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Homeownership, Informality and the Transmission of Monetary Policy*

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Abstract

Cross-country aggregate data exhibits a strong (positive) relationship between the size of the informal employment and aggregate homeownership rates. We investigate this empirical observation using a cash-in-advance model with housing markets and and argue that the rate of inflation is important in explaining the nexus between informality and homeownership rates. Specifically, we uncover a novel monetary transmission mechanism and show that households with informal employment desire to economize on their short-term cash usage and avoid periodic rental payments when (i) informality is associated with constrained business investment finance, and (ii) inflation expectations are high. Our empirical and theoretical findings highlight an important interaction between the conduct of monetary policy and the performance of housing markets.

JEL codes: E26; E41; E44.

Keywords: Cash-In-Advance, Informality, Cross-Country Data; Monetary Transmission.

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1 Introduction

Does informal production stimulate the demand to own a house, and what is the effect of monetary policy in explaining this relationship? In this paper we address these questions by developing a general equilibrium model of housing markets with nominal frictions, and studying the empirically testable implications of informality on homeownership demand using a cross-country dataset covering 67 economies.

Our benchmark model predicts that the informal production intensity of a household raises the demand for owning a home when informality is associated with constrained business investment. We also show that monetary policy has non-trivial effects on explaining the nexus between informal sector size and the rate of aggregate homeownership. Specifically, by augmenting our benchmark model with a Cash-In-Advance constraint we show that a rise in the inflation rate weakens the sensitivity of homeownership with respect to the intensity of informal production when households' home purchases are constrained with their cash-holdings. When housing purchases are not subject to cash constraints, or in other words household finance is available, the rate of inflation strengthens the effects of informality on homeownership.

We motivate our theoretical study with a cross-country empirical observation. As we present in figure 1 there is a positive correlation between the aggregate size of the informal sector and the homeownership rates. A comprehensive econometric analysis using this 67-country dataset also supports the existence of this positive relationship. Moreover, we also show that inflation strongly interacts with this relationship. Specifically, we find that in countries where the private credit markets are well (less) developed, inflation strengthens (weakens) the positive relationship between informality and homeownership.

Building upon this cross-country empirical evidence we develop a stylized two-sector general equilibrium model with housing markets that has the following features: There are two types of goods in our model economy that we denote as the consumption good and the housing good. Consumption good is produced by a continuum of households who are heterogeneous in terms of the informality of their production plants. We assume that the informality of production constrains the ability to invest in future consumption good production. *Housing investment* then emerges as an alternative

mean of saving for the future for households with a large informal production intensity. We derive closed form expressions for the equilibrium measure of households that choose to become homeowners, and show that the larger the fraction of "informality intensive" households in the economy the larger is the aggregate homeownership rate of the society.

We extend our benchmark model specification with a Cash-In-Advance constraint. In our cash-in-advance model we allow for financial market imperfections in the form of limited access to finance. Specifically, in addition to the investment barriers generated by the informal production delineated in the benchmark model, in the cash-in-advance extension we assume that exogenously determined fractions of housing and business investment are subject to a cash-in-advance constraint as in Dotsey and Sarte (2000). In equilibrium, the fraction of housing and investment spending that need to be financed by cash-holdings (and not by mortgage finance and investment credit) in turn determines the effects of inflation on homeownership rates. We show that, on the one hand, households with a high informal production intensity increase their demand for homeownership as the rate of monetary growth (and hence the inflation rate) rises if financing housing purchases is relatively less constrained compared to investment credit. On the other hand, informal households decrease demand for homeownership with rising inflation when home-purchases are subject to financing constraints.

There are important policy implications that one can draw upon from our work. Most importantly, we highlight a novel monetary transmission channel and show that the interactions between informal sector size and homeownership rates are important in determining the effects of monetary policy on the real economy. Therefore, our theoretical findings show that monetary growth influences the demand for housing. However, we also show that the implications of monetary policy are non-trivial. For informally employed households, monetary growth and the demand for housing are positively related as long as the mortgage markets are more developed compared to the business credit markets. Since the housing boom-bust cycles are extremely crucial for an economy's aggregate welfare, as we have experienced over the years that led the world economy to the Great Recession, our theoretical and empirical findings point out a novel and important interaction between the conduct of monetary policy and the performance of housing markets.

Related Literature: There is a recent and growing literature that studies the interactions between the size of the informal sector, investment finance and real economy. The studies in this literature

that are related to our work are Straub (2005), Amaral and Quintin (2006), Antunes and Cavalcanti (2007), Boedo and D'Erasmo (2009), Massenot and Straub (2011) and much more recently Elgin and Uras (2013). As we highlight in our benchmark model, the common feature of these models is that the magnitude of informality of an entrepreneurial firm constrains the opportunity to access finance to invest in future production opportunities.

Our paper is also related to the literature on housing and homeownership. Chambers, Garriga and Schlagenhauf (2009 and 2011) provide explanations for the significant changes in aggregate homeownership rates during 1940s and 1990s. Gervais (2002) and Nakajima (2010) study the effects of fiscal policy and taxes on demand for housing and homeownership rates. Yang (2009) and Diaz and Luengo-Prado (2010) investigate how housing affects the life cycle properties of consumption and wealth respectively. To the best of our knowledge our paper is the first to study the implications of informality on homeownership.

Finally, there is a non-exhaustive list of papers that are motivated to identify channels of monetary transmission. Important strands of this large literature are, balance sheet channel of monetary policy, pioneered by Bernanke and Gertler (1989 and 1995), credit and bank lending channel highlighted in Bernanke and Blinder (1992), Kashyap and Stein (1995), Peek and Rosengren (1995), and Kishan and Opiela (2000). Some research, similar to our motivation in this paper, focused on studying the implications of monetary policy on housing markets and homeownership. For example, Aoki et al. (2004) study a financial accelerator model of monetary policy with housing markets. Iacoviello (2005) is interested in investigating the interaction between monetary policy and borrowing constraints in a general equilibrium business cycle model. And, Taylor (2007) studies the effects of monetary policy on boom-bust cycles to explain the episode of great moderation. Different from these studies our model uncovers a monetary transmission channel and argues that informality and access to mortgage markets exhibit non-trivial interactions in determining the effects of monetary on policy on homeownership rates.

The rest of the paper is organized as follows. Section 2 provides cross-country aggregate empirical evidence that supports the existence of a robust relationship between informality and homeownership. Section 3 presents a benchmark general equilibrium model of housing markets to investigate the effects of informal sector on homeownership rates. Section 4 extends this benchmark model

into a cash-in-advance framework and analyzes the implications of inflation for the nexus between informality and homeownership in line with the empirical evidence presented in Section 2. Finally, Section 5 concludes the paper.

2 Homeownership and Informality: Empirical Evidence

In this section we document a cross-country empirical relationship between the informal sector size and aggregate homeownership rates. Specifically, we will test the following empirically-testable hypotheses:

1. Informality stimulates the demand for homeownership.
2. The rate of inflation determines the sensitivity of homeownership to informality.
3. The rate of inflation strengthens the relationship between informality and homeownership in countries with developed credit markets.
4. The rate of inflation weakens the relationship between informality and homeownership in countries with less-developed credit markets.

Table 1: Cross-Country Summary Statistics

Variable	Mean	Std. Dev.	Min.	Max.
Homeownership (%)	63.93	17.64	21.90	95.30
Informal Sector (% GDP)	30.17	13.86	8.80	67.00
Population Density	282.97	1062.64	1.52	6340.21
Government Spending (% GDP)	15.95	5.15	5.69	25.74
GDP per-capita (thousand USD)	12.42	11.32	0.51	42.56
Young Population Ratio (%)	32.19	10.04	15.99	50.03
Law and Order	4.60	1.24	2.00	6.00
Gini	37.77	8.93	24.00	59.20
CRD (% of GDP)	53.75	48.80	5.39	231.08
CRBAN (% of GDP)	66.82	57.22	6.55	317.94
M2 (% of GDP)	54.28	44.36	9.99	239.91
Inflation (%)	7.49	14.57	-3.69	96.09

We test our empirical hypotheses using cross-country aggregate data. Table 1 presents descriptive summary statistics of all the variables that we use in our empirical analysis. We use the informal

sector data[1] constructed by Elgin and Oztunali (2012). Accordingly, the informal sector[2] consists of market-oriented production activities that are hidden from the governing authority to avoid, payment of income, value added, or other taxes, payment of social security contributions, having to meet certain legal labor market standards, such as minimum wages, maximum working hours, safety standards; and complying with certain administrative procedures, such as completing statistical questionnaires or other administrative forms.

Moreover, we use population density, GDP per-capita government spending (% GDP), Young Population Ratio (% of total population), law and order index and the Gini index as control variables. We obtain government spending and GDP per-capita series from Penn World Tables 8.0 and percentage of population under 15 (young population ratio) and Gini Index from the World Development Indicators. To control for quality of institutions, we use the law and order index from the International Country Risk Guide. Finally, we obtained the homeownership data[3] from Fisher and Jaffe (2003). As measures of development of credit markets we choose three variables that are widely used in the literature as proxies. These are domestic credit provided by banking sector (% of GDP), shortly denoted by CRBAN, domestic credit to private sector (% of GDP), shortly denoted by CRD and finally money and quasi money. (i.e. M2 as % of GDP). All these series are obtained from the World Development Indicators (WDI). Moreover, we also use inflation series from the WDI. In our cross-country regression, in addition to the designated control variables, we also use dummies for three regional country groups, namely Latin American and Caribbean economies, post-socialist transition economies and Middle East and North African (MENA) economies. At the end, we end up with cross-country dataset for 67 countries for the year 2000.[4]

Figure 1 illustrates the cross-country correlation between homeownership rates and informal sector size. As we observe from this figure, there is a striking positive correlation between aggregate homeownership rates and the size of the informal sector. Using cross-country regressions, then, we estimate the following linear model with the standard heteroskedasticity - consistent OLS estimator:

[1] As a robustness check we also use the shadow economy (as % of GDP) estimates provided by Buehn and Schneider (2012) and the informal employment (as % of total non-agricultural employment) data presented by Charmes (2009) and obtained qualitatively similar results. These results are available for interested readers upon request from the corresponding author.

[2] The term "shadow economy" is generally in the literature to refer to the informal sector.

[3] Homeownership rate measures the average % of ownership of the house one lives in.

[4] The homeownership data is only available for this particular year; that is why our dataset is restricted to one year only. Moreover, the list of the 67 countries as well as detailed definitions and sources of all the variables are given in the appendix.

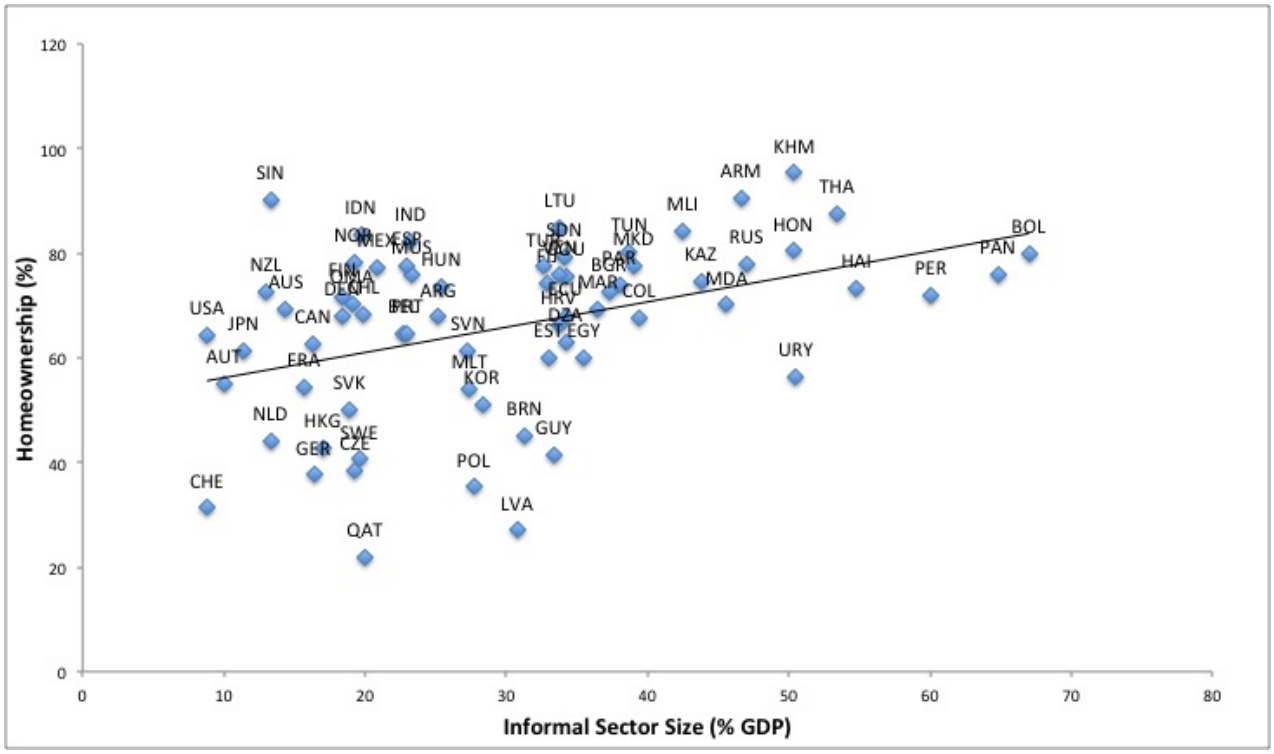

Figure 1: Homeownership vs. Informal Sector Size

$$Ownership_i = \beta_0 + \beta_1 Informal_i + \sum_{k=3}^{n} \beta_k X_{k_i} + \epsilon_i.$$

In this specification, X_{k_i} denotes additional control variables that potentially can have explanatory power on homeownership rates which includes population density, GDP per-capita and government spending; and ϵ_i is the error term. The results from this first pass cross-sectional regressions are reported in Table 2. As we observe from this table, the positive correlation between informal sector size and homeownership is quite robust. In addition to the informal sector size, as expected, we observe that homeownership is also positively correlated with the population density and negatively correlated with the percentage of population under 15. The results in Table 2 provides strong support for our first hypothesis: There is an aggregate association between the size of the informal sector and homeownership rates.

In order to test the remaining empirical hypotheses we also estimate the following equation using the heteroskedasticity-consistent OLS estimator:

Table 2: Home Ownership and Informal Sector

Dep. Var.: Ownership

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Informal	0.33**	0.32**	0.50*	0.40**	0.38**	0.39**	0.38**	0.44**
	(0.14)	(0.13)	(0.17)	(0.17)	(0.18)	(0.18)	(0.18)	(0.19)
Pop. Dens.		0.003**	0.003**	0.004*	0.004**	0.004**	0.004***	0.004***
		(0.001)	(0.001)	(0.001)	(0.002)	(0.002)	(0.002)	(0.002)
Latin			-8.85	-8.33	-8.05	-8.09	-7.47	-6.77
			(5.68)	(5.26)	(5.18)	(5.21)	(8.49)	(8.63)
Transition			-11.68**	-11.77**	-11.19**	-11.03**	-11.36***	-10.79***
			(5.79)	(5.82)	(5.57)	(5.60)	(6.24)	(6.16)
MENA			-14.30	-8.76	-8.15	-8.04	-8.18	-10.67
			(9.26)	(8.88)	(9.56)	(9.44)	(9.63)	(10.54)
GDP per-capita				-0.22	-0.18	-0.10	-0.20	-0.23
				(0.20)	(0.22)	(0.21)	(0.25)	(0.27)
Gov. Sp.					-0.17	-0.15	-0.17	-0.08
					(0.51)	(0.49)	(0.51)	(0.54)
Young Pop..						-0.04***	-0.04***	-0.05**
						(0.02)	(0.02)	(0.02)
Gini							-0.05	-0.11
							(0.48)	(0.50)
Law								2.29
								(1.61)
R-squared	0.07	0.11	0.19	0.19	0.19	0.20	0.21	0.22
Observations	67	67	67	67	67	67	66	66
F-Test	0.00	0.00	0.00	0.00	0.01	0.01	0.01	0.01

Robust standard errors are reported in parentheses. *, **, *** denote 1, 5 and 10% confidence levels, respectively. In all regressions a constant is also included but not reported. Latin, Transition and MENA refer to dummies for Latin American and Caribbean, Post-Socialist Transition and Middle East and North African economies, respectively.

$$Ownership_i = \beta_0 + \beta_1 Informal_i + \beta_2 Inflation_i + \beta_3 (Informal_i) \cdot (Inflation_i) + \sum_{k=4}^{n} \beta_k X_{k_i} + \epsilon_i.$$

For each three measures of private credit market development that we describe in table 1, we split our sample and estimate the regression equation twice: (1) for countries where the variable takes a value less than the median of the cross-country sample (2) when it is larger than the median of the sample. Moreover, we also report regression results after dividing the sample into two as "rich" and "poor", with countries having GDP per-capita above or equal to and below the median GDP per-capita of the original sample, respectively. We conduct this sample split analysis[5] in order

[5]Alternatively, we have also estimated single equations with triple interaction terms and obtained qualitatively similar results.

to capture the impact of financial development in explaining the interactions between informality, homeownership and inflation. In our estimations we also use the control variables from Table 2 that turned out to be significant determinants of aggregate homeownership rates, namely the population density, dummy for transition economies and young population ratio.

Table 3: Home Ownership and Informality

Dep. Var.: Ownership

	Low CRD	High CRD	Low CRBAN	High CRBAN	Low M2	High M2	Poor	Rich
Informal	0.94**	0.71**	0.58**	0.61**	0.62**	0.72**	0.93*	0.50**
	(0.45)	(0.34)	(0.27)	(0.24)	(0.30)	(0.31)	(0.26)	(0.21)
Inflation	2.60***	5.48*	1.64	5.74**	1.91	6.90*	3.57**	4.19**
	(1.29)	(1.92)	(1.52)	(2.11)	(1.48)	(2.20)	(1.64)	(2.10)
Informal · Inflation	-0.07**	0.19**	-0.14***	0.22**	-0.06**	0.19**	-0.10**	0.15**
	(0.03)	(0.09)	(0.07)	(0.10)	(0.03)	(0.07)	(0.05)	(0.07)
Pop. Dens.	0.05***	0.006*	0.001	0.006*	0.001	0.006*	0.07*	0.004*
	(0.03)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.02)	(0.001)
Transition	-9.09	-26.44*	-10.55	-22.03**	-8.94	-33.39*	1.02	-10.28
	(6.84)	(6.02)	(6.89)	(9.04)	(6.33)	(8.80)	(8.12)	(8.90)
Young Pop.	-0.02***	-0.01	-0.03*	-0.02***	-0.02**	-0.02	-0.03**	-0.02***
	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)
R-squared	0.23	0.32	0.21	0.29	0.20	0.33	0.33	0.22
Observations	33	34	33	34	33	34	33	34
F-Test	0.02	0.01	0.01	0.00	0.00	0.00	0.00	0.00

Robust standard errors are reported in parentheses. *, **, *** denote 1, 5 and 10% confidence levels, respectively. In all regressions a constant is also included but not reported.Transition refers to a dummy variable for Post-Socialist Transition economies.

The results that we present in Table 3 confirm the hypotheses we listed at the beginning of this section. Particularly, we observe that the rate of inflation significantly interacts with the relationship between informal sector size and the aggregate rate of homeownership: The rate of inflation strengthens the relationship between informality and homeownership in countries with developed private credit markets whereas it weakens it in countries where the credit markets are less developed.

3 A Two-Sector Model

In this section we develop a general equilibrium model with housing and consumption good markets to account for the aggregate empirical association between the informal sector size and homeownership rates that we present in figure 1. What we study is a two sector model with a consumption good production and a housing production. Both types of goods enter the utility of the economic agents. The key difference between our model and a standard two-sector RBC model with durable goods is that in our model a

distribution of consumption good producers exhibit varying degrees of informality. Informality increases the cost of investing for consumption good production and raises the demand for alternative methods of carrying capital over-time. In this respect, in our model the individual demand for owning a house rises with the level informal of production. We will investigate a set of qualitative properties building upon this theoretical intuition generated by the model.

3.1 The Environment

In the economy there is a continuum of households with measure M, who derive utility from consuming housing services and consumption good. To this end, each household optimizes consumption allocation according to the following preference specification

$$V_0 = \sum_{t=0}^{\infty} \beta^t U_t(c_t, h_t),\ 0 < \beta < 1,$$

where $U(.,.)$ is the period utility function that is strictly concave and twice differentiable in both *consumption good* c and the *housing good* h.

Consumption good production. There is a continuum of households in the economy with measure $N^C < M$, who have the means of producing the consumption good. Consumption good producers are differentiated from each other to the extent of "informality" of the production technology that they operate. Specifically, each consumption good producer operates formal and informal modes of a production technology which are specified as the following

$$y_{i,t}^F = A(k_{i,t}^F)^{\alpha}(n_i^F)^{1-\alpha},\ 0 < \alpha < 1 \quad (1)$$

$$y_{i,t}^I = A(k_{i,t}^I)^{\alpha}(n_i^I)^{1-\alpha}, \quad (2)$$

where for the producer i, y_i^F is the output from the formal production, and y_i^I is the output from the informal production which are perfect substitutes of each other. The formal and informal employment are denoted with n_i^F and n_i^I which are agent specific and $n_i^F + n_i^I = n$ for all i. In this formulation, n_i^I determines the intensity of a household's informal production which is exogenously given and distributed with a cumulative distribution function $G(n^I)$ among consumption good producers. The total factor productivity, A, of formal and informal modes of production are equal to each other. We make this assumption to isolate any effects of informality on macroeconomic variables that are channeled through

aggregate productivity.

This assumption allows us to derive an analytical solution without influencing our qualitative results. The key assumption of our model is that the stock of capital utilized in the consumption good production in period t, denoted by $x_{i,t}$ must be saved in period $t-1$. We assume that the size of the informal sector affects the ease of capital good transfer in between two periods via an investment cost function

$$c(x_{i,t+1}, n_i^I) = \theta n_i^I x_{i,t},\ \theta > 0. \tag{3}$$

In this functional form, the parameter θ measures the cost of carrying over the consumption good to the next-period as capital investment. The higher a household's informal employment the larger is the cost of capital investment. This assumption resembles the constrained investment associated with a large informal production size, also highlighted in Amaral and Quintin (2006), Antunes et al. (2007) and Elgin and Uras (2013).

Housing production. Housing stock is produced by the housing sector which consists of a continuum of households with measure N^H household - with $N^H = M - N^C$ - who have the means of converting their labor supply into the housing services using the following technology specification:

$$H_t = BN^H. \tag{4}$$

The parameter B measures the productivity of the housing sector. Since N^H and B are constants, the stock of houses in the economy is also time invariant. We work with a model, where the stock of houses is fixed, for the following reason: What we are interested in this model is that given there are some inefficiencies in the business capital investment associated with being informal, entrepreneurs with high informality would choose alternative methods of accumulating capital from one period to the other, such as demanding home-ownership. Since in our model the supply of houses is determined exogenously, the informality of consumption good producers does not raise the cost of housing investment. To put it differently, housing production is separated from consumption good production in our model. Informality affects doing business of a consumption good producer, hence the cost of investing for consumption good production. In this respect, informality induces the consumption good producer to purchase a home in order to ease up carrying capital from one period to another. The investment in next periods housing stock is done by housing producers. The efficiency of this sector is determined by parameter B (at equation 4). One could extend the current set-up to investigate the impact of informality on housing production (and

investment) as well, by letting B to be determined endogenously. Such an extension will not alter the qualitative findings from our paper though, because as we will delineate at propositions 3.1. and 4.1. the demand for homeownership of consumption good producers conditional on the level of informality - is independent from the efficiency of housing production.

Housing, similar to the consumption good, is a non-durable good. However different from the consumption good it can be purchased and stored from one-period to the next, or rented during a given period of time. This assumption allows us to capture the stylized feature of housing as a financial instrument. Specifically, on the one hand a house "purchased" in period t can be utilized in period $t+1$. We call households who purchase a house in period t to be consumed in period $t+1$ as *homeowners*. On the other hand, households who *rent* their homes in period t utilize the housing services in period t.

We assume that purchasing a house and becoming a homeowner has an additional cost relative to renting a house. Specifically, the price of a house, denoted by q_t equals to $r_t(1+\tau)$ where r_t is the rental rate of the house and $\tau > 0$ is an exogenously determined wedge between the cost of renting a house and purchasing it. Both r and q are denominated in terms of the consumption good. The parameter τ can be motivated with maintenance costs associated with owning a house and/or uncertainty about future housing prices which can deteriorate the value of owning a house today.

In our model the housing capital has the feature of a durable good that it depreciates fast, but it can be stored to transfer wealth in between any two periods. Similar to the housing capital, the business capital's depreciation rate is also assumed to be 100%. Comparable depreciation rates allows us to study the impact of cost of informality on investment decisions in housing and business capital. Alternatively, one can also assume a less than 100% depreciation rate for both business and housing capital. Such an assumption wouldn't affect our qualitative results but will come at the cost of loosing the closed form solutions, which allow us to investigate comparative statics regarding the impact of the size of informality and the monetary policy on equilibrium homeownership rates.

Timing of Events in any period t. The following list characterizes the sequence of events in any given period t.

1. House production takes place and housing market opens for rentals.

2. Housing consumption: Renters consume rented houses in period t, and homeowners consume the

houses purchased in period $t-1$.

3. Consumption good production and consumption good market opens and agents consume the consumption good.

4. Capital saving for period $t+1$'s consumption good production.

5. House production and housing market opens for housing purchases.

This timing of events imply that the consumption good savings and housing investment are substitutes for generating the capital input for consumption good production, which is going to be key for our general equilibrium analysis.

3.2 Equilibrium and Optimizing Behavior

Equilibrium. The general equilibrium of the economy is characterized by an infinite stream of housing prices, q_t and rental rates r_t at which consumption good and housing markets clear and households maximize their utility subject to their respective budget constraints.

Consumption good producer's problem. Consumption good producers' problem is stated as follows:

$$\max_{c_{i,t},h_{i,t},h^p_{i,t},x^I_{i,t+1},x^F_{i,t+1}} \quad \sum_{t=0}^{\infty} \beta^t U_t(c_{i,t}, h_{i,t}) \tag{5}$$

$$s.t. \quad c_{i,t} + x_{i,t+1} + c(x_{i,t+1}, n^I_i) + r_t h_{i,t} + q_t h^p_{i,t+1} \leq y^F_{i,t} + y^I_{i,t}. \tag{6}$$

The left-hand-side of (6) is the total expenditures of a consumption good producer i, which includes consumption good expenditures, investment for consumption good production of the next period, cost of saving capital in the form of business investment (associated with household specific intensity of informality), current period housing rentals (h) and housing purchases for the next period (h^p). The right-hand-side of (6) is the total income accruing from formal and informal modes of production.

House producer's problem. We assume that the house producer consumes the entirety of her flow income from rentals and housing purchases in every period. Therefore, the representative house producer's

problem is stated as:

$$\max_{c_t, h_t} \quad \sum_{t=0}^{\infty} \beta^t U_t(c_t, h_t), \tag{7}$$

$$s.t. \quad c_t + r_t h_t \leq q_t H_t^p + r_t H_t^r, \tag{8}$$

where at (8) the left-hand-side is her total expenditures, and the right-hand-side is the total income accruing from housing sales (H^p) and housing rentals (H^r).

Solution. Purchasing a house at the end of a period t and renting it at the beginning of period $t+1$ to another household generates a consumption good cash flow for the home-owner, which can be invested into the production technology. Hence, capital investment, k, and housing investment, h, are substitutes. Furthermore, since the cost of informality kicks in through the cost of accumulating capital, a consumption good producer's output - $y_{i,t} = y_{i,t}^F + y_{i,t}^I$ - simplifies to the following expression:

$$y_{i,t} = A k_{i,t}^{\alpha} n.$$

Therefore, we can re-write a consumption good producer's utility maximization problem as the following:

$$\max_{c_{i,t}, h_{i,t}, h_{i,t}^p, x_{i,t+1}} \quad \sum_{t=0}^{\infty} \beta^t U_t(c_{i,t}, h_{i,t}) \tag{9}$$

$$s.t. \quad c_{i,t} + r_t h_{i,t} + x_{i,t+1} + c(x_{i,t+1}, n^I) + r_t h_{i,t+1}^p + \tau r_t h_{i,t+1}^p \leq y_{it} \tag{10}$$

We denote the lagrange multiplier associated with a consumption good producer's budget constraint by $\lambda_{i,t}^c$ and the lagrange multiplier of house producer with λ_t^h. Taking first-order conditions at consumption good producer's problem yields:

$$c_t: \quad U_1(c_t, h_t) = \lambda_{i,t}^c, \tag{11}$$

$$h_t: \quad U_2(c_t, h_t) = r_t \lambda_{i,t}^c, \tag{12}$$

$$x_{t+1}: \quad \alpha A k_{i,t}^{\alpha-1} n \lambda_{i,t+1}^c = \lambda_{i,t}^c [1 + c'(k_{i,t+1}, n_i^I)], \tag{13}$$

$$r_t h_{t+1}^p: \quad \alpha A k_{i,t}^{\alpha-1} n \lambda_{i,t+1}^c = \lambda_{i,t}^c [1 + \tau]. \tag{14}$$

Similarly, taking first-order conditions at house-producer's problem yields:

$$c_t : \qquad U_1(c_t, h_t) = \lambda^c_{i,t}, \tag{15}$$

$$h_t : \qquad U_2(c_t, h_t) = r_t \lambda^c_{i,t}. \tag{16}$$

Using (13) and (14) together provides and expression that equates the cost and benefits of business investment:

$$c'(k_{i,t+1}, n^I_i) = \tau.$$

Using the linear functional form for the cost of capital accumulation; we can see that

$$\theta n^I_i = \tau \tag{17}$$

must hold to have an interior solution with both consumption good and housing good savings. The following proposition summarizes our key finding from this benchmark model, which also forms the basis for our first empirically testable hypothesis.

Proposition 3.1

1. *If $n^I_i > \frac{\tau}{\theta}$, household savings are channeled from one period to the next via housing purchases, and hence through homeownership.*

2. *If $n^I_i < \frac{\tau}{\theta}$, all savings are channeled via (business) consumption good investment.*

This proposition implies that the intensity of a household's informality increases its demand for homeownership.

For the rest of the analysis we concentrate on the steady-state equilibrium where c, k and h are invariant for all households in the economy. To characterize the steady-state, we evaluate (11) and (13) at a stationary equilibrium and show that

$$\frac{1 + \beta\theta n^I_i}{\beta} = \alpha A k_i^{\alpha-1} n \tag{18}$$

if the intensity of a household's informal production satisfies $n^I_i < \frac{\tau}{\theta}$. Similarly, using (11) and (14) together

shows that

$$\frac{1+\beta\tau}{\beta} = \alpha A k_i^{\alpha-1} n \tag{19}$$

if the intensity of a household's informal production satisfies $n_i^I > \frac{\tau}{\theta}$.

Remarks. Equation (18) shows that as an household's informality increases at the margin, the size of his total capital investment and the consumption good produced by the same household decreases. Equation (19) reveals that in an economy with a large informal sector, reductions in the overall level of informality (captured by the shape of the distribution function $G(.)$) stimulates the capital stock and the total output produced in the aggregate.

Simple comparative statics at the steady-state shows that as the aggregate size of the informal employment rises in an economy, which is governed by the expected value of informal production intensity, $E[n^I]$, the capital stock and the aggregate output produced shrinks. In addition to this, following up on the result derived in proposition 3.1, the rise in the aggregate informality increases the demand for housing purchases and hence home-ownership. Hence, the first key hypothesis of our paper is as the following.

H_0**:** *Ceteris paribus, a larger informal sector size implies a higher aggregate demand for homeownership.*

4 A Model with a Cash-In-Advance Constraint

In this section we augment our benchmark model with a cash-in-advance constraint and investigate the effects of monetary policy and the implied inflation rate on explaining the relationship between the size of the informal sector and homeownership. In order to do so we assume that consumption good purchases, a fraction of investment in the form of consumption good savings (business investment) and housing investment are constrained with the monetary balances carried over from the previous period as also assumed in Dotsey and Sarte (2000). We denote the general price level of the society with p_t, and governments real monetary transfers to consumption (and also housing) producers with $\frac{v_t}{p_t}$. The cash-in-advance implies

that a consumption good producer solves:

$$\max_{c_{i,t},h_{i,t},h^p_{i,t},x_{i,t+1},m^d_{i,t+1}} \sum_{t=0}^{\infty} \beta^t U_t(c_{i,t}, h_{i,t}) \tag{20}$$

$$s.t. c_{it} + r_t h_{it} + \psi_x(x_{i,t+1} + c(x_{i,t+1}, n^I)) + \psi_h(r_t h^p_{i,t+1} + \tau r_t h^p_{i,t+1}) \leq \frac{m^d_{i,t}}{p_t} \tag{21}$$

$$c_{i,t} + r_t h_{i,t} + x_{i,t+1} + c(x_{i,t+1}, n^I) + r_t h^p_{i,t+1} + \tau r_t h^p_{i,t+1} + \frac{m^d_{i,t+1}}{p_t} \leq \frac{m^d_{i,t} + v_t}{p_t} + y_{it} \tag{22}$$

The inequality (21) is the cash-in-advance constraint. The LHS of this inequality is the total expenditures that is subject to the cash-in-advance constraint which includes consumption and ψ_c fraction of the business investment and ψ_h fraction of the housing purchases. The relative size of ψ_h and ψ_c represents the (relative) financial development of level of household finance markets: If $\psi_h < \psi_c$, then only a small fraction of housing purchases are subject to the cash-in-advance constraint. The RHS of (21) contains only the real money-balances carried over from the previous period. The variable m^d_t is agent's money demand and p_t is the general price level in the economy which includes house and consumption good prices. Budget constraint (22) differs from (10) as the LHS of (22) now contains the real monetary balances carried over period t to $t+1$ and the RHS includes the current real monetary balances and the cash transfers from the government. Cash transfers determines the inflation rate in the economy - as standard in cash-in-advance models.

In a similar fashion, the house producer solves:

$$\max_{c_t,h_t,m^d_{t+1}} \quad \sum_{t=0}^{\infty} \beta^t U_t(c_t, h_t) \tag{23}$$

$$s.t. \quad c_t + r_t h_t \leq \frac{m^d_t}{p_t} + q_t H^p_t + r_t H^r_t \tag{24}$$

$$c_t + r_t h_t + \frac{m^d_{t+1}}{p_t} \leq \frac{m^d_t + v_t}{p_t} + q_t H^p_t + r_t H^r_t \tag{25}$$

4.1 Equilibrium and Optimizing Behavior

Equilibrium. In addition to the equilibrium conditions listed in section 3, in an economy with binding cash-in-advance (CIA) constraints money market clearance should also hold in an equilibrium. Denoting

the supply of money in any period with $\bar{M}_t$, the money market clearance is stated as:

$$\bar{M}_t = \int_{N^C} m^d_{t,i} di + N^H m^d_{t,i}.$$

Money supply grows at the exogenous rate z_t through end-of-period cash injections to households, v_t as specified above, such that:

$$\bar{M}_{t+1} = z_t \bar{M}_t = \bar{M}_t + N^C v_t + N^H v_t.$$

Solution. We denote the lagrange multipliers associated with budget constraints with λ as in the previous section. The Lagrange multipliers associated with CIA constraints are denoted with $\mu^c_{i,t}$ and μ^h_t respectively for consumption good and house producers. First order conditions at consumption good producer's problem yield:

$$c_t : \quad U_1(c_t, h_t) = \lambda^c_{i,t} + \mu^c_{i,t} \tag{26}$$

$$h_t : \quad U_2(c_t, h_t) = r_t \lambda^c_{i,t} + \mu^c_{i,t} \tag{27}$$

$$x_{t+1} : \quad \alpha A k^{\alpha-1}_{i,t} n \lambda^c_{i,t+1} = (\lambda^c_{i,t} + \psi_x \mu^c_{i,t})[1 + c'(k_{i,t+1}, n^I_i)] \tag{28}$$

$$r_t h^p_{t+1} : \quad \alpha A k^{\alpha-1}_{i,t} n \lambda^c_{i,t+1} = (\lambda^c_{i,t} + \psi_h \mu^c_{i,t})[1 + \tau] \tag{29}$$

$$m^d_{i,t+1} : \quad \lambda^c_{i,t} = \lambda^c_{i,t+1} + \mu^c_{i,t+1} \tag{30}$$

Similarly taking first-order conditions at house-producer's problem yields:

$$c_t : \quad U_1(c_t, h_t) = \lambda^c_{i,t} \tag{31}$$

$$h_t : \quad U_2(c_t, h_t) = r_t \lambda^c_{i,t} \tag{32}$$

$$m_{t+1} : \quad \lambda^h_{i,t} = \lambda^h_{i,t+1} + \mu^h_{i,t+1} \tag{33}$$

Solving (28) and (29) together yields:

$$1 + \theta n^I_i = (1 + \tau) \left[\frac{\lambda^c_{i,t} + \psi_h \mu^c_{i,t}}{\lambda^c_{i,t} + \psi_c \mu^c_{i,t}} \right] \tag{34}$$

As in standard Cash-In-Advance models, the rate of inflation is determined by z_t. The policy parameter z

in turn determines the size of the of the CIA lagrange multipliers μ. Specifically, The higher z the larger is μ for all households.

Applying simple comparative statics at equation (34) provides us with the result summarized in the following proposition which forms the basis for our second empirically testable hypothesis.

Proposition 4.1

1. *There is a threshold η^I such that if $n_i^I > \eta^I$, a consumption good producer saves for next-period's production via housing investment.*
2. *If $\psi_h > \psi_c$, the threshold η^I rises with the rate of inflation.*
3. *If $\psi_h < \psi_c$, the threshold η^I goes down with the rate of inflation.*

Remarks. The key conclusion that we draw from proposition 4.1 relates the sensitivity of homeownership-informality nexus to the rate of inflation. Specifically, if $\psi_h > \psi_c$, as the inflation rate rises the effect of informality on homeownership diminishes: For $\psi_h > \psi_c$, the fraction of informal producers who invest in housing declines as inflation rate rises. This result implies that if a household does not have access to mortgage markets and have to finance housing purchases via monetary holdings, the rate of inflation makes the cash-in-advance constraint bind, increases the cost of housing investment relative to consumption good investment and weakens the relationship between the informality and homeownership. In other words, even households with low informal production intensity switch to invest in housing as inflation rises as long as access to mortgage is not costly ($\psi_h < \psi_c$). This conclusion allows us to formulate the hollowing empirically testable hypothesis.

H_0**:** *Controlling for the development level of household finance markets, in countries with a higher rate of inflation the sensitivity of homeownership rates on informal sector size is higher.*

Our key theoretical result is also consistent with the findings of Mian and Sufi (2011), which argues that homeownership protects against rental shocks. Our framework suggests that informality makes it hard to use future income to pay rents, and shocks to future income - for instance due to unexpected inflationary changes would incentivize homeownership among informal households in order to avoid rent payment difficulties. Furthermore, our key mechanism that volatility in monetary policy should increase homeownership rates sensitivity to being informal is an empirically plausible argument. In developing

countries, where the size of the informality is large, households tend to take inflationary expectations into account in their economic decisions due to weak institutions that induce governments not to commit to a long-run monetary policy. This is especially true when it comes to choices in the housing market, because rent payments are usually indexed based on the inflation rate. This gives rise for our economic mechanism to be an empirically plausible one for a representative agent of informal production: Informality makes it hard to pay current nominal rents using future nominal income in the face of rising inflation. This economic channel incentivizes the informal household to undertake one of the following two actions: (1) reduce informality and/or (2) reduce rental payments. Consistent with action (1), Aruoba (2010) provides an optimal policy recommendation regarding the use of high inflation rates in curbing informal sector production. We focus on action (2) and suggest a novel mechanism that informal households might cut the demand for renting houses and increase their homeownership rates when inflationary expectations are high for the near future. Finally, our model is consistent with the findings of Aruoba, Davis and Wright (2012) as well, who suggest a theoretical impact of inflation on home-production and in turn on homeownership rates. There is a close interaction between informality and production at home, which reinforces the theoretical and empirical plausibility of our results.

5 Conclusion

In this paper, we investigated the effects of informality of production on demand for homeownership and the contribution of monetary policy in explaining this relationship. We developed a benchmark model of housing markets and argued that the informal production intensity of a household raises the demand for owning a home when informality is associated with constrained business investment. We also showed that monetary policy has non-trivial effects on explaining the nexus between informal sector size and the rate of aggregate homeownership. Specifically, we showed that a rise in inflation rate weakens the sensitivity of homeownership to the intensity of informal production when households' home purchases are constrained with their cash-holdings. When housing purchases are not subject to cash constraints, the rate of inflation strengthens the effects of informality on homeownership. We tested the key findings from our model using cross-country data and found some empirical support for our theory.

There are important policy implications that one can draw upon from our work. Most importantly, we highlight a novel monetary transmission channel and show that the interactions between informal sector size and homeownership rates are important in determining the effects of monetary policy on real economy.

Therefore, our theoretical findings show that monetary growth influences the demand for housing in an economy. However, we also show that the implications of monetary policy are non-trivial. For informally employed households, monetary growth and the demand for housing are positively related as long as the housing finance markets are developed well enough. Since the housing boom-bust cycles are extremely crucial for an economy's aggregate welfare, as we have experienced over the years that led the world economy to the Great Recession, our theoretical and empirical findings point out a novel and important interaction between the conduct of monetary policy and the performance of housing markets.

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Appendix

List of Countries in the Cross-Section:

Algeria, Argentina, Armenia, Australia, Austria, Belgium, Bolivia, Brunei, Bulgaria, Cambodia, Canada, Chile, Colombia, Croatia, Czech, Denmark, Ecuador, Egypt, Estonia, Fiji, Finland, France, Germany, Guyana, Haiti, Honduras, Hong Kong, Hungary, India, Indonesia, Japan, Kazakistan, South Korea, Latvia, Lithuania, Macedonia, Mali, Malta, Mauritius, Mexico, Moldova, Morocco, Netherlands, New Zealand, Norway, Oman, Panama, Paraguay, Peru, Poland, Portugal, Qatar, Romania, Russia, Singapore, Slovakia, Slovenia, Spain, Sudan, Sweden, Switzerland, Thailand, Tunisia, Turkey, USA, Uruguay, Venezuela

Table A1: List and Description of Variables in the Empirical Analysis

Name	Explanation	Source
Ownership	Average % of ownership of the house one lives in	Fisher and Jaffe (2003)
Informal	Informal Sector Size (% GDP)	Elgin and Oztunali (2012)
Pop Dens.	Population per square km. land area	World Development Indicators
GDP Per-capita	Real GDP per-capita (2005 $)	Penn World Tables 8.0
Gov. Sp.	Government Final Expenditures (% GDP)	Penn World Tables 8.0
Young Pop.	% of population under 15	World Development Indicators
Gini	Gini Index	World Development Indicators
Law	Law and Order Index	International Country Risk Guide
Inflation	Annual % change in consumer prices	World Development Indicators
CRD	Credit provided to private sector (% GDP)	World Development Indicators
CRBAN	Credit provided by the banking sector (% GDP)	World Development Indicators
M2	Money and quasi money (M2) as % GDP	WDI

All variables are obtain for year 2000, since the homeownership variable is only available for this particular year.