD. The shares are defined as averages over 2000–12.

[24] For high-income economies, the share of adults that report having borrowed from a formal financial institution in the previous year is 14%, while credit card ownership is reported as 50% of the adult population. However, it is not possible to determine what share of the reported formal borrowing in the survey reflects the use of credit cards. Therefore, we consider a proxy defined as the simple average of the share of adults that report having borrowed money in the past year and the share of credit card ownership.

5. Conclusions

In this paper we have examined the implications of changes in the level of financial inclusion for welfare-maximising monetary policy. As in the previous literature on limited asset market participation, our model is based on the assumption that only financially included households are able to smooth their consumption in response to income volatility, whereas financially excluded households consume their entire labour income each period. We have extended the theoretical analysis of Galí et al (2004) by characterising optimal monetary policy and determining how the ratio of output volatility to inflation volatility varies with the degree of financial inclusion.

Results from our model indicate that the ratio of output volatility to inflation volatility is increasing in the share of financially included consumers in the economy when monetary policy is conducted optimally. Using a broad cross-country dataset on financial inclusion from the Global Findex database, we find strong empirical evidence consistent with the model's predictions. The results are driven primarily by economies – both emerging market and advanced – where central banks have a high degree of autonomy in their monetary policy decisions. Such central banks are arguably most likely to set monetary policy optimally.

Given the official programmes in various emerging market economies to enhance the degree of financial inclusion, both output volatility and inflation volatility may be expected to fall as a result of increased inter-temporal substitution, financial market development and reduced sensitivity to some types of shocks (eg related to weather and natural disasters). But while the volatility of both variables may decline, our model suggests that the *ratio* of output volatility to inflation volatility may be expected to increase as the share of financially included consumers rises. In our model, this outcome is primarily the result of changes in the optimal monetary policy response to shocks. It is also consistent with the observation that, at the same time as financial inclusion has increased, emerging market central banks have been increasingly pursuing policies with an emphasis on price stability, either explicitly, via the adoption of inflation targeting, or implicitly, in the day-to-day management of monetary conditions.

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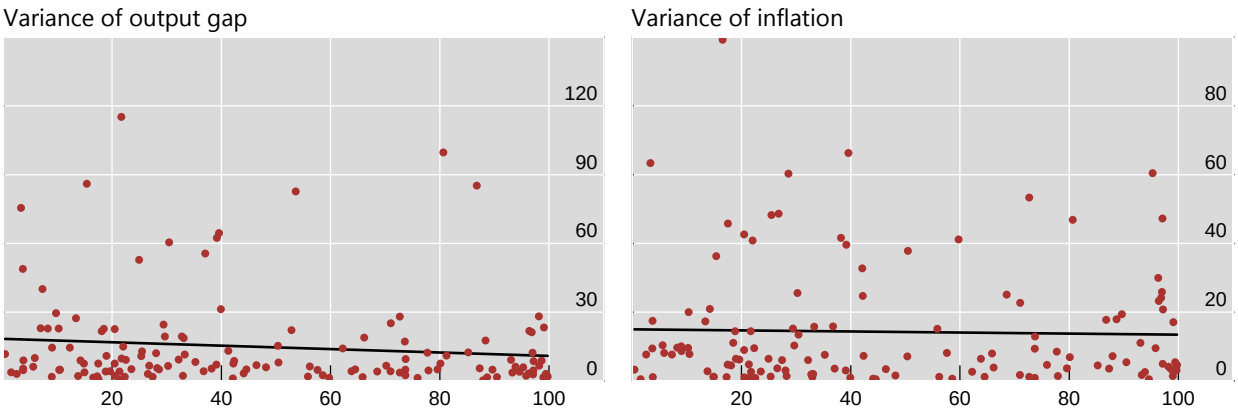
Appendix

Financial inclusion and the variance of output gap and inflation

Graph A1



The horizontal axis shows the per cent of consumers that have an account at a formal financial institution. The following outliers are excluded in the right panel: Angola, Belarus, Democratic Republic of Congo, Dominican Republic, Ecuador, Ethiopia, Montenegro, Romania, Serbia, Seychelles, Suriname and Turkey.

Sources: World Bank, *Global Financial Inclusion Database*; IMF WEO; Authors' calculations.

Estimation results, saving at formal financial institution

Table A1

	(11)	(12)	(13)	(14)	(15)
	Dependent variable is log of variance ratio				
Saving	6.103***	6.664***	6.134***	6.793***	5.394**
	(1.044)	(2.472)	(1.049)	(2.530)	(2.305)
Credit-to-GDP		-0.002		-0.002	0.001
		(0.006)		(0.006)	(0.006)
Energy imports, share of GDP			-0.015	-0.012	-0.030
			(0.035)	(0.038)	(0.035)
Adjustment for crises	No	No	No	No	Excluding crisis years from variance ratio
Adj R squared	0.163	0.079	0.151	0.057	0.185
N	80	77	79	77	77

Source: All estimations are two stage least squares estimations, where regulatory quality is used to instrument for the financial inclusion variable. Other right-hand side variables are used as their own instruments. Only more autonomous central banks are included (see note to Table 2). *, ** and *** denote statistical significance at 10%, 5% and 1% levels respectively. Standard errors are in parentheses. Intercepts are not shown. Greece, an outlier, is excluded. The variance ratio is computed as the ratio of the variance of the output gap to the variance of inflation over 2000–12. The variables for financial inclusion are from the Global Findex Database.

Estimation results, loans and credit cards

Table A2

	(16)	(17)	(18)	(19)	(20)
	Dependent variable is log of variance ratio				
Loans and credit cards	8.742***	9.015***	8.657***	8.550***	6.789***
	(1.459)	(3.191)	(0.029)	(2.970)	(2.486)
Credit-to-GDP		-0.001		0.0002	0.003
		(0.005)		(0.005)	(0.005)
Energy imports, share of GDP			0.029	0.032	0.005
			(0.035)	(0.037)	(0.034)
Adjustment for crises	No	No	No	No	Excluding crisis years from variance ratio
Adj R squared	0.202	0.161	0.203	0.180	0.278
N	80	77	80	77	77

Source: All estimations are two stage least squares estimations, where regulatory quality is used to instrument for the financial inclusion variable. Other right-hand side variables are used as their own instruments. The variable loans and credit cards is a simple average of the share of adults who borrowed at formal financial institution during the previous 12 months and the share of adults with credit card ownership. Only more autonomous central banks are included (see note to Table 2). *, ** and *** denote statistical significance at 10%, 5% and 1% levels respectively. Standard errors are in parentheses. Intercepts are not shown. Greece, an outlier, is excluded. The variance ratio is computed as the ratio of the variance of the output gap to the variance of inflation over 2000–12. The variables for financial inclusion are from the Global Findex Database.