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Firm Creation, Entry Costs, and House-Price Volatility*

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Abstract

Recently, reforms aimed at reducing the regulatory barriers to firm creation have gained significant prominence in economies beyond the US. Such reductions in firm-entry costs are associated with greater levels of average firm creation. Motivated by these facts and given growing evidence linking firm formation and housing-market dynamics, we exploit cross-country variation in new firm density (NFD) and examine the potential relationship between the average level of NFD and cyclical house price-volatility. We find a significant, positive, and robust cross-country relationship between these two variables. A business cycle model with endogenous firm entry, housing, and housing-finance constraints quantitatively replicates this new stylized fact. In the model, greater average firm entry is associated with higher average house prices. This makes the cost of housing loans more sensitive to housing-finance shocks, leading to sharper credit and lending-spread fluctuations, and ultimately sharper house price fluctuations. The model's mechanisms are corroborated by the data.

JEL Classification: E30, E32, E44, R21

Keywords: Endogenous firm entry, entry costs, housing price dynamics, financial frictions and shocks, business cycles.

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1 Introduction

In recent years, reforms aimed at reducing the regulatory barriers to firm creation have taken center stage across several countries beyond the US. Indeed, per World Bank Doing Business data for 2018, out of 9 categories of business-environment reforms, reducing the costs of starting a business stand out as the most prominent one amid increasing evidence suggesting that lower regulatory firm-entry costs are strongly associated with greater levels of firm creation (Djankov, et al., 2002; Klapper, Laeven, and Rajan, 2006; Klapper and Love, 2014). Importantly, a growing literature centered around the US has highlighted a positive link between the cyclical behavior of firm formation and house prices (Decker, 2015; Davis and Haltiwanger, 2019). Motivated by the existence of this cyclical relationship between firm creation and house prices in the US and the potential level changes in new firm creation across the world driven by reductions in firm-creation costs, this paper addresses the following question: Is there a relationship between the average level of new firm creation and house-price volatility? The answer to this question is important not only because of the noted prominence of recent reforms that prioritize reducing firm entry costs and bolstering the level of new firm creation in countries beyond the US, but also because understanding the factors that can contribute to differences in the cyclical volatility of house prices across economies is critical given the macroeconomic relevance of housing around the globe.

To address our research question, we begin with a stylized empirical analysis that reveals a robust positive cross-country relationship between average new firm density (NFD) and the cyclical volatility of real house prices relative to GDP. Specifically, our baseline estimates suggest that a 1 standard deviation increase in NFD is associated with nearly a 16-percent increase in relative house-price volatility. This link is consistently present under a host of control variables generally associated with cross-country differences in house-price volatility. Moreover, further analysis suggests that there may be a causal relationship from NFD to relative house-price volatility. Of note, our analysis does not include the US for two main reasons. First, our research question is motivated by understanding the broad impact of reform initiatives beyond the US. Second, the only comprehensive dataset that offers a comparable measure of new firm density-a proxy for new firm creation-for a large sample of countries that goes beyond advanced economies does not include the US.[1]

To shed light on how such causal relationship could emerge, and the economic mechanisms behind this link, we build a tractable business cycle model with endogenous firm entry, housing, and housing-finance constraints. We show that our framework can successfully generate a positive relationship between the volatility of house prices (relative to GDP) and average NFD that is *quantitatively* in line with the data. Moreover, our model-based analysis suggests that housing-finance shocks are critical for *quantitatively* generating an empirically-consistent link between average NFD and house-price volatility.

To analyze the link between NFD and house-price volatility in our model, we generate changes in average (or steady-state) NFD over the range observed in our country sample by exogenously changing firms' sunk firm-entry costs, which embody the extent of regulatory firm-entry costs. The quantitative change in these costs is disciplined by these costs' data counterpart. Our model generates a negative relationship between firm entry costs and NFD that is quantitatively consistent with the data. In turn, steady-state changes in average NFD are associated with changes in house-price volatility.

The economics behind our results are as follows. A reduction in firms' sunk entry costs bolsters average (or steady-state) firm creation. Greater firm creation increases physical capital and labor demand, and results in greater labor income and consumption for households, as well as higher average output. The resulting rise in household income boosts housing demand and leads to higher average house prices, both in absolute terms and relative to income (of note, this last fact is equivalently reflected in a positive relationship between percent deviations in steady-state new firm entry in a given economy from mean new firm entry based on the steady-state NFD range we consider, and percent deviations of real house prices in a given economy from mean real house prices based on the steady-state NFD range we consider).

Importantly, higher average house prices make housing purchases more expensive in the economy, implying that households who borrow to purchase housing now need larger average

[1] Another benefit of our data is that average NFD across countries exhibits a non-trivial degree of variation in the country sample we consider, where this variation is important and necessary to identify whether a link between NFD and house price dynamics exists in the data. Variation in *average* firm creation rates *across states within the US*, which can in principle be used for a *within-country* analysis, is considerably lower, thereby making identification much less clear-cut.

housing loans for a given amount of new housing. Critically, this fact makes these households' demand for housing credit more sensitive to housing-finance shocks. The greater sensitivity of housing loans feeds into the demand for credit and borrowing rates—a component of borrower households' cost of house purchases—which in turn makes credit and lending spreads more sensitive to these shocks as well. The responsiveness of credit and lending spreads to housing-finance shocks ultimately leads to greater house price volatility amid greater average new firm entry. We provide cross-country empirical evidence on NFD, average house prices, and the volatility of credit and lending spreads for our sample that broadly corroborates this mechanism. Indeed, in our sample, greater average new firm entry is, on average, associated with: (1) greater average real house prices, or, more intuitively, a positive relationship between percent deviations in new firm entry in a given economy from mean new firm entry and percent deviations of real house prices in a given economy from mean real house prices (see Figure A10 in Appendix A.8 for the data counterpart); (2) greater volatility in bank credit; and (3) greater volatility in lending spreads.

The mechanism just described is also complemented by a secondary mechanism that works as follows. In an environment with endogenous firm entry and housing, both individual-firms and housing represent assets to entrepreneur households. The view of firms as assets is a well-known feature of macroeconomic models with endogenous firm entry rooted in the seminal work of Bilbiie, Ghironi, and Melitz (2012) (henceforth BGM). With this mind, greater steady-state firm entry implies greater firm competition, which puts downward pressure on steady-state individual-firm profits. A reduction in these profits makes the value of entrepreneur households' assets, among which are firm-profits, more sensitive for a given set of shocks. This sensitivity spills over into the demand for other assets in the economy, including housing, thereby further contributing to more volatile house prices. We note, though, that the first mechanism unambiguously dominates the second one from a quantitative standpoint.

More broadly, our results suggest that greater average firm entry represents a powerful amplification mechanism of housing-finance shocks. The combination of housing finance constraints and these shocks can shed light on the positive empirical link between NFD and house price volatility in the data under a calibration with a parsimonious and plausible shock specification. Importantly, we show that this empirical fact cannot be *quantitatively* explained by other relevant shocks, such as housing demand shocks or shocks that reflect global liquidity movements, suggesting that shocks that *directly* affect domestic housing finance markets are important for better understanding differences in house price fluctuations across countries.

The relevance of house-price dynamics in aggregate fluctuations took center stage during the GFC, with such relevance extending beyond the US. For example, existing work has found that housing shocks in the US can propagate to other economies (Cesa-Bianchi, 2013), and that housing price dynamics differ in advanced and emerging economies (Cesa-Bianchi, Cespedes, and Rebucci, 2015).[2] Recent work also focuses on the impact of housing markets on entrepreneurship and firm creation in specific economies (Adelino, Schoar, and Severino, 2015; Decker, 2015; Schott, 2015; Schmalz, Sraer, and Thesmar, 2017), as well as on the evolution of economic dynamism as reflected in firm startup rates and firm creation (see Decker, Haltiwanger, Jarmin, and Miranda, 2014, for the US; and Calvino et al., 2015, for select cross-country OECD evidence).

Our work contributes primarily to existing empirical and theoretical work on cross-country differences in housing market dynamics (Igan and Loungani, 2012; Hirata, Kose, Otrok, and Terrones, 2012; Cesa-Bianchi, Cespedes, and Rebucci; 2015) and to the growing literature on endogenous firm entry and macroeconomic dynamics.[3] To the best of our knowledge, our work is the first to present a business cycle model with endogenous firm entry in the spirit of BGM with housing and housing finance constraints. Importantly, in contrast to studies that analyze how housing and finance—in particular, how housing-based collateral facilitates credit access—affects firm formation (Adelino, Schoar, and Severino, 2015; Decker, 2015; Schott, 2015; Schmalz, Sraer, and Thesmar, 2017; among others), we focus on a complementary relationship, mainly on how differences in average firm formation across countries have implications for housing market dynamics. Moreover, firm-creation costs fall

[2]See Ng and Feng (2016) for the link between news shocks and housing price dynamics in small open economies; Cesa-Bianchi, Ferrero, and Rebucci (2016), for work on the amplification role of housing prices in response to capital inflows; and Kydland, Rupert, and Šustek (2016) for the relevance of the mortgage structure for housing dynamics.

[3]Hirata, Kose, Otrok, and Terrones (2012) focus specifically on housing cycle synchronization across countries, and the role of global financial and interest rate shocks, rather than on cross-country differences in housing-market dynamics.

within the realm of *domestic* factors that may impact house-price volatility, where these factors have received little attention. Indeed, existing studies of cross-country differences in house-price fluctuations have primarily focused on the relevance of *external* factors, such as global liquidity movements and capital inflows, and their heterogeneous transmission across countries (Cesa-Bianchi, Cespedes, and Rebucci, 2015; Cesa- Bianchi, Ferrero, and Rebucci, 2016).

All told, our work uncovers an important domestic factor that further contributes to understanding *cross-country* differences in house-price volatility, and provides a plausible economic mechanism corroborated by the data that can quantitatively rationalize the cross-country link between NFD and house-price volatility. Moreover, the fact that our model suggests that higher average NFD implies *both* higher NFD volatility *and* house-price volatility reveals a new channel that can be a driving force behind the link between firm formation and house price dynamics established for the US by earlier literature.

The rest of the paper is structured as follows. Section 2 presents new evidence on average NFD and the cyclical volatility of house prices. Section 3 presents the model. Section 4 presents our main findings, discusses the intuition behind our results, presents evidence corroborating the model's main mechanisms, and summarizes a series of robustness checks. Section 5 concludes.

2 Empirical Background

This section uses cross-country data and presents evidence of a robust positive relationship between average new firm density (henceforth NFD)—a proxy of firm entry—and the volatility of real house prices relative to the volatility of real GDP (that is, the relative volatility of house prices). Moreover, we also characterize this relationship *conditional on other factors that may be associated with the cyclical variability of house prices* to highlight the significance of this link, and a stylized analysis of causality suggests causality from NFD to house-price volatility, but not the reverse.

2.1 Data

Our country sample depends on data availability pertaining to our two main variables of interest, real house prices at a quarterly frequency and new firm density (NFD).

NFD is a *comparable measure of firm creation across countries* obtained from the World Bank Entrepreneurship Survey. This variable is commonly used for cross-country analyses of entrepreneurship and the business environment (see, for example, Klapper and Love, 2014). In particular, NFD is measured by the number of newly-registered, formal-sector firms with limited liability (or LLC) per 1000 individuals ages 15-64. Of note, this variable is a flow: it focuses solely on newly-registered firms and *not* on the stock of existing firms. NFD is available at a yearly frequency from 2006 to 2016. We obtain average NFD by taking the average of NFD over the period 2006-2016 for each country in our sample, which circumvents the presence of secular trends in NFD in some economies (see Figures A1 through A3 in Appendix A.2 for time series for NFD by country).[4] We briefly discuss the advantages and limitations of using NFD further below.

Real house prices are available at a quarterly frequency from the Bank for International Settlements (BIS) (period coverage varies by country). We construct the relative volatility of real house prices by obtaining the cyclical components of real house prices and real GDP for each country using an HP filter with smoothing parameter 1600. We then compute the ratio of the standard deviation of the cyclical component of the log of real house prices to the standard deviation of the cyclical component of the log of real GDP. For completeness and to confirm that our results are insensitive to alternatives detrending methodologies, we compute the same second moments using detrended data based on first differences and show that our main findings remain unchanged (See Table A4 in the Appendix). Our baseline analysis focuses on the period 2000Q1-2016Q4 (a compromise between having long-enough time series for house prices and also accounting for the fact that NFD is only available starting in 2006), but we also explore alternative sample periods including 1990Q1-2016Q4,

[4] The majority of countries in our sample have observations for all years. Only a very small subset of countries has missing values for particular years. This, however, is not an issue as we consider *average* NFD as our main measure of firm entry. We show that using NFD in 2006 as our main measure of NFD does not change any of our main findings. See http://www.doingbusiness.org/data/exploretopics/entrepreneurship and http://econ.worldbank.org/research/entrepreneurship for more details on NFD.

for which data for several countries is available, and 2006Q1-2016Q4, which encompasses the period covered by NFD (more on this below).

After removing outliers based on both the relative volatility of house prices and average NFD using standard techniques, our *baseline country sample* is comprised of 50 economies: Austria, Belgium, Brazil, Bulgaria, Chile, Colombia, Croatia, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Iceland, India, Indonesia, Ireland, Israel, Italy, Japan, Korea, Latvia, Lithuania, Luxembourg, Macedonia, Malaysia, Malta, Mexico, Morocco, Netherlands, New Zealand, Norway, Peru, Philippines, Poland, Portugal, Romania, Russia, Serbia, Singapore, Slovak Republic, Slovenia, Spain, Sweden, Switzerland, Thailand, Turkey, and United Kingdom (time coverage for real house prices varies by country).[5] In this country sample during our baseline time span of 2000Q1-2016Q4, the average relative volatility of house prices is 2.21 and average NFD is 4.40.

In addition to our main variables of interest, our baseline empirical analysis considers a host of other country-specific variables that related literature highlights as relevant factors associated with house-price volatility.[6] Specifically, as a baseline, we consider the following country-specific variables: the share of the population with a loan for a home purchase (*Loan for Home Purchase*); the average volatility of the quarterly inflation rate (*Inflation Volatility*), the cyclical correlation between global liquidity from banks and the country's real GDP (*Corr(Global Liquidity,GDP)*), average household credit as a share of total (that is, household and firm) credit (*Household Credit Share*), and a dummy variable that specifies whether the country is an advanced economy following standard IMF classification criteria.[7] We discuss how additional empirical specifications using alternative sets of controls, different

[5]The outliers excluded from our baseline sample are Australia, Cyprus, Hong Kong, and South Africa (these countries exhibit either very high relative house price volatility, very high NFD, or both relative to the other countries with available data). Canada only has observations for 2015 and 2016 and as such is excluded from our baseline sample. However, we note that including Canada in our analysis does not change any of our main conclusions. Finally, note that our measure of NFD from the World Bank dataset is not available for the US. While it would be possible to construct a measure of new firm entry using US Census data, it would not be immediately comparable to the World Bank's NFD measure. As such, the US is not included in our analysis.

[6]The details of each of these variables is presented in the Data Appendix.

[7]All these variables are averaged over the relevant sample period based on data availability. Using total global liquidity instead of global liquidity from banks does not change our main findings. Note that we cannot include global liquidity itself as a control since, by construction, there is a single time series for global liquidity for all economies (hence our use of the cyclical correlation of global liquidity with each economy's real GDP). See the Data Appendix for more details.

detrending methodologies, and alternative time periods among other robustness checks affect our main findings after presenting our baseline findings.

A Note on NFD and Alternative Measures We choose the World Bank Entrepreneurship Survey's NFD measure for two reasons. First, it is readily comparable across countries. Second, it is available for a large set of countries with quarterly data on house prices, which allows us to maximize the number of country observations in our analysis. Of course, one limitation of NFD is that, since this measure is based on new firm *registrations*, *in principle*, NFD may not *explicitly* measure firm entry or new firms. However, it does provide a reasonable cross-country, comparable proxy for *firm creation* if we consider registration as a necessary condition for firms to operate within the institutional framework of a country. Importantly, we note that per World Bank Enterprise Survey data, roughly 90 percent of surveyed firms in our country sample began operations as formal firms (per standard definitions of firm formality, formal firms are those that are registered with local or tax authorities). This implies that firm registration was a necessary step for their creation. Given this important fact, we can conclude that NFD provides a reasonable measure of new (formal-)firm entry.[8] Of note, other potential measures of new firm entry include, for example, annual firm entry rates and total employment in new firms. An important disadvantage of these alternative measures is that they are only available for a very select set of economies; as such, adopting them in our analysis would severely restrict the number of observations in our sample.[9] We revisit the potential limitations of NFD and ways to address these limitations as part of our robustness analysis further below.

Before moving forward, we note that the NFD data we use is, to the best of our knowledge, the largest and most comprehensive dataset that offers a *comparable* measure of new firm creation *across a large set of countries beyond a select number of advanced economies.*

[8]Some countries—especially developing and emerging economies—may exhibit greater shares of unregistered firms, thereby making NFD a less reliable proxy of firm creation. We discuss this issue as part of our robustness analysis, where we control for different measures of informality (the majority of which is associated with unregistered, informal-sector firms) in each country and show that our main results remain unchanged.

[9]Calvino et al. (2015) provide comparable data on firm startup rates across countries, but these data are only available for 14 economies, all of which are developed. We note, though, that their measure of firm startup rates is highly correlated with NFD for the economies for which both measures are available.

Unfortunately, this dataset does not include the US That said, while our theoretical analysis is motivated by the stylized empirical findings based on a sample of economies that does not include the US outlined in this section, the nature of our theoretical results speak broadly to the relationship between NFD (whose levels are affected by reforms that affect firm entry costs) and relative house-price volatility, and not to a country or group of countries in particular.

2.2 Empirical Specification and Baseline Results

In this section, we explore the relationship between NFD and the volatility of real house prices relative to the volatility of real GDP across countries using several specifications. The first issue that we explore is the extent to which differences in NFD contribute to differences in cyclical relative house-price volatility across countries. Therefore, as a benchmark we implement the relative volatility of house prices as the dependent variable and NFD as an explanatory variable. *Of note, throughout the remainder of the paper, NFD is short-hand for average NFD—that is, NFD averaged over the period the measure is available, 2006-2016—unless otherwise noted.*

To do so, we run the cross-section OLS regression:

$$\sigma_{Q_i} = \beta_0 + \beta_1 NFD_i + \beta_2 \mathbf{X_i} + \varepsilon_i, \tag{1}$$

where: σ_{Q_i} is the volatility of real house prices *relative* to the volatility of real GDP in country i (*that is, the relative volatility of house prices and not the absolute volatility of house prices*); NFD_i is the NFD measure in country i; $\mathbf{X}_i$ is a vector of country-specific control variables; and ε_i is an error term. We implement this regression as a benchmark using data for the period 2006Q1-2016Q4, which is the period over which we have overlapping data on NFD and house prices. Of note, as discussed further below, our results are robust to alternative time spans that include house-price data prior to 2006, which is worth highlighting since the period 2006Q1-2016Q4 includes the GFC.

Table 1: Relative Volatility of House Prices and Average New Firm Density

Dependent Var.	$\sigma_{Q,2006-2016}$	$\sigma_{Q,2000-2016}$	$\sigma_{Q,1990-2016}$
Ave. New Firm Density	0.0838**	0.0870**	0.0707**
	(2.17)	(2.04)	(2.04)
Constant	1.730***	1.824***	1.872***
	(7.84)	(7.37)	(7.88)
Adjusted R^2	0.079	0.072	0.045
Observations	50	50	51

t statistics in parentheses. Standard errors are heteroskedasticity-robust.
$^*p < 0.10$, $^{**}p < 0.05$, $^{***}p < 0.01$

Sources: World Bank Entrepreneurship Survey and Bank of International Settlements. Notes: The relative volatility of house prices for a given country is computed as the volatility of HP-filtered real house prices divided by the volatility of HP-filtered real GDP for that country, using a smoothing parameter of 1600. Average new firm density (NFD) for each country is given by new firm density averaged over the period 2006-2016. See the Data Appendix for details regarding data sources, country sample, and definitions.

Table 2: Relative Volatility of House Prices (2006Q1-2016Q4) and NFD in 2006 vs. Reverse Causality

Dependent Var.	$\sigma_{Q,2006-2016}$	NFD_{2016}	NFD_{2016}	NFD_{2016}
New Firm Density 2006	0.0865**			
	(2.65)			
$\sigma_{Q,2006-2016}$		1.012		
		(1.42)		
$\sigma_{Q,2000-2016}$			0.939	
			(1.33)	
$\sigma_{Q,1990-2016}$				0.867
				(1.25)
Constant	1.640***	3.065*	3.130*	3.416**
	(8.38)	(1.94)	(1.97)	(2.19)
Adjusted R^2	0.092	0.027	0.028	0.018
Observations	47	48	48	49

t statistics in parentheses. Standard errors are heteroskedasticity-robust.
$^*p < 0.10$, $^{**}p < 0.05$, $^{***}p < 0.01$

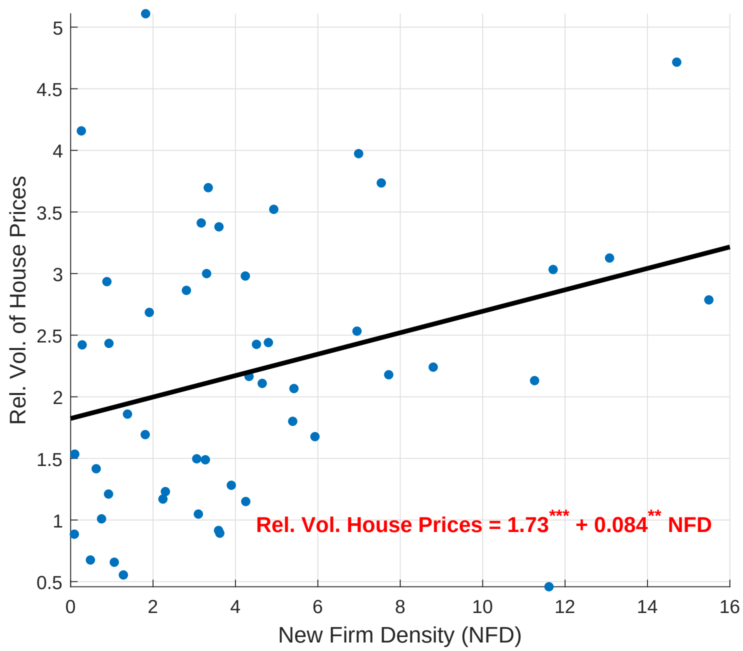
Sources: World Bank Entrepreneurship Survey and Bank of International Settlements. Notes: The relative volatility of house prices for a given country is computed as the volatility of HP-filtered real house prices divided by the volatility of HP-filtered real GDP for that country, using a smoothing parameter of 1600. NFD denotes New Firm Density. See the Data Appendix for details regarding data sources, country sample, and definitions.

The first column of Table 1 presents a preliminary set of results from running equation (1) without any country-specific control variables other than average NFD. The coefficient on NFD is significant at the 5-percent level. To understand the economic significance of our findings, recall that in our country sample, average relative house-price volatility is 2.1 and average NFD is 4.40 new firms per 1000 individuals. Then, for the average country in our sample, a 1 standard deviation increase in the level of NFD is associated with a nearly 16-percent increase in the relative volatility of house prices. To see this, recall that as noted in the Introduction, our model is able to successfully reproduce the *quantitative* relationship between NFD and relative house-price volatility. As such, to put our empirical results in more context, from a model perspective and as related to other house-price dynamics, we note the following: as shown in Figure 4 in Section 4, in our benchmark calibration (which, again, reproduces the data's empirical relationship between NFD and house-price volatility) a 1 standard deviation increase in aggregate productivity is associated with (only) slightly over a 2 percent deviation of house prices from steady state. Therefore, the in relative house-price volatility due to a change in NFD in the data is non-trivial in absolute terms and also relative to other house-price statistics.

The second and third columns of Table 1 show results from the same regression but now using the period 2000Q1-20016Q4 to calculate the relative volatility of house prices (second column), and the period 1990Q1-20016Q4 to calculate the relative volatility of house prices (third column). In both cases, the coefficient on NFD continues to be significant at the 5-percent level and only changes marginally. *Then, given these results and for the purposes of robustness, we focus on the period 2000Q1-2016Q4 beyond this empirical section unless otherwise noted.*

Figure 1 presents a scatter diagram of the data used in our benchmark regression using this data span (second column of Table 1) along with the implied linear prediction. Importantly, the purpose of our paper is to develop a theoretical understanding of how this relationship between relative house-price volatility and NFD can emerge and, ultimately, *to examine the extent to which a model can quantitatively rationalize the stylized fact in Figure 1.* As such, Figure 1 is the main empirical reference to keep in mind throughout the paper.

Figure 1: Average New Firm Density and House-Price Volatility in the Data



Sources: World Bank Entrepreneurship Report, Bank for International Settlements, and International Monetary Fund. Notes: The fitted line shown in red is based on the results in the first column of Table 1. *** and ** denote significance at the 1 and 5 percent levels, respectively.

Of course, the results in Table 1 imply correlation, but not causality. To get a stylized sense of causality, we run equation (1), again without any other country-specific controls, using as the regressor NFD *in 2006*, only, rather than the average level of NFD as in our benchmark specification. Intuitively this modified specification examines whether NFD *at the beginning of the sample period we consider* influences the relative volatility of house prices going into the future, which would suggest some sense of causality from NFD to relative house-price volatility. Results from this exercise are shown in the first column of Table 2. Note that the coefficient on NFD *in 2006* is magnitude-wise fairly similar to that in our benchmark specification, and it continues to be significant at the 5-percent level.

In turn, to get a stylized sense of reverse causality, we perform a similar exercise as above, but instead with NFD *in 2016* (that is, *NFD at the end of our sample period instead of average NFD or NFD in 2006*), only, as the regressand, and relative house-price volatility as the regressor, again without any other country-specific controls. Results are shown in columns two, three, and four of Table 2, with relative house-price volatility calculated, respectively, over the periods: 2006Q1-2016Q4; 2000Q1-2016Q4; and 1990Q1-2016Q4 for robustness. In all cases the coefficient on relative house-price volatility is *in*significant, suggesting that relative house-price volatility is unlikely to affect NFD in the future.

Because in a very stylized sense the results from Table 2 suggest that there may be causality from NFD to relative house-price volatility, we examine this relationship further using a host of country-specific control variables. In particular, the control variables we consider are intuitively prone to have an impact on house-price volatility and consist of: inflation volatility; the cyclical correlation of global liquidity with a country's GDP; and the household credit share. In addition, we include a dummy for advanced economies. The Appendix shows additional results confirming that other plausible controls do not affect our findings either. As in our benchmark specification, the regressand is relative house-price volatility and the regressor is average NFD in addition to the country-specific control variables. As such, we henceforth refer to running equation (1).

Results for house-price volatility calculated over the period 2006Q1-2016Q4 are shown in Tables 3 and 4 using average NFD and NFD *in 2006*, respectively. In all cases, the coefficient on NFD continues to be significant at the 5-percent level, and none of the controls are significant except the advanced-economy dummy in the third-column specification.

Returning to our stylized analysis of causality, Table 4 shows results akin to those in the first column of Table 2: in Table 4, the regressand is the relative volatility of house prices from 2006Q1 to 2016Q4, and the regressors are NFD *in 2006* and the same country-specific controls as in Table 3. Magnitude-wise, the results are similar to those in Table 1, as are those for the country specific controls. The only differences are for the advanced-economy dummy in the third-column specification, which is now only significant at the 10-percent level, and the fact that when all country-specific controls are used, the coefficient on the cyclical correlation between global liquidity and a country's GDP is significant at the 5-percent level (fourth column). We note that NFD continues to remain significant throughout.

Table 3: Relative Volatility of House Prices (2006Q1-2016Q4) and Average New Firm Density, Additional Controls

Dependent Var.	$\sigma_{Q,2006-2016}$	$\sigma_{Q,2006-2016}$	$\sigma_{Q,2006-2016}$	$\sigma_{Q,2006-2016}$	$\sigma_{Q,2006-2016}$
Ave. New Firm Density	0.0838**	0.109**	0.0886*	0.104**	0.161**
	(2.17)	(2.61)	(1.91)	(2.19)	(2.55)
Loan to Purchase Home		-0.0135	-0.00188	0.00967	-0.00906
		(-1.13)	(-0.14)	(0.64)	(-0.52)
Inflation Volatility			1.117	0.802	0.497
			(1.41)	(1.00)	(0.47)
Corr(Global Liquidity,GDP)				0.496	0.965
				(0.79)	(1.27)
Advanced Econ.				-0.772**	-0.696
				(-2.04)	(-1.67)
Household Credit Share					1.899
					(1.29)
Constant	1.730***	1.851***	1.129**	1.250**	0.348
	(7.84)	(6.99)	(2.11)	(2.06)	(0.30)
Adjusted R^2	0.079	0.090	0.113	0.135	0.284
Observations	50	47	47	47	32

t statistics in parentheses. Standard errors are heteroskedasticity-robust.
$^{*}p < 0.10$, $^{**}p < 0.05$, $^{***}p < 0.01$

Sources: World Bank Entrepreneurship Survey, World Bank Global Financial Inclusion Database, World Bank Doing Business, World Bank World Development Indicators, IMF International Financial Statistics, Bank of International Settlements. Notes: The relative volatility of house prices for a given country is computed as the volatility of HP-filtered real house prices divided by the volatility of HP-filtered real GDP for that country, using a smoothing parameter of 1600. Average new firm density (NFD) for each country is given by new firm density averaged over the period 2006-2016. The cyclical correlation between global liquidity supplied by banks and real GDP is computed as the contemporaneous correlation of HP-filtered global liquidity supplied by banks and HP-filtered real GDP, using a smoothing parameter of 1600. See the Data Appendix for details regarding data sources, country sample, and definitions.

Table 4: Relative Volatility of House Prices (2006Q1-2016Q4) and New Firm Density in 2006, Additional Controls

	$\sigma_{Q,2006-2016}$	$\sigma_{Q,2006-2016}$	$\sigma_{Q,2006-2016}$	$\sigma_{Q,2006-2016}$	$\sigma_{Q,2006-2016}$
New Firm Density 2006	0.0865**	0.140***	0.142***	0.168***	0.129**
	(2.65)	(3.43)	(3.10)	(3.69)	(2.20)
Loan to Purchase Home		-0.0128	-0.0137	-0.00275	-0.0141
		(-1.20)	(-1.13)	(-0.22)	(-0.92)
Inflation Volatility			-0.0883	-0.388	0.876
			(-0.12)	(-0.50)	(0.79)
Corr(Global Liquidity,GDP)				0.211	1.380**
				(0.40)	(2.07)
Advanced Econ.				-0.715*	-0.555
				(-1.98)	(-1.35)
Household Credit Share					2.448
					(1.53)
Constant	1.640***	1.692***	1.744***	1.978***	-0.224
	(8.38)	(6.78)	(3.40)	(3.49)	(-0.20)
Adjusted R^2	0.092	0.123	0.101	0.127	0.186
Observations	47	44	44	44	30

t statistics in parentheses. Standard errors are heteroskedasticity-robust.
$^{*}p < 0.10$, $^{**}p < 0.05$, $^{***}p < 0.01$

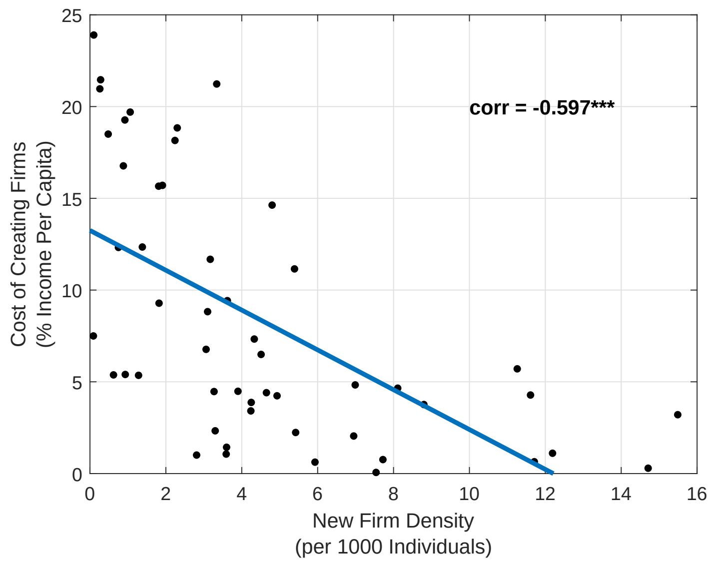
Sources: World Bank Entrepreneurship Survey, World Bank Global Financial Inclusion Database, World Bank Doing Business, World Bank World Development Indicators, IMF International Financial Statistics, Bank of International Settlements. Notes: The relative volatility of house prices for a given country is computed as the volatility of HP-filtered real house prices divided by the volatility of HP-filtered real GDP for that country, using a smoothing parameter of 1600. The cyclical correlation between global liquidity supplied by banks and real GDP is computed as the contemporaneous correlation of HP-filtered global liquidity supplied by banks and HP-filtered real GDP, using a smoothing parameter of 1600. See the Data Appendix for details regarding data sources, country sample, and definitions.

All told, our analysis suggests a new stylized fact: a significant and robust relationship between NFD and house-price volatility. Of note, while earlier literature has established a relationship between the variability of firm creation (not the average level) and house-price volatility in the US, our study complements this literature by going beyond the US and by establishing a relationship between average new firm density and house-price volatility across countries.

Taken together, our stylized empirical findings motivate our research question: what are the underlying economic mechanisms that can explain a causal relationship from NFD to house-price volatility? As such, our main focus goes beyond a simple empirical analysis and evidence on the relationship between NFD and house-price volatility, and instead lies in understanding why and if this relationship could exist with a particular causality.

With these findings in mind, we note that Klapper and Love (2010) document that the regulatory costs of starting a business is an important determinant of NFD. To briefly give an empirical sense of the relationship between firm entry costs and NFD, Figure 2 uses data from our sample of countries and presents a scatter diagram of the average cost of starting a business (as a percent of income per capita) against average NFD over the period 2006-2016 alongside a linear trend.

Figure 2: Cost of Starting a Business and New Business Density



Source: World Bank Enterprise Surveys. The average cost of starting a business for the period 2006-2016 is the average of such cost for men and women. Malta is the only country in our country sample that does not have data on the cost of starting a business. *** denotes significance at the 1 percent level.

Figure 2 confirms a strong and significant negative relationship between the average cost of starting a business and average NFD.[10] Of course, other factors could contribute to differences in NFD across countries, including, for example, the level of financial development, the share of self-employed individuals and entrepreneurs, and whether the economy is an advanced economy, among others. The strong, negative link between the regulatory cost of starting a business continues to be highly significant even after controlling for the bank credit-GDP ratio (a measure of financial development), the share of self-employment in the economy, and whether the economy is advanced.[11] We revisit this evidence as part of our quantitative analysis in Section 4.

[10] A simple regression of average NFD on the average cost of starting a business (as a share of income per capita) delivers a coefficient on the cost starting a business of -0.33 (significant at the 1 percent level) and an R-squared of 0.36.

[11] Results available upon request.

2.3 Additional Robustness and Caveats

Alternative Sample Periods Our specification above focuses on the period 2006Q1-2016Q4. The Appendix shows similar findings when we focus on the period 2000Q1-2016Q4, which is an important robustness check given that the series on NFD starts a year before the onset of the GFC (see Table A1), and 1990Q1-2016Q4, which we consider for completeness given that a handful of countries in our sample have house-price data going back to the early 1990s (this longer time span allows us to consider a much longer period that predates the GFC; see Table A2). All of our main results remain unchanged.

Additional Controls The significance of NFD highlighted above is also robust to controlling for the average inflation rate, average population growth and the average urban population share, all of which may affect the cyclical variability of house prices (see Table A3 in the Appendix). Similarly, controlling for average population density does not change the quantitative relevance of NFD.[12] Also, we note that all results continue to hold if we control for average real GDP per capita, suggesting that differences in economic development do not play a relevant role in the NFD-house price volatility nexus. For additional robustness, Table A7 in the Appendix shows that our findings remain unchanged after controlling for each economy's average level of real house prices.

Potential Limitations of NFD and Solutions As noted in the description of NFD in Section 2.1, one potential limitation of NFD is that this measure only considers *registered* firms. This implies that (1) NFD may be capturing firms that may have already been operating and simply became formal by registering, and (2) NFD may be severely underestimating the extent of new firm entry in economies with a large informal sector (that is, economies where unregistered (both new and old) firms tend to be more prevalent). To address (1) and as we already noted in the description of NFD in Section 2.1, we stress once more that World Bank Enterprise Survey (WBES) data confirms that virtually all registered firms that

[12] We note that the correlation between average population density and average NFD in our data is 0.12 and insignificant at conventional levels. The coefficient on population density in a regression of the relative volatility of house prices on average NFD and average population density is also insignificant. Results available upon request.

were surveyed in our country sample were not in operation prior to registering. Then, NFD is indeed capturing (formal) new firm entry.

To address (2), Table A3 in the Appendix shows that our main empirical findings are robust to controlling for the share of own-account-workers—a proxy for owner-only firms, which are more likely than not to be *un*registered and therefore not considered in the measurement of NFD—and the size of the informal sector (as a percent of GDP). Both of these measures capture, in different ways, the prevalence of unregistered (or informal) firms already in the market or the size of the unregistered-firm market.[13] Finally we note that while comparable cross-country data on firm startup rates is limited to only a handful of countries, using the firm startup rate measure from Calvino et al. (2015) for 14 economies with available data as an alternative to NFD (with the caveats that come with using a very small sample) confirms a positive and strong relationship between house-price volatility and firm startup rates.[14]

Detrending Methodologies and House-Price Series As an additional robustness check, we perform the same analysis presented in Table 1 using real house price and GDP series detrended using first differences as opposed to the HP filter: our main results are unchanged (see Table A4 in the Appendix). In addition, we perform the same analysis using the dataset on quarterly real house prices constructed by Cesa-Bianchi et al. (2015), which goes back to 1990Q1 for a similar *though not identical* country sample. The findings with this alternative series are broadly similar to those in Table 1 (see Table A5 in the Appendix).[15]

[13] An alternative would be to control for institutional quality, rule of law, or government effectiveness. Note, though, that variables embodying institutional quality are highly correlated with measures of informality. As such, using these alternative controls would deliver similar findings to those using our informality measures (results available upon request).

[14] Regressing relative house price volatility on the firm startup ratio yields a coefficient of 0.08 (significant at the 5 percent level and, importantly, quantitatively similar to the results in Table 1 using NFD, which is based on a larger country sample). Controlling for other factors that may affect house-price volatility does not change these results.

[15] Real house price data from Cesa-Bianchi, Cespedes, and Rebucci (2015), is available at a quarterly frequency from 1990Q1 to 2012Q4 for: Argentina, Austria, Belgium, Brazil, Bulgaria, Chile, Colombia, Croatia, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hong Kong, Hungary, Iceland, India, Indonesia, Ireland, Israel, Italy, Japan, Korea, Latvia, Lithuania, Luxembourg, Malaysia, Malta, Mexico, Morocco, Netherlands, New Zealand, Norway, Peru, Philippines, Poland, Portugal, Russia, Serbia, Singapore, Slovak Republic, Slovenia, South Africa, Spain, Sweden, Switzerland, Thailand, United Kingdom (sample period varies by country).

3 The Model

Our baseline framework is an RBC model comprised of perfectly-competitive intermediate-goods firms who produce using capital and labor, monopolistically-competitive final goods firms whose entry is endogenous, a monopolistically-competitive banking system, and two household categories. Following the literature on business cycles and housing, which we thoroughly build on, the total housing stock in the economy is fixed and normalized to 1 (a standard assumption in line with Iacoviello, 2015, or Kydland et al., 2016, among others). Households are divided into two categories—saver (s) and entrepreneur (e) households—each of measure 1 (see Iacoviello, 2015; introducing asymmetric shares of s and e households does not change our findings). Each household derives utility from consumption, leisure, and housing. Household heterogeneity is a standard feature of macro models of housing and financial constraints.

Saver (s) households consume, purchase housing, and supply labor to intermediate-goods firms; they own banks and supply deposits to the domestic banking system. In the baseline model, s households do *not* borrow to purchase new housing (we relax this assumption, which we show to be innocuous for our main conclusions, as part of our robustness analysis).

Entrepreneur (e) households own all firms. They consume, purchase housing, supply labor to intermediate-goods firms, and accumulate capital to rent to intermediate-goods firms. Importantly, in contrast to s households, e households devote household resources to the creation of (final goods) firms in the spirit of BGM. Moreover, they also borrow from banks to finance the purchase of new housing. We follow Kydland et al. (2016) by adopting their specification of housing-finance constraints. Specifically, e households face a financing constraint whereby a fraction of the value of housing is financed with bank credit, and that this constraint always binds. This assumption is completely standard in business cycle models with housing, where housing-finance constraints are motivated by the existence of enforcement frictions between lenders and borrowers.

We assume that banks are monopolistically-competitive, which gives rise to a lending-deposit spread for housing loans (more on the importance of such spread below). Finally, as a baseline, business cycles are driven by aggregate productivity shocks and housing-finance shocks that affect e households' housing loan-to-value ratio.[16]

Model Elements and Relevance Each of the elements in our model is relevant in the context of our main question. Having endogenous firm entry in the model is key to exploring the link between firm entry (our proxy for NFD) and house-price volatility. The presence of housing finance constraints is standard in RBC models of housing. Moreover, a standard assumption in most of these models is that housing-finance constraints are always binding (see Iacoviello and Neri, 2010; Iacoviello, 2015). In turn, assuming a monopolistically-competitive banking system serves two non-trivial purposes. First, given homogeneity in household discounting among e and s households (which we assume), this banking structure introduces lending-deposit spreads, thereby allowing e households' housing-finance constraints to have a bite and introducing a channel via which housing-finance shocks affect households' decisions. Second, this banking structure readily allows us to determine the extent to which household differences in housing-finance usage affect the link between NFD and house-price volatility by easily accommodating a richer environment where all households borrow with minimum additional complexity without the need for additional household heterogeneity (such heterogeneity would not alter the main mechanisms in our model but would imply a more complicated framework).

There are two differences between our framework and related models where entrepreneurs demand housing (see, for example, Iacoviello, 2015). First, in our model, housing is simply an element in both households' utility function and is not used in the production process. Second, we assume that the housing-finance constraint for e households is such that a fraction of current-period value of housing purchases is partially financed with bank credit; this differs from the general-borrowing specification whereby household borrowing is based on the expected value of households' housing stock. The first assumption stems primarily from the data we use for the stylized facts in Section 2. In particular, our house-price data is based on *residential* and not commercial property prices, suggesting that housing is not used for production of goods and services. Moreover, our data on NFD refers to registered firms. As such, the likelihood that entrepreneur households are using their residential properties to

[16] We explore other shocks, including housing demand and foreign interest rate shocks, as part of our robustness analysis.

produce is much less likely relative to a case with a high prevalence of unregistered firms, many of which are family and household-based firms. The second assumption is consistent with cross-country evidence showing that mortgage credit is one of the largest components of total household credit in many economies (Beck et al., 2012). The structure of housing finance we adopt is therefore consistent with the cross-country focus we adopt in Section 2.

3.1 Final Goods Firms

Following the endogenous entry framework in BGM, there is a continuum of monopolistically-competitive final-goods firms. These firms are owned by entrepreneur (e) households. Each firm produces a single differentiated final good $\omega \in \Omega$ using inputs from intermediate-goods firms, where Ω denotes the subset of differentiated goods that are potentially available (as is standard in the literature, only a fraction of these goods end up being produced). Total final output is given by $Y_t = \left(\int_{\omega\in\Omega} y_t(\omega)^{\frac{\varepsilon-1}{\varepsilon}} d\omega\right)^{\frac{\varepsilon}{\varepsilon-1}}$, where ε is the elasticity of substitution and $y_t(\omega)$ is output produced by firm ω. Then, the price index in the economy is given by $P_t = \left(\int_{\omega\in\Omega} p_t(\omega)^{1-\varepsilon} d\omega\right)^{\frac{1}{1-\varepsilon}}$ where $p_t(\omega)$ is firm ω's price. Then, the real relative price of a given good ω is given by $\rho_t(\omega) = p_t(\omega)/P_t$.

Incumbent Firms Profits for incumbent firm ω are given by $\pi_{e,t}(\omega) = [\rho_t(\omega) - mc_t]\, y_t(\omega)$, where mc_t denotes the price of intermediate goods used in production by final-goods firms. Firms face an exogenous exit probability $0 < \delta < 1$ at the end of each period. Thus, firm ω maximizes $\mathbb{E}_t \sum_{s=t}^{\infty} \Xi^e_{s|t}[(1-\delta)^{s-t}\pi_{e,s}(\omega)]$ subject to households' demand, where $\Xi^e_{s|t}$ is the discount factor used by firms to discount the future (i.e., e households' stochastic discount factor). The first-order conditions yield a standard pricing equation under monopolistic competition with a markup over marginal cost: $\rho_t(\omega_j) = (\varepsilon/(\varepsilon-1))\, mc_t$.

Firm Entry Amid an unbounded number of potential entrants, let N_t be the mass of incumbent (producing) firms in period t. Following the literature, there is a one-period production lag for new entrants $N_{E,t}$ in period t. After accounting for the exogenous probability of exit δ, it follows that the current mass of firms is $N_t = (1-\delta)\left(N_{t-1} + N_{E,t-1}\right)$. Potential new firms must incur an exogenous sunk entry cost ψ_e (expressed in terms of final goods).

This cost can represent the technological and resource costs of entering a market, but also the regulatory costs that firms face in order to become established in that market (see Cacciatore, Duval, Fiori, and Ghironi, 2016a,b). We take the latter interpretation. Of note, given our focus on cross-country differences in new firm density, we assume that this cost is exogenous and we vary it to explore the implications of firm entry for house-price volatility. Expressing this cost in effective labor units (see, for example, BGM) does not change our results.

Potential firms considering entry in period t anticipate their future profits once they enter the market such that the present discounted value of expected profits obtained once production takes place (i.e., in period $t+1$ and beyond) is $v_t(\omega) = \mathbb{E}_t \sum_{s=t+1}^{\infty} \Xi^e_{s|t}(1-\delta)^{s-t}\pi_{e,s}(\omega)$. As shown in e households' problem below, in equilibrium and after imposing symmetry across firms, the entry decision can characterized as $v_t(\omega) = v_t = \psi_e/(1-\delta)$. Of note, since our framework assumes a fixed population in the economy, $N_{E,t}$ is the model counterpart of NFD in the data.

3.2 Intermediate Goods Firms

Perfectly-competitive intermediate-goods firms rent capital from e households at price $r_{k,t}$ and use (perfectly-substitutable) labor from both household categories to produce goods using a Cobb-Douglas production function. These goods are then supplied as inputs to differentiated final goods firms at price mc_t. Specifically, intermediate-goods firms choose capital demand k_t and labor demand n_t to maximize profits $\Pi_{i,t} = \left[mc_t z_t n_t^{1-\alpha} k_t^{\alpha} - w_t n_t - r_{k,t} k_t\right]$, where z is exogenous aggregate productivity, $0 < \alpha < 1$, and $r_{k,t}$ and w_t represent the real rental rate of capital and the real wage, respectively. Optimal capital and labor demand are standard and given by $r_{k,t} = \alpha mc_t z_t n_t^{1-\alpha} k_t^{\alpha-1}$ and $w_t = (1-\alpha) mc_t z_t n_t^{-\alpha} k_t^{\alpha}$, respectively.

3.3 Households

Saver (s) Households There is a continuum of identical saver (s) households over the interval $[0,1]$. They choose consumption $c_{s,t}$, housing demand $h_{s,t}$, bank deposits d_t, and labor supply $n_{s,t}$ to maximize $\mathbb{E}_0 \sum_{t=0}^{\infty} \beta^t \mathbf{u}(c_{s,t}, n_{s,t}, h_{s,t})$ subject to the budget constraint

$$c_{s,t} + Q_{h,t}(h_{s,t} - h_{s,t-1}) + d_t = w_t n_{s,t} + R_{t-1} d_{t-1} + \Pi_{b,t}, \tag{2}$$

where $0 < \beta < 1$ is the subjective discount factor, $Q_{h,t}$ is the real price of housing, w_t is the real wage, R_t is the gross real interest rate on deposits, and $\Pi_{b,t} = \int_0^1 \pi_{jb,t} dj$ denotes total bank profits (defined further below). Households have GHH preferences over consumption and labor: $\mathbf{u}(c_{s,t}, n_{s,t}, h_{s,t}) = \left[\frac{1}{1-\sigma} \left(c_{s,t} - \frac{\kappa}{1+\xi} n_{s,t}^{1+\xi} \right)^{1-\sigma} + \frac{\gamma_h}{1-\sigma_h} (h_{s,t})^{1-\sigma_h} \right]$ with $\sigma, \sigma_h, \kappa, \xi, \gamma > 0$. Of note, the adoption of GHH preferences is important for the model to be consistent with the positive and significant relationship between NFD and (population-adjusted) total hours worked in our data and country sample.[17] Importantly, as we note in Section 4 further below, the calibration we adopt is such that labor supply always remains bounded within a plausible empirical range and never reaches its upper limit as steady-state real wages increase with greater NFD.

The first-order conditions yield a standard optimal labor supply condition and an Euler equation over deposits, $\kappa n_{s,t}^{\xi} = w_t$ and $\mathbf{u}_{c_{s,t}} = \beta \mathbb{E}_t \mathbf{u}_{c_{s,t+1}} R_t$, as well as a housing demand expression

$$Q_{h,t} = \gamma_h \frac{(h_{s,t})^{-\sigma_h}}{\mathbf{u}_{c_{s,t}}} + \mathbb{E}_t \Xi_{t+1|t}^s Q_{h,t+1}, \tag{3}$$

where $\Xi_{t+1|t}^s \equiv \beta \mathbf{u}_{c_{s,t+1}} / \mathbf{u}_{c_{s,t}}$. The economic intuition behind these conditions is standard, with households equating the marginal cost of working to the marginal benefit, the marginal cost of purchasing an additional unit of housing $Q_{h,t}$ to the expected marginal benefit (given by the marginal gain in utility from housing adjusted by the marginal utility of consumption and the expected change in house prices next period), and the marginal cost of saving one more unit of resources to the expected marginal benefit.

[17] The correlation between average NFD and total hours worked is 0.32 and significant at the 5 percent level. Importantly, this relationship holds even after controlling for the size of the informal sector, which is important as the informal sector is non-negligible and an important source of income in several economies in our sample and can therefore affect the link between NFD and labor. Standard preferences in the business cycle literature that allow for a wealth effect *on labor supply* deliver no change in hours worked amid changes in firm entry, which is counterfactual in our data.

Entrepreneur (e) Households: Utility Maximization and Firm Creation There is a continuum of identical entrepreneur (e) households indexed by i over the interval $[0, 1]$. These households supply labor to intermediate-goods firms, own all firms and, in contrast to s households, invest in the creation of new final-goods firms by incurring sunk entry costs for the creation of these firms. In addition, e households obtain (differentiated) loans from banks to finance the purchase of new housing, only. We note that the Appendix presents: (1) a richer version of the model where both households use bank credit to finance new housing purchases, and (2) a version of the model where, in addition to the standard housing-finance constraint for e households we describe below, the sunk entry costs and a fraction of intermediate-goods firms' wage and capital bills are also financed with bank credit.[18]

Formally, e households choose consumption $c_{e,t}$, housing demand $h_{e,t}$, labor supply $n_{e,t}$, capital accumulation k_t, total borrowed funds $l_{e,t}$, the number of new final-goods firms $N_{E,t}$, and the desired number of future final-goods firms N_{t+1} to maximize $\mathbb{E}_0 \sum_{t=0}^{\infty} \beta^t \mathbf{u}(c_{e,t}, n_{e,t}, h_{e,t})$ subject to the budget constraint

$$\begin{aligned} & c_{e,t} + k_t + \psi_e N_{E,t} + Q_{h,t}(h_{e,t} - h_{e,t-1}) + R_{e,t-1} l_{e,t-1} \\ = \quad & w_t n_{e,t} + N_t \pi_{e,t} + \Pi_{i,t} + l_{e,t} + (1-\delta) k_{t-1} + r_{k,t} k_{t-1}, \end{aligned}$$

the evolution of final-goods firms

$$N_{t+1} = (1-\delta)\left(N_t + N_{E,t}\right), \tag{4}$$

and the housing finance constraint

$$l_{e,t} = \phi_{h,t} Q_{h,t} h_{e,t}, \tag{5}$$

where $0 < \delta < 1$ is the depreciation rate of capital as well as the exogenous exit probability of firms.[19] Preferences over consumption and labor are also of the GHH form over consumption

[18] We discuss the results from these richer frameworks in more detail in Section 4.5.

[19] We include standard capital adjustment costs as part of our quantitative analysis in order to obtain a reasonable degree of investment volatility. We abstract from these costs in the description of the model for

and labor: $\mathbf{u}(c_{e,t}, n_{e,t}, h_{e,t}) = \left[\frac{1}{1-\sigma}\left(c_{e,t} - \frac{\kappa}{1+\xi}n_{e,t}^{1+\xi}\right)^{1-\sigma} + \frac{\gamma_h}{1-\sigma_h}\left(h_{e,t}\right)^{1-\sigma_h}\right]$ with $\sigma, \sigma_h, \kappa, \xi, \gamma > 0$. The household takes profits from final-goods firms and intermediate-goods firms as well as all relevant prices as given. In the budget constraint, $R_{e,t}$ is the *average* (over all housing loans) real gross rate at which households borrow to finance their housing purchases.

The financing constraint is very similar to Kydland et al. (2016) and specifies that e households' borrowed funds for housing purchases are a fraction $\phi_{h,t}$ of households' value of current-period housing purchases, where $\phi_{h,t}$ can be broadly interpreted as the loan-to-value (LTV) ratio. We assume that $\phi_{h,t}$ is time-varying and subject to shocks, which we refer to as housing-finance or LTV shocks (for similar shocks in the literature, see, for example, Iacoviello, 2015). Of note, this constraint should not be interpreted as a standard borrowing limit for entrepreneur households but instead as a constraint akin to a "working capital" constraint for housing purchases (as is standard in macro models of housing, this constraint can be motivated by the presence of enforcement frictions between lenders and borrowers). Moreover, note that by choosing housing demand, entrepreneur households are effectively choosing the amount they borrow (that is, the amount borrowed is a choice).[20]

Plugging the housing finance constraint into the budget constraint, we obtain a standard Euler equation for physical capital

$$1 = \mathbb{E}_t \Xi^e_{t+1|t}\left[r_{k,t+1} + 1 - \delta\right], \tag{6}$$

where $\Xi^e_{t+1|t} \equiv \beta \mathbf{u}_{c_{e,t+1}}/\mathbf{u}_{c_{e,t}}$ is the household's stochastic discount factor; a standard labor supply condition

$$\kappa n_{e,t}^{\xi} = w_t, \tag{7}$$

an optimal firm creation condition

$$v_t = \mathbb{E}_t \Xi^e_{t+1|t}\left[\pi_{e,t+1} + (1-\delta)\, v_{t+1}\right], \tag{8}$$

expositional clarity. Also, assuming differences between the depreciation rate of physical capital and the exit probability of firms does not change any of our conclusions.

[20]Assuming that the amount borrowed depends not on the current total value of housing (as is the case in the constraint we use), but instead on the expected value of housing (as is the case in other models, like Iacoviello, 2015) does not change our main conclusions.

where v_t denotes the value of creating a new firm and is given by

$$v_t = \frac{\psi_e}{(1-\delta)}, \tag{9}$$

and an optimal housing demand condition that takes into account households' housing finance constraint

$$Q_{h,t} = \frac{(h_{e,t})^{-\sigma_h}}{\mathbf{u}_{c_{e,t}}} + \mathbb{E}_t \Xi^e_{t+1|t} Q_{h,t+1} - Q_{h,t}\phi_{h,t}\left[\mathbb{E}_t \Xi^e_{t+1|t} R_{e,t} - 1\right]. \tag{10}$$

Intuitively, e households equate the marginal cost of spending resources on the creation of an additional firm (adjusted by the probability of firm survival), v_t, to the expected marginal benefit of having an additional firm, given by future individual-firm profits and the continuation value. Of note, the firm creation condition effectively implies that households consider firms as an additional asset (in addition to housing, physical capital), which is a well-known feature of models of endogenous firm entry in the spirit of BGM. Of note, investing in firm creation differs from investing in other assets since, in contrast to housing, greater firm entry induces more demand for intermediate goods and therefore intermediate inputs, including capital and labor. This structure links households and housing via labor markets. Finally, the housing demand condition states that e households equate the marginal cost of purchasing an additional unit of housing, $Q_{h,t}$, to the expected marginal benefit, which is given by the utility gain from housing and any expected capital gains from housing appreciation, $E_t \Xi^e_{t+1|t} Q_{h,t+1}$, *net of any costs that arise from borrowing for new housing purchases in period* t, where $\left[\mathbb{E}_t \Xi^e_{t+1|t} R_{e,t} - 1\right]$ represents the expected lending spread.[21]. Of note, the fact that the banking sector is monopolistically competitive and that s households own the banks implies that this spread will be positive, both in steady state *and* over the business cycle, even if both s and e households have the same subjective discount factor.

Entrepreneur (e) Households: Borrowing Cost-Minimization Amid monopolistic competition in the banking sector, each e household i chooses *differentiated* borrowed funds

[21] recall that per the problem of s households, $1 = \beta \mathbb{E}_t \Xi^s_{t+1|t} R_t$, so that $\left[\mathbb{E}_t \Xi^e_{t+1|t} R_{e,t} - 1\right] = \left[\mathbb{E}_t [\Xi^e_{t+1|t} R_{e,t} - \mathbb{E}_t \Xi^s_{t+1|t} R_t\right]]$, that is, the expected lending spread.

from each bank j. Specifically, denote by $l_{ie,t} = \left(\int_0^1 l_{ije,t}^{\frac{\varepsilon_h - 1}{\varepsilon_h}} dj \right)^{\frac{\varepsilon_h}{\varepsilon_h - 1}}$ the amount of borrowed funds e household i has, where ε_h is the elasticity of substitution between bank resources and $l_{e,t} = \int_0^1 l_{ie,t} di$. Then, each e household i chooses $l_{ije,t}$ to minimize the total cost of borrowed funds $\int_0^1 R_{je,t} l_{ije,t} dj$ subject to $l_{ie,t} = \left(\int_0^1 l_{ije,t}^{\frac{\varepsilon_h - 1}{\varepsilon_h}} dj \right)^{\frac{\varepsilon_h}{\varepsilon_h - 1}}$, where $R_{je,t}$ is taken as given and $R_{e,t} = \left(\int_0^1 R_{je,t}^{1-\varepsilon_h} dj \right)^{\frac{1}{1-\varepsilon_h}}$. The solution to this problem yields a standard demand for *differentiated* borrowed funds from bank j: $l_{ije,t} = \left(\frac{R_{je,t}}{R_{e,t}} \right)^{-\varepsilon_h} l_{ie,t}$. At the e-household level, then, the demand for borrowed funds from bank j is simply $l_{je,t} = \int_0^1 l_{ije,t} di = \int_0^1 \left(\frac{R_{je,t}}{R_{e,t}} \right)^{-\varepsilon_h} l_{ie,t} di$.

3.4 Banks

The banking sector has a measure $[0, 1]$ of banks. Banks are monopolistically competitive in the market for loans but perfectly competitive in the market for deposits. They turn all their profits to s households. Each bank j chooses its gross real loan rate $R_{je,t}$ to maximize profits $\pi_{jb,t} = R_{je,t} l_{je,t} - R_t d_{j,t} - l_{je,t} - d_{jt}$ subject to the balance sheet constraint $l_{je,t} = d_{jt}$ and the bank's loan demand condition from e households (derived above). Then, the optimal loan rate for bank j is a standard (constant) markup over the deposit rate $R_{je,t} = (\varepsilon_h / (\varepsilon_h - 1)) R_t$.

3.5 Symmetric Equilibrium and Market Clearing

A symmetric equilibrium implies that we $Y_t = y_t N_t^{\frac{\varepsilon}{\varepsilon - 1}}$ and $R_{e,t} = (\varepsilon_h / (\varepsilon_h - 1)) R_t$ across firms and banks. Market clearing in the credit, labor, and goods markets implies that $d_t = l_{e,t}$, $n_{e,t} + n_{s,t} = n_t$, and $z_t n_t^{1-\alpha} k_t^a = N_t y_t$. Since the total housing stock is normalized to 1, market clearing in the housing market is given by $h_{e,t} + h_{s,t} = 1$. The economy's resource constraint is

$$Y_t = c_{s,t} + c_{e,t} + i_t + \psi_e N_{E,t}, \tag{11}$$

where physical capital investment $i_t = k_t - (1 - \delta) k_{t-1}$. Section A.4 of the Appendix presents the full set of equilibrium conditions.

As noted in BGM, when comparing the model to the data, variables expressed in final consumption goods need to be adjusted to account for CPI measurements when it comes to the variety component present in models with endogenous entry (which arise with preferences that have a "love for variety" component). As such, if variable $x_{m,t}$ in the model is expressed in final consumption units, its empirical counterpart is $x_{d,t} = x_{m,t}/\rho_t$ (see BGM for more details). Of note, by building on the workhorse RBC framework and the literature on the macroeconomics of housing, our model does not allow for business cycle volatility to affect the steady state. Therefore, given our main objective and in line with the cross-country evidence presented in Section 2, our experiments focus on analyzing how changes in average (steady-state) NFD influence house-price volatility.

4 Quantitative Analysis

4.1 Operationalization

Parameters from Literature A period is a quarter. Following the business cycle literature, $\alpha = 0.32, \beta = 0.985, \delta = 0.025, \sigma = 2, \sigma_h = 2$, all of which are standard values. We set the inverse Frisch elasticity of labor supply to 0.75, as suggested by Chetty et al. (2011). This implies that $\xi = 1.33$.[22] Importantly, we note that given our adoption of GHH preferences and the range of NFD we consider in our quantitative experiments, this calibration also guarantees that labor supply remains bounded within an empirically-plausible range, and never reaches its upper limit amid an increase in real wages resulting from greater NFD. We set the steady-state LTV ratio $\psi_h = 0.80$ based on evidence on average LTV ratios in our country sample and consistent with related studies (see, for example, Kydland et al., 2016; we note that there is no correlation between average NFD and average LTV ratios in our data). We introduce standard capital adjustment costs using the function $\Phi(k_t/k_{t-1}) = (\varphi_k/2)(k_t/k_{t-1} - 1)^2 k_t$, $\varphi_k > 0$, and assume independent AR(1) processes in logs for each of the shocks: $\ln(x_t) = (1-\rho_x)\ln(x) + \rho_x \ln(x_{t-1}) + \varepsilon_t^x$, where $0 < \rho_x < 1$ and $\varepsilon_t^x \tilde{} N(0, \sigma_x)$ for $x = z, \phi_h$. As a baseline, we set $\rho_x = 0.90$ for $x = z, \phi_h$.[23] Without loss of

[22] Alternative values such as $\xi = 1$, which is more standard in the macro literature, make our main results even stronger.

[23] This is consistent with the values adopted in models with housing-based LTV shocks.

generality, we normalize aggregate productivity to $z = 1$ and set $\sigma_z = 0.01$.[24] Given that we are interested in the change in relative house-price volatility as average (or steady-state) NFD changes, imposing $\sigma_z = 0.01$ is innocuous and does not alter our main conclusions. We describe the calibration of housing-finance shocks further below.

Calibrated Parameters Since population in our model is fixed, the model counterpart of NFD is N_E.[25] The parameters $\kappa, \psi_e, \gamma_h, \phi_k$, and ε_h are chosen to match: steady-state total hours worked of 0.33 (a standard target in business cycle models), a steady-state measure of new firms N_E of 0.09 (consistent with the lowest average NFD in our country sample, which allows us to vary NFD in our model from its lowest to its highest value in the data; alternative targets do not change our conclusions), a household credit-GDP ratio of 33 percent (consistent with the average in our country sample with available data), a relative volatility of investment of 3.8 percent (consistent with the average relative volatility of investment in our country sample) and an average quarterly lending-deposit rate of 1 percent (consistent with evidence on average spreads in our country sample). We find no significant relationship between lending-deposit spreads and NFD in our data, implying that these spreads do not change with NFD (recall that the lending-deposit spread is important insofar as it allows financial shocks to have a bite, as is standard in business cycle models with housing finance constraints). This yields: $\kappa = 21.9289, \psi_e = 1.338, \gamma_h = 0.0503, \phi_k = 0.4125$, and $\varepsilon_h = 102.5228$. Of note, this calibration also delivers plausible housing wealth-income ratios broadly in line with the literature.

Calibration of Housing-Finance Shocks To provide the most transparent comparison between our model to the data, we proceed to calibrate the volatility of housing-finance shocks as follows.

As detailed below, we generate changes in the model's level of NFD by changing the sunk

[24]We discuss the consequences of introducing foreign interest rate shocks and housing demand shocks further below. Results using these shocks are presented in Figure A9 of Appendix A.7 and confirm that our main conclusions remain unchanged.

[25]A note on our mapping from the data to the model: given that NFD in the data represents a proxy for new firm entry based on newly-registered firms, some firms may not be producing yet at the time they registers. The timing in our model, where new firms in period t, $N_{E,t}$, start producing in period $t+1$, would capture the potential lag between registration and production. Adopting a different timing where new firms begin production upon entry would not change our findings.

entry costs within the range observed in the data. Given this methodology, the volatility of housing-finance shocks is calibrated so that regressing the model- generated relative volatility of house prices on steady-state N_E delivers *the same intercept (and not the slope)* as in the *data-based* regression of relative house-price volatility on average NFD shown earlier in Figure 1. This procedure yields a standard deviation of housing-finance shocks of $\sigma_{\phi_h} = 0.0313$. More broadly, this strategy is appropriate when comparing the *average* effect of changes in NFD on the volatility of house prices in the model to the data, as we do below, which is consistent with the fact that our empirical experiments in Section 2 indeed show the average effect of changes in (cross-country) average NFD on (cross-country) relative house-price volatility.

It is important to stress once more that this calibration strategy for σ_{ϕ_h} *does not at all* imply that the model-generated slope will match the data-based slope by construction: it is simply a normalization for ease of comparison between the model-generated results and the empirical facts in Figure 1. Furthermore, while the data-based and model-based trend lines do have the same *intercept* by construction, the model-generated slope as NFD changes, which is the object we are interested in, is indeed an endogenous outcome of the model.

4.2 Results

In light of the facts highlighted in Section 2 regarding the relationship between NFD and sunk entry costs (recall Figure 2) and given our focus on the relationship between average NFD and house-price volatility, we explore the model's implications by changing the sunk entry cost ψ_e in the model—which is the model-counterpart of the cost of starting a firm—to generate a change in steady-state N_E from 0.09—the lowest average NFD in our country sample—to roughly 16, which corresponds to the highest average NFD in our country sample after removing outliers. In our baseline calibration, the increase in steady-state NFD over the 0.09-16 range is obtained by reducing the sunk entry cost ψ_e from its baseline value of 1.3122 to 0.107. This is a reduction in the cost of creating a firm of roughly 92 percent. In our country sample, reducing the regulatory cost of creating a business from its highest value to its lowest value implies a reduction in such cost of roughly 99 percent, so the reduction in the sunk entry cost ψ_e we consider is not only quantitatively plausible but also empirically consistent.

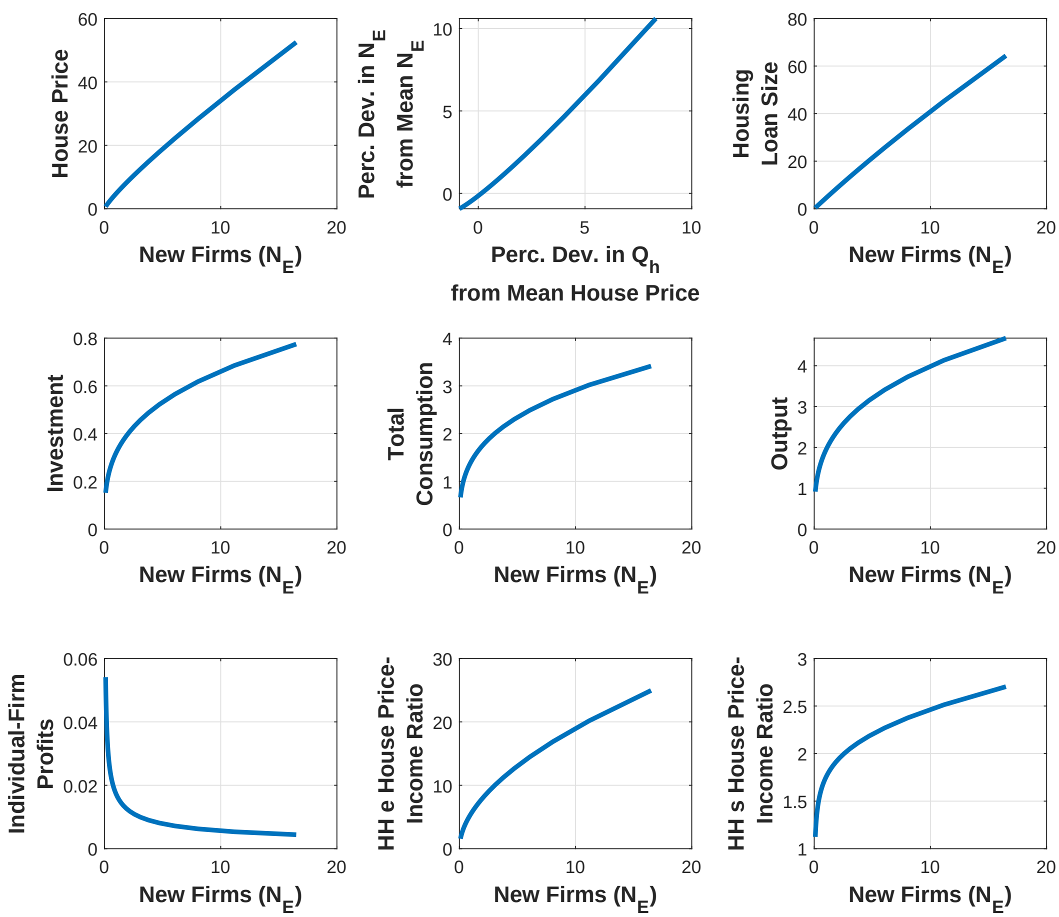
The change in the sunk entry cost ψ_e (and hence steady-state new firm entry N_E) described above generates *endogenous* changes in the model's steady state, which affects cyclical dynamics, *including those of house prices*, in the presence of aggregate productivity and housing-finance shocks. Specifically, our exercise yields a cross-section of pairs of steady-state N_E and the relative volatility of house prices (that is, the volatility of house prices relative to the volatility of output) associated with each value of steady-state N_E in the range outlined above.[26]

4.2.1 Steady State Implications

Changes in the model's steady state are important for understanding the economic mechanisms behind our main results. Figure 3 shows the steady-state behavior of key variables that are needed to understand our model's implications. In particular, this figure shows, for the range of NFD over which we operationalize our model, that steady-state house prices, the housing-loan size, investment, consumption, output, and house price-income ratios all rise with greater N_E. Also, the *percent deviation* of N_E relative to its model-based sample mean rises as the *percent deviation* of steady-state house prices relative to their model-based sample mean rises as well. In contrast, individual-firm profits fall.

[26]Of note, unless we change other parameters *alongside* ψ_e, our exercise delivers unique pairings of N_E and the relative volatility of house prices (one for each value of ψ_e (and hence N_E) we consider, which we use to run the regression of the model-generated relative volatility of house prices on model-generated steady-state N_E to calibrate the housing-finance shocks. Changing other parameters alongside ψ_e would allow us to generate additional cross-sectional dispersion in the NFD-house-price volatility pairings but, by changing more than one parameter at a time, would cloud the key mechanisms of the model.

Figure 3: Steady State Results–New Firm Entry and Select Variables in Benchmark Model



To understand these steady-state results, note that e households have the choice of allocating resources across three main asset classes: housing (via the purchase of new housing), firms (via investment in new firms), and physical capital. Without loss of generality, focus on the first two asset classes. As the sunk entry cost falls, the marginal cost of creating a new firm falls, which increases e households' incentive to reallocate resources towards firm creation, and therefore away from new housing purchases (that is, e households' demand for housing falls). The resulting reallocation of resources towards firm creation eventually results in greater capital accumulation and hence investment (middle-left panel of Figure 1) and labor demand among intermediate-goods firms, while the rise in firm entry depresses *individual-firm* profits π_e (bottom-left panel of Figure 3). It is important to note, though, that e households' *total* income from ownership of final goods firms ($N\pi_e$) still rises since the increase in the number of firms N partially offsets the fall in individual-firm profits π_e. Ultimately, greater firm creation, labor demand, and capital accumulation lead to greater output (middle-right panel of Figure 3), wages, labor income, and total household income across households. However, since households differ in their sources of income (with e households depending on labor income but also on firm profits), the rise in household-s income is, in relative terms, larger than the rise in household-e income. More broadly, the resulting rise in household income leads to greater consumption across households (middle-middle panel of Figure 3).

Turning to steady-state house prices, as π_e falls and e households reallocate resources away from housing and into firm creation, the fall in housing demand from these households *initially* puts downward pressure on the price of housing. Since s households do not have to devote resources to the creation of firms, a fraction of the gains in labor income noted above is devoted to purchasing more housing (in addition to increasing consumption). That is, there is a rise in housing demand by s households.

In fact, the rise in housing demand by these households is strong enough to more than offset the fall in housing demand by e households. Intuitively, this occurs for two reasons. First, amid an increase in labor income (and total income more broadly), s households can allocate a larger share of this income to housing since s households do not have to devote resources to firm creation (the fact that firm creation is costly naturally implies that greater firm creation takes away from the total amount of e households' labor income that could otherwise be devoted to housing purchases). This is amplified by the fact that, as noted above, the increase in household-s income compared to household-e income is larger *in relative terms*. Second, s households' increase in housing demand is further bolstered by the *initial* downward pressure on house prices exerted by e households' lower housing demand. These mechanisms are responsible for increasing s households' demand for housing by more than the reduction by e households such that *in equilibrium* we observe a non-negligible and unambiguous increase in steady-state house prices (top-right panel of Figure 3). Of note, the rise in steady-state house prices occurs not only in absolute terms, but also relative to income (bottom-middle and bottom-left panels of Figure 3). This is due to the asymmetric response in housing demand and income across household categories, as well as the adoption of GHH preferences for consumption and labor which, as already noted in Section 3, are important for the model to be consistent with the positive relationship between NFD and (population-adjusted) hours worked in the data. Amid the increase in house prices, the steady state size of housing loans rises (top-right panel of Figure 3).

All told, note that the behavior of steady-state house prices implies a positive relationship between *percent deviations in N_E from the sample-mean N_E* (where sample-mean N_E represents the mean of N_E over the empirical range in the data), *and percent deviations in real house prices from the sample-mean real house price as we increase N_E* (top-middle panel of Figure 3).[27] Per Figure A10 in Appendix A.8, this positive link in the model is corroborated in the data.

4.2.2 Dynamic Implications

Picking up immediately from the last section, having a greater average loan size makes households' decisions over housing loans more sensitive to housing-finance (or LTV) shocks. The greater sensitivity of borrowed funds to these shocks translates into more volatile borrowing rates (and, ultimately, more volatile lending spreads) and hence more volatile costs associated with the purchase of new housing. Coupled with the greater volatility in firm profits (which embody the value of firms) that accompanies greater average firm entry, the volatility in housing-related borrowing rates (and lending spreads) ultimately contributes to more volatile asset prices, *including house prices.*

More formally, to better understand how endogenous firm entry acts as an amplification mechanism of house-market-based financial shocks in our model, consider once again e households' housing finance constraint, $l_{e,t} = \phi_{h,t} Q_{h,t} h_{e,t}$. In particular, it is easy to see that *for a given housing stock held by e households*, higher steady-state house prices that result from greater steady-state N_E naturally imply that the housing-loan size that e households

[27]The sample-mean real house price is obtained by varying N_E over its empirical range and computing the resulting mean real house price).

need to purchase new housing, l_e, is higher (this holds in both absolute terms and relative to household income).[28] Critically, this implies that all else equal the sensitivity of housing loans *to a given set of housing-finance shocks* is greater in these economies. The greater response of l_e to housing-finance shocks ultimately translates into a greater response in borrowing rates R_e (and ultimately lending spreads).[29] Importantly, it is not greater average house prices *by themselves* that are critical, but rather their implications for the sensitivity of housing loans *and* borrowing rates to housing-finance shocks, which ultimately affect house-price dynamics. In addition to this effect, the fact that steady-state *individual-firm* profits π_e are lower amid greater firm entry also implies that such profits become more sensitive to shocks. This greater volatility in firm profits further contributes to the cyclical variability in house prices.

The preceding mechanisms are further clarified by deriving the following expression for house-price deviations from trend, $\widehat{Q}_{h,t}$, as a function of key variables related to firm entry *and* housing finance:

$$\begin{aligned} \widehat{Q}_{h,t} &= \Phi_1 \left[\frac{\mathbf{u}_{h_s}}{\mathbf{u}_{c_s}} \left(\widehat{\mathbf{u}}_{h_s,t} - \widehat{\mathbf{u}}_{c_s,t} \right) - \frac{\mathbf{u}_{h_e}}{\mathbf{u}_{c_e}} \left(\widehat{\mathbf{u}}_{h_e,t} - \widehat{\mathbf{u}}_{c_e,t} \right) \right] + \Phi_2 \mathbb{E}_t \widehat{\Xi}^s_{t+1|t} \\ &\quad + \Phi_3 \mathbb{E}_t \hat{\pi}_{e,t+1} + \Phi_4 \mathbb{E}_t \widehat{R}_{e,t} - \widehat{\phi}_{h,t}. \end{aligned} \tag{12}$$

where hatted variables denote variables in log-deviations from steady-state and variables without time subscripts denote these same variables in steady state (see Appendix A.9 for the details behind the derivation of this expression). Above, $\Phi_1 \equiv \left(\frac{1}{\phi_h Q_h (1-\Xi^e R_e)} \right) < 0$, $\Phi_2 \equiv \frac{\Xi^s}{\phi_h (1-\Xi^e R_e)} < 0$, $\Phi_3 \equiv \frac{\Xi^e [1-\phi_h R_e]}{\phi_h (1-\Xi^e R_e)} \left[\frac{[1-(1-\delta)\beta]}{\beta + [1-(1-\delta)\beta]} \right] < 0$, and $\Phi_4 \equiv \frac{\Xi^e R_e}{(1-\Xi^e R_e)} < 0$. We note that in our baseline calibration, $\Phi_3 < \Phi_4$, so fluctuations in borrowing rates R_e have a larger impact on house-price fluctuations relative to movements in individual-firm profits.[30]

Importantly, the last expression above shows that all else equal greater steady-state de-

[28] As noted earlier, greater N_E reduces the equilibrium housing stock holdings by e households. However, from a quantitative standpoint and under any plausible calibration, this reduction is more than offset by the rise in steady-state house prices.

[29] This result would still hold in an environment where only a fraction of deposits is lent out by banks, as existing regulations in many economies require.

[30] This is also the case under other plausible parameterizations of the model.

viations in borrowing rates (and ultimately borrowing spreads) and individual-firm profits—both of which are more volatile when average firm entry is higher—contribute to greater percent deviations in house prices from steady state. This implies greater cyclical fluctuations in house prices in absolute terms *and* relative to fluctuations in output. We note that while both greater volatility in (expected) individual-firm profits and borrowing rates translates into greater house-price volatility, the rise in the volatility of borrowing rates amid higher average firm entry dominates and is responsible for quantitatively explaining the sharper fluctuations in house prices. This suggests that housing-finance constraints—and, as shown further below, the inclusion of shocks affecting housing finance—are critical for explaining the empirical positive connection between average NFD and and house-price fluctuations.

To put all of the preceding in broader context, Figure 4 compares the response to a positive aggregate productivity shock in our baseline economy to the response to the same shock in a second economy that is otherwise identical in terms of parameters except for the fact that, *for illustrative purposes only,* the sunk entry cost is only half of the one in the benchmark economy (this lower sunk entry cost *is not* the lowest when generating the complete NFD range in the data). In turn, Figure 5 compares the response of the two same economies to a positive housing-finance (or LTV) shock.

As shown in Figure 4, after an aggregate productivity shock, the economy with a lower ψ_e—that is, an economy with higher steady-state N_E—exhibits *smoother* responses to these shocks. Thus, aggregate productivity shocks alone *cannot* rationalize the empirical link between NFD and relative house-price volatility. In contrast, as shown in Figure 5, the response to housing-finance shocks confirms the intuition and channels outlined earlier.

Figure 4: Response to Positive Aggregate Productivity Shock (Quarters After Shock)

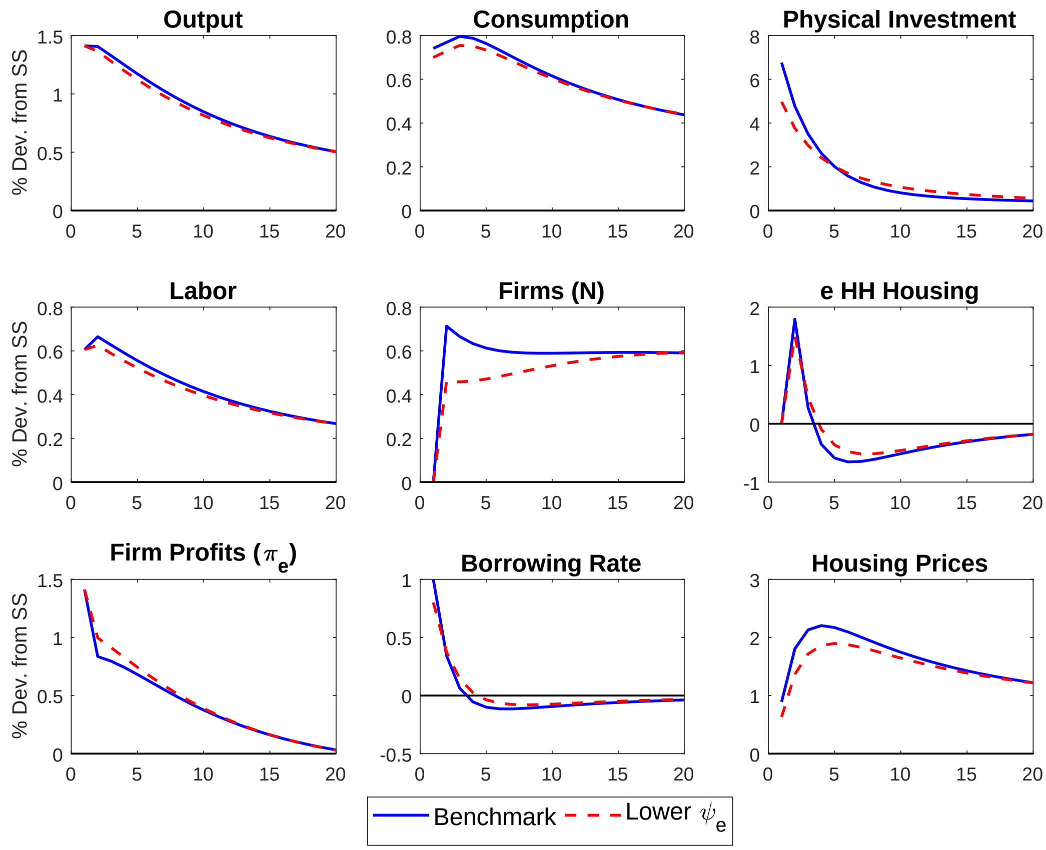
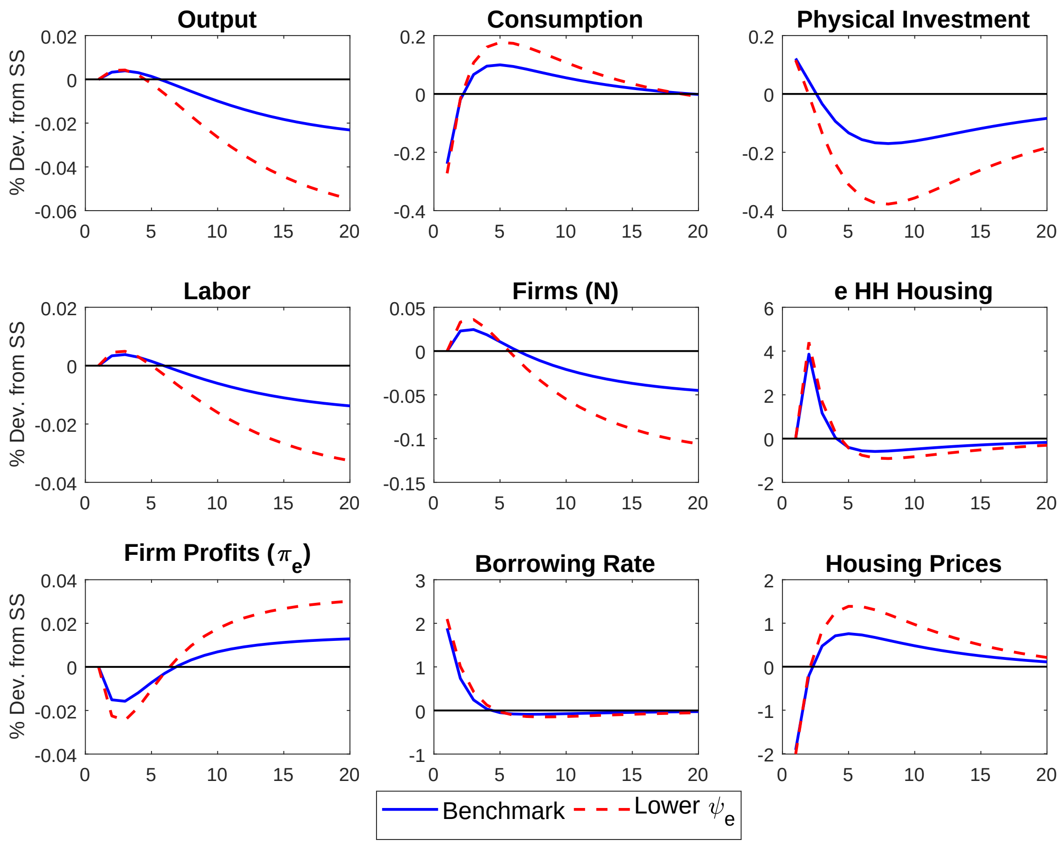


Figure 5: Response to Positive Housing-Finance Shock (Quarters After Shock)



Specifically, in response to a positive housing-finance shock, output, labor, physical investment, and firm entry all rise marginally before falling in the aftermath of the shock, while consumption falls on impact and then increases as resources are initially reallocated away from consumption and into the purchase of housing *and* the creation of firms (as the shock subsides, consumption rises and physical investment falls, following the medium-term pattern in firm dynamics). We note that the negative co-movement between consumption and investment *conditional on housing-finance shocks specifically* is consistent with the findings in Iacoviello (2015) in response to similar LTV shocks among households.[31]

[31]Thus, this particular model result is *not* a counterfactual prediction. In fact, considering more standard financial shocks that affect the production (and not housing) side delivers factual responses in consumption and investment (see, for example, Figure A9 of Appendix A.7, which shows the response to the economy to a foreign interest rate shock—a type of financial shock—in a small-open-economy version of our framework).

Of particular importance for our purposes is the fact that, for a given set of shocks, house prices become more responsive in the economy with a lower ψ_e (and hence greater steady-state N_E). As discussed above and as shown in Figure 5, this is driven by both an initial larger response in borrowing rates amid housing-finance shocks as well as larger fluctuations in individual-firm profits (recall that the reduction in ψ_e in Figures 3 and 4 is small relative to the range of ψ_e we consider in Figure 2. Thus, the differential response in borrowing rates and individual-firm profits relative to the baseline (low steady-state N_E) calibration are bound to be larger the lower ψ_e (and hence the higher steady-state N_E) is). Moreover, note that while the responsiveness of both output and house prices increases, the response of house prices is greater than that of output, ultimately resulting in greater variability in house prices (relative to the variability of output) compared to an economy with lower steady-state N_E.

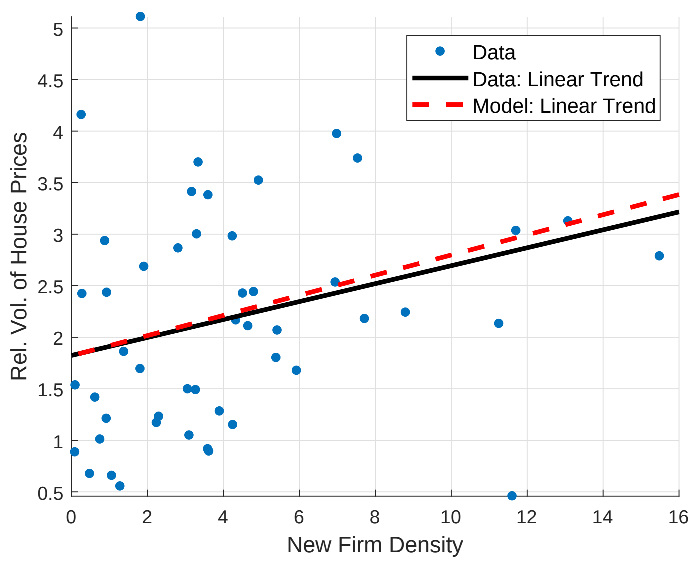
As we move on to present our main result, we stress once more that in Figures 4 and 5, the reduction in the sunk entry cost we implement to create these figures is a fraction of the total change we consider to match the range of NFD in the data.

4.3 New Firm Density and House Price Volatility: Data vs. Model

With the preceding economic mechanisms in mind, Figure 6 shows our main result. This figure plots the relationship between average NFD and the relative volatility of house prices in the data, which Section 2 confirmed was quantitatively and statistically significant, against the model-generated (endogenous) relationship between these two variables (recall that in the model, this relationship arises from varying firms' sunk entry costs alone, as described above, with the range of NFD in the model covering the same NFD range as our cross-country data). Once again, as noted in the description of the calibration of financial shocks, by construction, the model-based and empirical-based regression lines have the same intercept (a normalization for ease of comparison between the data and the model), *but critically, the slope—which provides a graphical representation of the extent to which the model can quantitatively capture the cross-country relationship between NFD and relative house-price* *volatility in the data—is an endogenous outcome in the model.*[32]

All told, Figure 6 shows that our benchmark model successfully replicates the positive relationship between average NFD and house price volatility in the data well.

Figure 6: Average New Firm Density and Relative House-Price Volatility: Data vs. Model

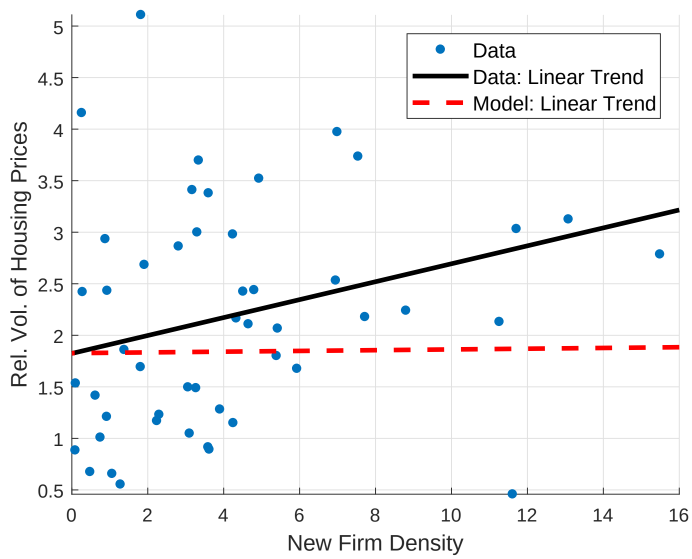


To explicitly highlight the role of housing-finance (or LTV) shocks in generating a non-trivial increase in relative house-price volatility as a result of greater average firm entry, we perform the same experiments shown in Figure 6 for two variants of the benchmark model. First, we consider a model without housing finance constraints (and therefore without housing-finance shocks) (Figure 7 below). Second, we consider a version of the benchmark model without housing-finance shocks (Figure 8 below). Of note, we introduce housing preference shocks *in both alternative frameworks* so that, consistent with the calibration of the benchmark model, these two other models can also replicate the same intercept in a model-based regression of relative house-price volatility on steady-stateN_E[33]

[32]Of note, in order to clearly dissect the economic mechanisms underlying the link between NFD and relative house-price volatility documented in Section 2, our model analysis assumes that the only difference across economies is in their average NFD (or, underlying NFD, the cost of creating a firm). Therefore, our analysis should be interpreted as shedding light on the cross-country link between house-price volatility and NFD, which is consistent with our empirical motivation in Section 2, and not on the change in relative house-price volatility as NFD changes *within* an economy.

[33]Otherwise, absent housing-market shocks (either preference or housing-finance shocks), the model with

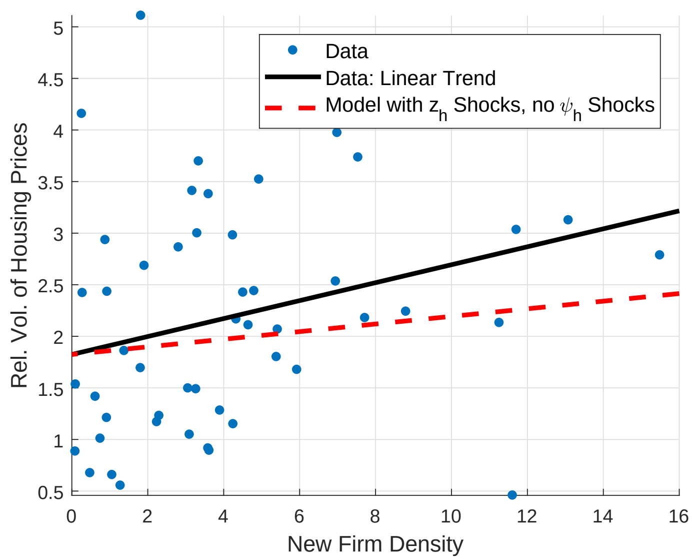
Figure 7: New Firm Density and Relative House-Price Volatility: Data vs. Model without Housing Finance Constraints



Absent housing finance constraints (and therefore housing-finance shocks), as shown in Figure 7 the model generates a positive *qualitative* relationship between NFD and the relative volatility of house prices. However, even amid housing preference shocks, a model without housing finance constraints faces severe limitations in *quantitatively* matching the changes in relative house-price volatility. This suggests that housing finance constraints play an important role in explaining the facts in Section 2, mainly because these constraints allow for housing-finance shocks to affect house prices via the economic mechanisms described earlier.

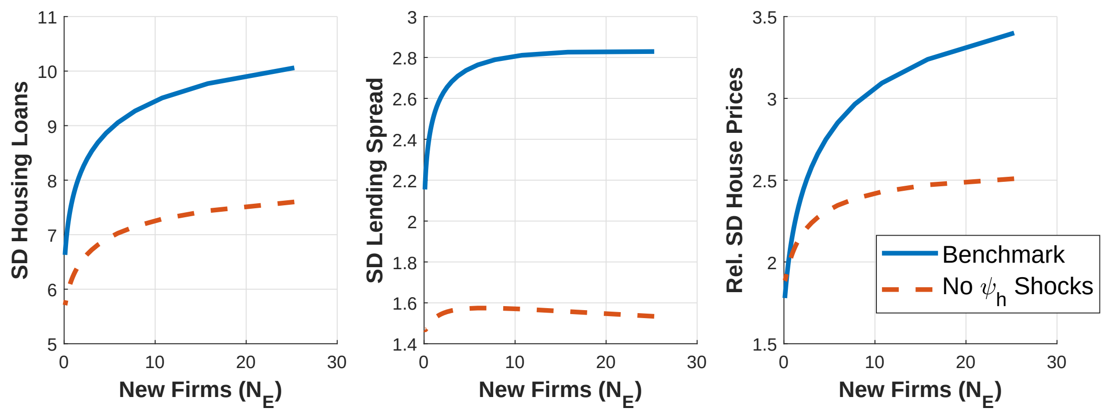
only aggregate productivity shocks generates too little volatility in house prices, both in absolute and relative terms (see Figure A4 in Appendix A.7). Thus, for the purposes of comparability, we introduce housing preference shocks. Section A.7 of the Appendix presents the calibration details for the housing preference shocks for the two alternative model specifications. For completeness, Figure A5 in Appendix A.7 also shows that introducing housing preference shocks *alongside* housing-finance and aggregate productivity shocks in our benchmark framework does not change any of our conclusions. This is not surprising given that, per Figure 6, housing-finance shocks can already quantitatively generate the empirical link between NFD and house-price volatility.

Figure 8: New Firm Density and Relative House-Price Volatility: Data vs. Benchmark Model with Housing Preference Shocks and *without* Housing Finance Shocks (but with Housing Preference Shocks)



As shown in Figure 8, a similar claim holds for a version of the benchmark model where housing preference shocks replace housing-finance shocks. In this case, the model does generate a positive relationship between NFD and the relative volatility of house prices, but the model still falls short of fully capturing the *quantitative* change in house price volatility as NFD changes. Intuitively, while housing preference shocks do increase the volatility of borrowing rates and lending spreads, the quantitative change in volatility is not as strong as the one from housing-finance shocks since these shocks have a more direct effect on the cost of credit by affecting housing loans directly. All told, these experiments suggest that housing-finance shocks play a key role in *quantitatively* explaining the link between NFD and house-price volatility in the data. Importantly, as we discuss briefly as part of our robustness analysis, it is domestic housing-finance shocks and not more general financial shocks—including, for example, foreign interest rate shocks that embody global liquidity movements—that play a key role in explaining the nexus between average NFD and house-price volatility in the data.

Figure 9: New Firm Density, Housing-Loan and Lending-Spread Volatility, and Relative House-Price Volatility



To summarize the main mechanisms and the importance of housing-finance shocks graphically, Figure 9 plots steady-state N_E against (1) the volatility of e-household housing loans (or credit); (2) the volatility of the lending-deposit spread; and (4) the relative volatility of house prices for both the benchmark model and a version of the model with housing preference shocks but no housing-finance shocks. We note that the volatility of lending spreads is completely driven by the volatility of borrowing rates; therefore, we do not plot the volatility of borrowing rates.[34] In the absence of housing-finance shocks, the increase in the volatility of both housing loans and borrowing rates due to greater average firm entry is considerably smaller, which ultimately results in a much smaller increase in the relative volatility of house prices.

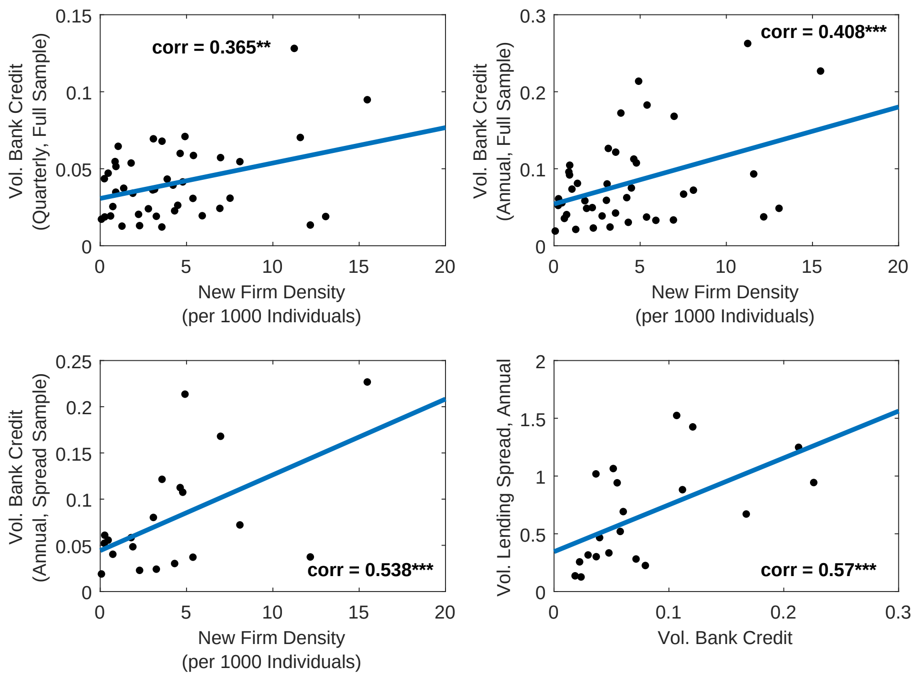
4.4 Empirical Corroboration of Model Mechanisms

As noted in the steady-state analysis of the model, greater average new firm entry generates an equilibrium increase in average house prices. By increasing the average size of housing loans, greater average NFD makes housing loans, borrowing rates, lending spreads, and bank credit more sensitive to shocks—*in particular, to housing-finance shocks.* This greater volatility in bank credit and lending spreads ultimately leads to higher house-price volatility

[34] As noted earlier, for comparability, the model without housing-finance shocks instead includes housing preference shocks so that both models have the same *initial* relative volatility of house prices at the intercept.

(in both absolute and relative terms). If this mechanism is indeed operative, then we should observe that greater average NFD is associated with greater bank-credit volatility, and that bank-credit volatility is positively associated with lending-spread volatility in the data.

Figure 10: New Firm Density, Average House Prices, and Credit Market Volatility: Evidence



Sources: World Bank Entrepreneurship Survey (NFD), World Bank Bank for International Settlements (house prices), IMF International Financial Statistics (bank credit), World Bank World Development Indicators (lending spread). Notes: Bank credit is given by real domestic claims on private sector by depository corporations. Similar facts hold with data for other depository corporations and with data at a quarterly frequency. Lending spreads are given by the difference between lending and deposit rates. The volatility measures for bank credit and lending spreads are computed based on filtered data using an HP filter with smoothing parameter 100. See the Appendix for more details regarding data sources and coverage for each variable. *** and ** denote significance at the 1 percent and 5 percent levels, respectively.

Figure 10 plots average NFD in the data against the volatility of real bank credit, and the volatility of real bank credit against the volatility of lending spreads. For completeness, the upper subpanels of Figure 10 plot the volatility of real bank credit at both quarterly and annual frequencies against average NFD for the economies in our sample that have available data on quarterly real bank credit. In turn, the lower subpanels of Figure 10 plot the volatility of real bank credit (at an annual frequency) against the volatility of lending spreads (also at an annual frequency) for the economies in our sample that have available data *on both measures* (this explains the smaller number of observations for bank-credit volatility).[35] All told, this evidence suggests that the main mechanism in our model is broadly corroborated by the data, which gives further validity to our framework.

4.5 Robustness of Model Results

The benchmark model assumes that s households do not borrow to purchase new housing; that bank credit is only directed towards household credit; and that the only shocks driving business cycles are aggregate productivity and housing-finance (or LTV) shocks. We briefly discuss plausible modifications of the benchmark model that relax these assumptions.

Richer Household-Borrowing Specifications Section A.5 of the Appendix presents the details of a richer version of the benchmark model where, in addition to having e households face housing finance constraints, these same households also borrow to cover a fraction of final goods firms' sunk entry costs and a fraction of intermediate goods firms' wage and capital bills. Similarly, Section A.6 of the Appendix presents the details of a version of the benchmark model where both e and s households face housing finance constraints (and housing-finance shocks).[36] Figure A6 in Appendix A.7 shows that our results remain un-

[35]Data on real bank credit that is closest to our model counterpart (that is, bank credit from depository institutions) is available at a quarterly frequency for 42 economies in our sample (after eliminating outliers). Uninterrupted series on lending spreads are available only at an annual frequency and for 23 economies in our sample. In turn, only 20 of those economies coincide with the economies that have data on our measure of real bank credit. However, as shown in two upper subpanels in Figure 10, the positive relationship between average NFD and the volatility of real bank credit continues to hold using both quarterly and annual data for the full sample of economies with available bank credit data. A similar claim applies if we restrict our sample to 2006-2016. We note that the same strong, positive link between average NFD and relative house-price volatility continues to hold in the smaller country sample used in Figure 10.

[36]Note that our model can accommodate this scenario without having to introduce an additional household category that only saves (a modification that would increase the model's complexity substantially). This stands in contrast with existing models of housing amid financing constraints that assume household heterogeneity rooted in differences in subjective discount factors. The reason we can seamlessly introduce housing-finance constraints for both households is simple: the presence of a monopolistically-competitive banking sector guarantees a lending-deposit rate spread in steady state without requiring heterogeneity in households' subjective discount factors. In turn, having housing finance constraints across both households allows housing-finance shocks—which, as noted earlier, play a key role in matching the facts in Section 2—to further affect house-price volatility (see Section A.6 for more details). Importantly, the fact that s households may hold deposit accounts (i.e., save) *and also have housing loans* is completely consistent with cross-country

changed when, in addition to the value of new housing, final goods firms' sunk entry costs and intermediate-goods firms' wage and capital bills are part of e households' financing constraints. In turn, Figure A7 in the same Appendix shows that assuming that all household categories have housing financing constraints generates a stronger relationship between NFD and the volatility of house prices. This result is a natural reflection of the amplification mechanism we described for the baseline model, which becomes stronger with more households facing housing-finance shocks. We note, though, that data on the share of individuals with a loan to purchase a home confirms that only a fraction of individuals across economies have housing loans. Thus, the case in Figure A7 should be seen as an upper bound for the model-based link between NFD and house price volatility. All told, the results in Figures A6 and A7 confirm that the strength of the model mechanism reflected in Figure 2 is robust to alternative shock specifications and richer specifications of e and s households' financing constraints.

Small Open Economy and Interest Rate Shocks International credit supply shocks play a relevant role by affecting asset prices, including housing (Cesa-Bianchi, Cespedes, and Rebucci, 2015; Cesa-Bianchi, Ferrero, and Rebucci, 2016, 2017). Figure A8 in Appendix A.7 shows that a small open economy (SOE) version of the model with foreign interest rate shocks (which embody global liquidity movements in a reduced-form way) delivers similar quantitative results.[37] In fact, greater average firm entry tends to *limit* the impact of foreign interest rate shocks by generating a more subdued response in macro aggregates and house prices (see Figure A9 in Appendix A.7). In other words, conditional on foreign interest rate shocks, greater average firm entry *lessens* the impact of these shocks on house-price dynamics. These results suggest that housing-market (financial) shocks *specifically* are critical for

data on financial account ownership and mortgage finance usage. Indeed, cross-country data from the World Bank Financial Inclusion Database shows that the share of individuals with financial accounts (as a share of the population ages +15) is *greater* than the share of individuals that have a loan to purchase a home (as a share of the population ages +15). This immediately suggests that an individual with a housing loan will, in all likelihood, also have a deposit account.

[37]Of course, not all countries in our sample can be labeled as SOEs. However, global liquidity shocks—which are tractably embodied in foreign interest rate shocks—can be plausibly seen as exogenous from the vantage view of most of the countries we consider. Thus, the SOE assumption is not a restrictive one for our particular purpose of briefly exploring the impact of global liquidity on house -rice volatility and firm creation.

generating the relationship between average NFD and house-price volatility in the data.

5 Conclusion

In recent years, reforms aimed at reducing the regulatory barriers to firm creation have gained significant prominence in economies beyond the US, where reductions in firm-entry costs are associated with greater levels of average firm creation. Motivated by these facts and given growing evidence linking firm formation and housing-market dynamics, we use a large sample of countries with available data on regulatory firm-creation costs, firm creation, and high-frequency data on house prices and document a new stylized fact: a strong and positive cross-country relationship between average new firm density (NFD) and house-price volatility. This relationship exists even after controlling for other factors that may be associated with cyclical house-price dynamics. Moreover, further stylized analysis suggests that the relationship may be causal from average NFD levels to house-price volatility.

We build a real business cycle model with housing, endogenous firm entry, and housing-finance constraints and shocks to explore whether differences in average firm creation (rooted in firm creation costs) can be a driving force behind the differences in house-price volatility across countries. Our framework can successfully replicate the increase in the relative volatility of house prices as average firm entry increases, both qualitatively *and* quantitatively. Greater average new firm entry bolsters household income and leads to higher average house prices. Higher average house prices imply larger average housing loans, making households' choices over loans more sensitive to housing-finance shocks. The greater sensitivity of housing loans feeds into borrowing rates—a component of households' cost of house purchases—and lending spreads, which in turn become more sensitive to these shocks as well. The responsiveness of borrowing rates and lending spreads to housing-finance shocks ultimately leads to greater house price volatility amid greater average new firm entry. We find that this mechanism is broadly corroborated by the data.

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A Online Appendix

A.1 Data Sources and Details

Our country sample is based on data availability on house prices by the Bank for International Settlements (BIS) and new business density by the World Bank Entrepreneurship Survey. The set of countries with available data is comprised of: Australia, Austria, Belgium, Brazil, Bulgaria, Chile, Colombia, Croatia, Cyprus, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hong Kong, Hungary, Iceland, India, Indonesia, Ireland, Israel, Italy, Japan, Korea, Latvia, Lithuania, Luxembourg, Macedonia, Malaysia, Malta, Mexico, Morocco, Netherlands, New Zealand, Norway, Peru, Philippines, Poland, Portugal, Romania, Russia, Serbia, Singapore, Slovak Republic, Slovenia, South Africa, Spain, Sweden, Switzerland, Thailand, Turkey, and United Kingdom (Canada only has observations for 2015 and 2016 and as such is excluded from the sample). Time coverage varies by country. We identify Australia, Cyprus, Hong Kong, and South Africa as outliers in terms of their relative volatility of house prices and/or their average new firm density (NFD).

Loan for Home Purchase Share of population ages 15+ with a loan for home purchase in 2011 (data availability restricted to 2011 and 2014). Source: World Bank Global Financial Inclusion Database.

New Firm Density New firm density (NFD) is given by the number of newly registered private, formal-sector corporations with limited liability (or LLC) per 1000 individuals ages 15-64, available at a yearly frequency from 2006 to 2016 (sample period varies by country). Source: World Bank Entrepreneurship Survey. Average NFD is computed as NFD averaged over the period 2006-2016. See http://www.doingbusiness.org/data/exploretopics/entrepreneurship and http://econ.worldbank.org/research/entrepreneurship.

Bank Credit to the Private Sector as a share of GDP Available at yearly frequency from 1990 to 2016 (sample period varies by country). Source: World Bank World Development Indicators.

Lending-Deposit Interest Rate Spreads Available at yearly frequency from 1990 to 2016 (sample period varies by country). Source: World Bank World Development Indicators.

Quarterly Real GDP Real Index, available at quarterly frequency from 1990Q1 to 2016Q4 (sample period varies by country). Source: IMF International Financial Statistics. All data is seasonally adjusted using the Census X12 method.

Quarterly Real Investment Available at a quarterly frequency from 1990Q1 to 2016Q4 (sample period varies by country). Source: IMF International Financial Statistics. All data is seasonally adjusted using the Census X12 method.

Quarterly Inflation Rate Growth rate of consumer price index (CPI), available at quarterly frequency from 1990Q1 to 2016Q4 (sample period varies by country). Source: IMF International Financial Statistics. All data is seasonally adjusted using the Census X12 method.

Real House Prices (BIS) Real residential property prices from the Bank for International Settlements (BIS) are available at a quarterly frequency from 1990Q1 to 2016Q4 (sample period varies by country). All data is seasonally adjusted using the Census X12 method.

Real House Prices (Cesa-Bianchi, Cespedes, and Rebucci, 2015) Real property prices from Cesa-Bianchi, Cespedes, and Rebucci (2015) are available at quarterly frequency from 1990Q1 to 2012Q4 for: Argentina, Austria, Belgium, Brazil, Bulgaria, Chile, Colombia, Croatia, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hong Kong, Hungary, Iceland, India, Indonesia, Ireland, Israel, Italy, Japan, Korea, Latvia, Lithuania, Luxembourg, Malaysia, Malta, Mexico, Morocco, Netherlands, New Zealand, Norway, Peru, Philippines, Poland, Portugal, Russia, Serbia, Singapore, Slovak Republic, Slovenia, South Africa, Spain, Sweden, Switzerland, Thailand, United Kingdom (sample period varies by country).

Global Liquidity from Banks Global Liquidity Indicators: cross-border total claims by domestic, foreign, consortium, and unclassified banks/financial institutions for all reporting countries and all sectors, available at quarterly frequency from 1990Q1 to 2016Q4. Source: Bank for International Settlements.

Household Credit Share Average household credit as a share of total (household and firm) credit, 1994-2005. Source: Beck, Büyükkarabacak, Rioja, and Valev (2012). Countries with available data: Australia, Austria, Belgium, Bulgaria, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Iceland, India, Indonesia, Ireland, Japan, Korea, Latvia, Lithuania, Macedonia, Malaysia, Mexico, Netherlands, New Zealand, Poland, Portugal, Russia, Slovak Republic, Slovenia, South Africa, Sweden, Switzerland, Thailand, Turkey, and United Kingdom.

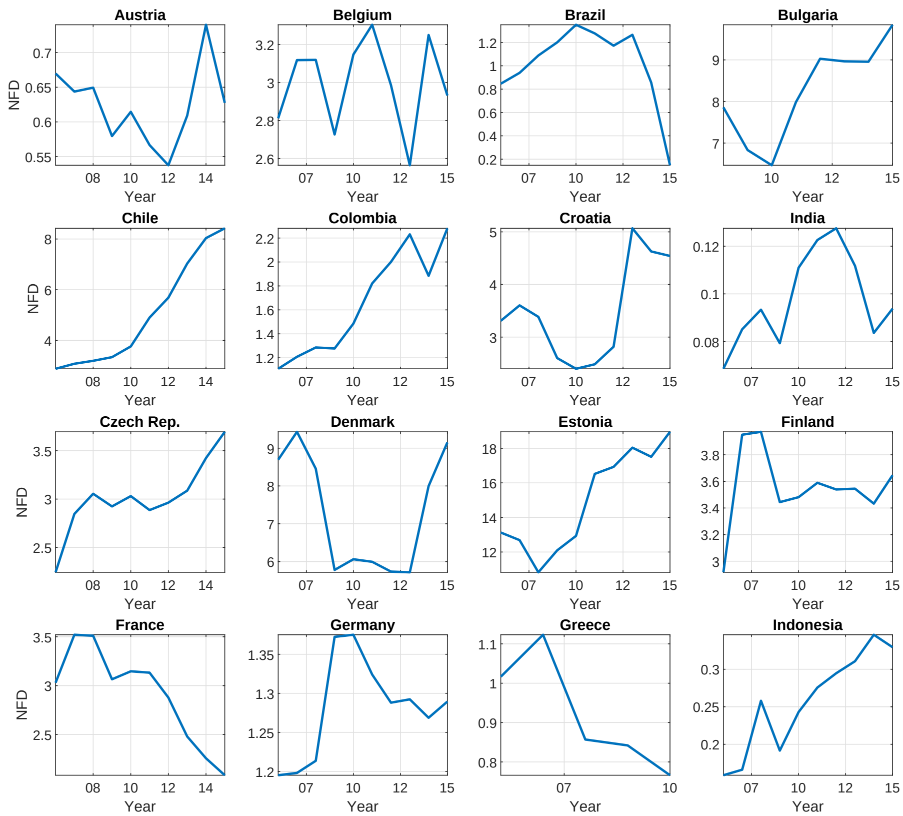
Own Account Worker Share Share of own account workers in total employment, yearly average from 2000 to 2016. Source: International labor Organization.

Informal Sector Size Average informal sector size as a percent of GDP, yearly average from 1999 to 2007 (only years available). Source: Schneider (2012).

Bank Credit Domestic Claims on Private Sector by Depository Corporations (Depository Corporations Survey, Domestic Claims, Claims on Other Sectors, Claims on Private Sector (refers to the Depository Corporations), Domestic Currency, Nominal). Available at quarterly frequency from 2001Q4 to 2016Q4 (*uninterrupted* coverage varies by country). Data is seasonally adjusted using the Census X12 method. Real bank credit is obtained using each country's CPI. Annual series are computed as quarterly averages. Countries with available data: Australia, Austria, Belgium, Brazil, Bulgaria, Chile, Colombia, Cyprus, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Iceland, Indonesia, Ireland, Israel, Italy, Japan, Korea, Luxembourg, Macedonia, Malaysia, Malta, Mexico, Morocco, Netherlands, Norway, Philippines, Poland, Portugal, Romania, Russia, Serbia, Slovenia, South Africa, Spain, Sweden, Thailand, and Turkey. Source: International Monetary Fund International Financial Statistics.

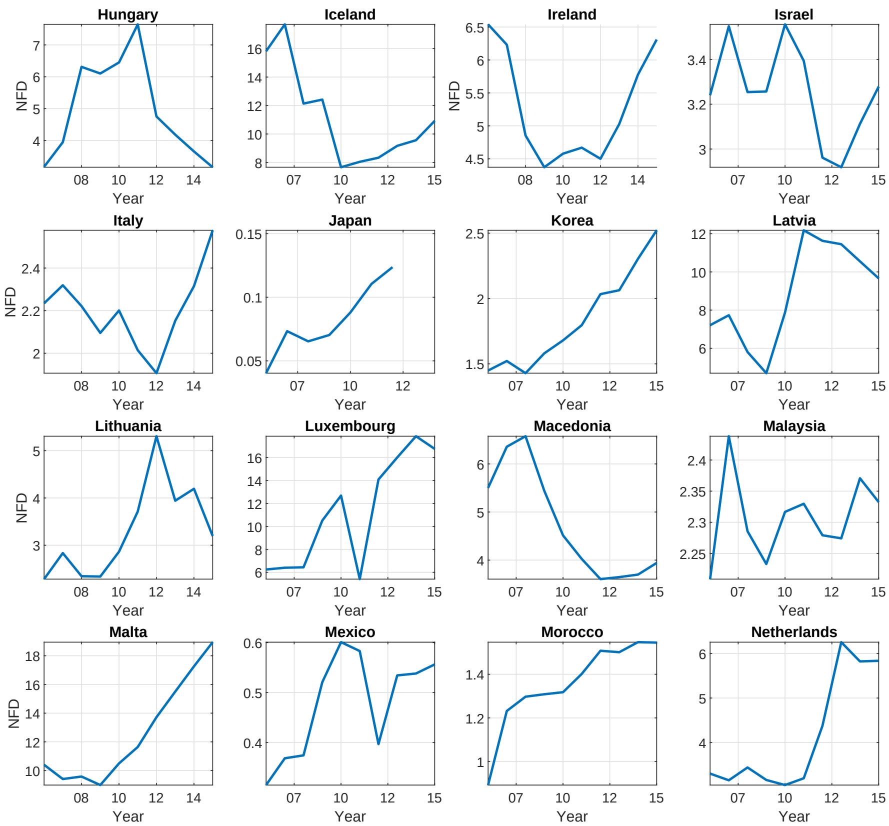
A.2 New Firm Density By Country Across Time

Figure A1: Time Series for New Firm Density



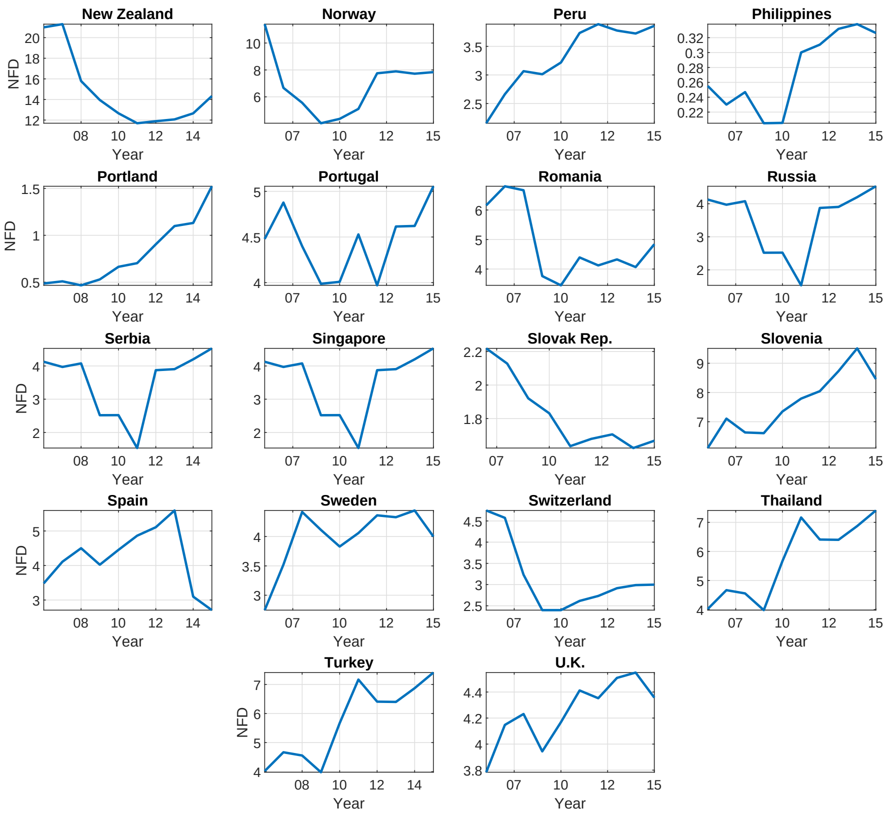
Source: World Bank Entrepreneurship Survey.

Figure A2: Time Series for New Firm Density



Source: World Bank Entrepreneurship Survey.

Figure A3: Time Series for New Firm Density



Source: World Bank Entrepreneurship Survey.

A.3 Robustness Checks: New Firm Formation and Housing Price Volatility Across Countries

A.3.1 Baseline Regressions

Table A1: Relative Volatility of House Prices and New Firm Density (1990Q1-2016Q4)

	(1)	(2)	(3)	(4)	(5)
Ave. New Firm Density	0.0707**	0.103***	0.0981***	0.105***	0.117***
	(2.04)	(3.02)	(2.91)	(3.26)	(2.87)
Loan to Purchase Home		-0.0177	-0.00240	0.0109	-0.00260
		(-1.46)	(-0.21)	(0.81)	(-0.17)
Inflation Volatility			0.868***	0.804***	2.055*
			(6.12)	(6.26)	(2.03)
Corr(Global Liquidity,GDP)				0.182	0.899
				(0.32)	(1.39)
Advanced Econ.				-0.647*	-0.449
				(-1.94)	(-1.21)
Household Credit Share					3.084**
					(2.75)
Constant	1.872***	2.030***	1.223***	1.331***	-0.978
	(7.88)	(7.06)	(4.57)	(3.37)	(-1.00)
R^2	0.045	0.076	0.318	0.330	0.371
Observations	51	48	48	48	33

t statistics in parentheses. Standard errors are heteroskedasticity-robust.
$^{*}p < 0.10$, $^{**}p < 0.05$, $^{***}p < 0.01$

Sources: World Bank Entrepreneurship Survey, World Bank Global Financial Inclusion Database, World Bank Doing Business, World Bank World Development Indicators, IMF International Financial Statistics, Bank of International Settlements. Notes: The relative volatility of house prices for a given country is computed as the volatility of HP-filtered real house prices divided by the volatility of HP-filtered real GDP for that country, using a smoothing parameter of 1600. The cyclical correlation between global liquidity supplied by banks and real GDP is computed as the contemporaneous correlation of HP-filtered global liquidity supplied by banks and HP-filtered real GDP, using a smoothing parameter of 1600. See the Data Appendix for details regarding data sources, country sample, and definitions.

Table 1: Relative Volatility of House Prices and New Firm Density (2000Q1-2016Q4)

	(1)	(2)	(3)	(4)	(5)
Ave. New Firm Density	0.0870**	0.117**	0.110**	0.121***	0.154**
	(2.04)	(2.65)	(2.52)	(2.80)	(2.18)
Loan to Purchase Home		-0.0150	-0.00131	0.0114	-0.00399
		(-1.25)	(-0.11)	(0.82)	(-0.20)
Inflation Volatility			0.804***	0.741***	1.577
			(7.97)	(8.08)	(1.27)
Corr(Global Liquidity,GDP)				0.00606	0.420
				(0.01)	(0.42)
Advanced Econ.				-0.622*	-0.390
				(-1.75)	(-0.91)
Household Credit Share					2.595*
					(1.77)
Constant	1.824***	1.957***	1.244***	1.420***	-0.340
	(7.37)	(6.52)	(4.39)	(3.22)	(-0.26)
R^2	0.072	0.086	0.278	0.285	0.294
Observations	50	47	47	47	32

t statistics in parentheses. Standard errors are heteroskedasticity-robust.
$^{*}p < 0.10$, $^{**}p < 0.05$, $^{***}p < 0.01$

Sources: World Bank Global Financial Inclusion Database, World Bank Doing Business, World Bank World Development Indicators, IMF International Financial Statistics, Bank of International Settlements. Notes: The relative volatility of house prices for a given country is computed as the volatility of HP-filtered real house prices divided by the volatility of HP-filtered real GDP for that country, using a smoothing parameter of 1600. The cyclical correlation between global liquidity supplied by banks and real GDP is computed as the contemporaneous correlation of HP-filtered global liquidity supplied by banks and HP-filtered real GDP, using a smoothing parameter of 1600. The largest country sample is comprised of: Austria, Belgium, Brazil, Bulgaria, Chile, Colombia, Croatia, Czech Republic, Denmark, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Israel, Italy, Japan, Korea, Latvia, Lithuania, Luxembourg, Macedonia, Malaysia, Malta, Mexico, Morocco, Netherlands, New Zealand, Norway, Peru, Philippines, Poland, Portugal, Romania, Russia, Serbia, Singapore, Slovak Republic, Slovenia, Spain, Sweden, Switzerland, Thailand, Turkey, and United Kingdom. See the Data Appendix for details regarding data sources, country sample, and definitions.

Table A3: Relative Volatility of House Prices and New Firm Density, Alternative Specifications (2000Q1-2016Q4)

	(1)	(2)	(3)	(4)	(5)	(6)
Ave. New Firm Density	0.112**	0.123***	0.123**	0.105**	0.123**	0.124**
	(2.55)	(3.00)	(2.68)	(2.14)	(2.62)	(2.66)
Inflation Volatility	0.730***	0.713***	0.715**	1.065	0.614**	0.706**
	(6.09)	(6.35)	(2.68)	(1.10)	(2.62)	(2.64)
Loan to Purchase Home	0.00339	0.0223	0.00576	0.0136	0.0143	0.00644
	(0.25)	(1.32)	(0.41)	(0.87)	(1.03)	(0.45)
Ave. Inflation Rate	0.277	0.0701				
	(0.67)	(0.15)				
Corr(Global Liquidity,GDP)	-0.250	0.136	-0.0421	-0.0947	-0.451	-0.0613
	(-0.38)	(0.21)	(-0.06)	(-0.14)	(-0.62)	(-0.09)
Ave Log GDPPC		-0.740*				
		(-1.96)				
Ave. Inflation Rate			0.144	0.122	0.165	0.144
			(0.38)	(0.32)	(0.46)	(0.37)
Ave. Own-Account-Worker Share			0.0128		0.0236	0.0115
			(0.76)		(1.31)	(0.64)
Ave. Informal Sector Size				0.0178		
				(0.79)		
Ave. Pop. Growth					-0.366*	
					(-1.80)	
Ave. Urban Pop. Share						-0.00255
						(-0.27)
Constant	1.151**	8.183**	0.832	0.388	0.991	1.036
	(2.54)	(2.23)	(1.36)	(0.55)	(1.48)	(0.99)
R^2	0.256	0.314	0.245	0.136	0.277	0.227
Observations	47	47	47	46	47	47

t statistics in parentheses. Standard errors are heteroskedasticity-robust.
$^{*}p < 0.10$, $^{**}p < 0.05$, $^{***}p < 0.01$

Sources: World Bank Entrepreneurship Survey, World Bank Global Financial Inclusion Database, World Bank Doing Business, World Bank World Development Indicators, IMF International Financial Statistics, Bank of International Settlements. Notes: The relative volatility of house prices for a given country is computed as the volatility of HP-filtered real house prices divided by the volatility of HP-filtered real GDP for that country, using a smoothing parameter of 1600. The cyclical correlation between global liquidity supplied by banks and real GDP is computed as the contemporaneous correlation of HP-filtered global liquidity supplied by banks and HP-filtered real GDP, using a smoothing parameter of 1600. See the Data Appendix for details regarding data sources, country sample, and definitions.

Table A4: Relative Volatility of House Prices and New Firm Density, Data in First Differences (2000Q1-2016Q4)

	(1)	(2)	(3)	(4)	(5)
Ave. New Firm Density	0.0627*	0.0926***	0.0921***	0.125***	0.147***
	(1.94)	(2.77)	(2.72)	(3.54)	(3.26)
Loan to Purchase Home		-0.00977	-0.00734	-0.000129	-0.00585
		(-0.97)	(-0.68)	(-0.01)	(-0.48)
Inflation Volatility			0.127	0.120	1.395
			(1.34)	(1.14)	(1.64)
Corr(Global Liquidity,GDP)				1.401**	1.890***
				(2.42)	(3.18)
Advanced Econ.				-0.620*	0.0563
				(-1.83)	(0.15)
Household Credit Share					1.762
					(1.58)
Constant	1.669***	1.746***	1.616***	1.391***	-0.794
	(8.67)	(7.36)	(5.75)	(4.15)	(-0.79)
R^2	0.049	0.079	0.068	0.124	0.326
Observations	52	49	49	49	34

t statistics in parentheses. Standard errors are heteroskedasticity-robust.
$^{*}p < 0.10$, $^{**}p < 0.05$, $^{***}p < 0.01$

Sources: World Bank Entrepreneurship Survey, World Bank Global Financial Inclusion Database, World Bank Doing Business, World Bank World Development Indicators, IMF International Financial Statistics, Bank of International Settlements. Notes: The relative volatility of house prices is computed as the volatility of real house prices in first differences divided by the volatility of real GDP in first differences. The cyclical correlation between global liquidity supplied by banks and real GDP is computed as the contemporaneous correlation of global liquidity supplied by banks in first differences and real GDP in first differences. See the Data Appendix for details regarding data sources, country sample, and definitions.

Table A5: Relative Volatility of House Prices and New Firm Density, Cesa-Bianchi et al. (2015) House Price Data (2000Q1-2012Q4)

	(1)	(2)	(3)	(4)	(5)
Ave. New Firm Density	0.0819**	0.135***	0.124***	0.130***	0.135***
	(2.03)	(3.50)	(3.59)	(3.58)	(3.09)
Loan to Purchase Home		-0.0353***	-0.0200*	-0.0141	-0.0147
		(-3.05)	(-1.88)	(-1.16)	(-0.88)
Inflation Volatility			0.679***	0.646***	1.665***
			(4.62)	(4.30)	(4.04)
Corr(Global Liquidity,GDP)				0.534	-0.418
				(0.95)	(-0.49)
Advanced Econ.				-0.368	0.359
				(-0.90)	(0.67)
Household Credit Share					0.737
					(0.51)
Constant	1.981***	2.344***	1.656***	1.520***	0.651
	(7.49)	(7.76)	(5.24)	(4.00)	(1.01)
R^2	0.062	0.207	0.410	0.396	0.510
Observations	47	44	44	44	30

t statistics in parentheses. Standard errors are heteroskedasticity-robust.
$^{*}p < 0.10$, $^{**}p < 0.05$, $^{***}p < 0.01$

Sources: World Bank Entrepreneurship Survey, World Bank Global Financial Inclusion Database, World Bank Doing Business, World Bank World Development Indicators, IMF International Financial Statistics, Cesa-Bianchi et al. (2015). Notes: The relative volatility of house prices for a given country is computed as the volatility of HP-filtered real house prices divided by the volatility of HP-filtered real GDP for that country, using a smoothing parameter of 1600. The cyclical correlation between global liquidity supplied by banks and real GDP is computed as the contemporaneous correlation of HP-filtered global liquidity supplied by banks and HP-filtered real GDP, using a smoothing parameter of 1600. See the Data Appendix for details regarding data sources, country sample, and definitions.

Table A6: Relative Volatility of House Prices and New Firm Density (2000Q1-2016Q4), Clustering by Region

	(1)	(2)	(3)	(4)	(5)
Ave. New Firm Density	0.0870***	0.117***	0.110***	0.121***	0.154**
	(10.06)	(21.13)	(17.93)	(21.06)	(4.43)
Loan to Purchase Home		-0.0150**	-0.00131	0.0114	-0.00399
		(-5.68)	(-0.43)	(2.19)	(-0.31)
Inflation Volatility			0.804***	0.741***	1.577
			(14.43)	(7.57)	(0.93)
Corr(Global Liquidity,GDP)				0.00606	0.420
				(0.02)	(0.89)
Advanced Econ.				-0.622	-0.390
				(-1.85)	(-0.63)
Household Credit Share					2.595
					(1.43)
Constant	1.824***	1.957***	1.244***	1.420***	-0.340
	(37.05)	(31.89)	(40.17)	(19.86)	(-0.22)
R^2	0.072	0.086	0.278	0.285	0.294
Observations	50	47	47	47	32

t statistics in parentheses.
$^{*}p < 0.10$, $^{**}p < 0.05$, $^{***}p < 0.01$

Sources: World Bank Entrepreneurship Survey, World Bank Global Financial Inclusion Database, World Bank Doing Business, World Bank World Development Indicators, IMF International Financial Statistics, Bank of International Settlements. Notes: The relative volatility of house prices for a given country is computed as the volatility of HP-filtered real house prices divided by the volatility of HP-filtered real GDP for that country, using a smoothing parameter of 1600. The cyclical correlation between global liquidity supplied by banks and real GDP is computed as the contemporaneous correlation of HP-filtered global liquidity supplied by banks and HP-filtered real GDP, using a smoothing parameter of 1600. See the Data Appendix for details regarding data sources, country sample, and definitions.

Table A7: Relative Volatility of House Prices and New Firm Density (2000Q1-2016Q4), Controlling for Average Real House Prices

	(1)	(2)	(3)	(4)	(5)	(6)
Ave. New Firm Density	0.0870**	0.0982**	0.134***	0.125***	0.137***	0.175***
	(2.04)	(2.29)	(3.21)	(3.05)	(3.47)	(3.12)
Ave. Real House Price		-0.0221*	-0.0253**	-0.0211**	-0.0217**	-0.0330***
		(-1.90)	(-2.25)	(-2.27)	(-2.64)	(-3.16)
Loan to Purchase Home			-0.0189	-0.00522	0.00709	-0.00783
			(-1.58)	(-0.45)	(0.49)	(-0.41)
Inflation Volatility				0.766***	0.698***	2.142*
				(5.91)	(6.41)	(1.89)
Corr(Global Liquidity,GDP)					-0.189	-0.0475
					(-0.30)	(-0.05)
Advanced Econ.					-0.587	-0.174
					(-1.65)	(-0.44)
Household Credit Share						2.454*
						(1.73)
Constant	1.824***	3.976***	4.458***	3.364***	3.682***	2.818*
	(7.37)	(3.56)	(3.94)	(3.64)	(4.68)	(1.71)
R^2	0.072	0.105	0.135	0.310	0.320	0.393
Observations	50	50	47	47	47	32

t statistics in parentheses. Errors are heteroskedasticity-robust.
$^{*}p < 0.10$, $^{**}p < 0.05$, $^{***}p < 0.01$

Sources: World Bank Entrepreneurship Survey, World Bank Global Financial Inclusion Database, World Bank Doing Business, World Bank World Development Indicators, IMF International Financial Statistics, Bank of International Settlements. Notes: The relative volatility of house prices for a given country is computed as the volatility of HP-filtered real house prices divided by the volatility of HP-filtered real GDP for that country, using a smoothing parameter of 1600. The cyclical correlation between global liquidity supplied by banks and real GDP is computed as the contemporaneous correlation of HP-filtered global liquidity supplied by banks and HP-filtered real GDP, using a smoothing parameter of 1600. See the Data Appendix for details regarding data sources, country sample, and definitions.

A.4 Equilibrium Conditions: Benchmark Model

Taking the sequence of shocks as given, the allocations and prices $\{\rho_t, N_t, N_{E,t}, v_t, r_{k,t}\}$, $\{w_t, c_{s,t}, n_{s,t}, h_{s,t}\}$ and $\{R_t, l_{e,t}, k_t, R_{h,t}, n_{e,t}, Q_t, d_t, n_t, y_t, h_{e,t}, i_t, Y_t, c_{e,t}\}$ satisfy

$$\rho_t = (\varepsilon/(\varepsilon-1))\, mc_t, \tag{13}$$

$$N_t = (1-\delta)\left(N_{t-1} + N_{E,t-1}\right), \tag{14}$$

$$v_t = \frac{\psi_e}{(1-\delta)}, \tag{15}$$

$$v_t = \mathbb{E}_t \Xi^e_{t+1|t}\left[\underbrace{\left[\rho_{t+1} - mc_{t+1}\right] y_{t+1}}_{\pi_{e,t+1}} + (1-\delta)\, v_{t+1}\right], \tag{16}$$

$$r_{k,t} = \alpha mc_t z_t n_t^{1-\alpha} k_t^{\alpha-1}, \tag{17}$$

$$w_t = (1-\alpha) mc_t z_t n_t^{-\alpha} k_t^{\alpha}, \tag{18}$$

$$c_{s,t} + Q_{h,t}(h_{s,t} - h_{s,t-1}) + d_t = w_t n_{s,t} + R_{t-1} d_{t-1}, \tag{19}$$

$$\kappa n_{s,t}^{\xi} = w_t, \tag{20}$$

$$Q_{h,t} = \frac{(h_{s,t})^{-\sigma_h}}{\mathbf{u}_{c_{s,t}}} + \mathbb{E}_t \Xi^s_{t+1|t} Q_{h,t+1}, \tag{21}$$

$$\mathbf{u}_{c_{s,t}} = \beta R_t \mathbb{E}_t \mathbf{u}_{c_{s,t+1}}, \tag{22}$$

$$l_{e,t} = \phi_{h,t} Q_{h,t} h_{e,t}, \tag{23}$$

$$1 = \mathbb{E}_t \Xi^e_{t+1|t}\left[r_{k,t+1} + 1 - \delta\right], \tag{24}$$

$$R_{e,t} = \left(\frac{\varepsilon_h}{\varepsilon_h - 1}\right) R_t, \tag{25}$$

$$\kappa n_{e,t}^{\xi} = w_t, \tag{26}$$

$$Q_{h,t} = \frac{(h_{e,t})^{-\sigma_h}}{\mathbf{u}_{c_{e,t}}} + \mathbb{E}_t \Xi^e_{t+1|t} Q_{h,t+1} - Q_{h,t}\phi_{h,t}\left[\mathbb{E}_t \Xi^e_{t+1|t} R_{e,t} - 1\right], \tag{27}$$

$$d_t = l_{e,t}, \tag{28}$$

$$n_{e,t} + n_{s,t} = n_t, \tag{29}$$

$$z_t n_t^{1-\alpha} k_t^{\alpha} = N_t y_t, \tag{30}$$

$$h_{e,t} + h_{s,t} = 1, \tag{31}$$

$$i_t = k_t - (1-\delta)k_{t-1}, \tag{32}$$

$$Y_t = y_t N_t^{\frac{\varepsilon}{\varepsilon-1}}, \tag{33}$$

$$Y_t = c_{s,t} + c_{e,t} + i_t + \psi_e N_{E,t}, \tag{34}$$

where $\Xi^s_{t+1|t} \equiv \beta \mathbf{u}_{c_{s,t+1}} / \mathbf{u}_{c_{s,t}}$ and $\Xi^e_{t+1|t} \equiv \beta \mathbf{u}_{c_{e,t+1}} / \mathbf{u}_{c_{e,t}}$.

A.5 Richer Specification of Financing Constraints

Recall that entrepreneur (e) households own all firms. For simplicity and in order to make the model as simple as possible, we assume that entrepreneur (e) households not only supply labor to intermediate-goods firms, but also act as demanders of labor from the vantage point of their intermediate-goods firms. This allows us to have a single financing constraint where the firms' wage and capital bills and the sunk entry costs are present. Put differently, in this modified environment, we can think of e households as supplying labor to intermediate-goods other than their own, and demanding labor for their intermediate-goods firms from households other than their own.

Entrepreneur (e) Households Entrepreneur (e) households choose consumption $c_{e,t}$, housing demand $h_{e,t}$, labor supply $n_{e,t}$, labor demand n_t, capital accumulation k_t, total borrowed funds $l_{e,t}$,, the number of new firms $N_{E,t}$, and the desired number of future firms N_{t+1} to maximize

$$\mathbb{E}_0 \sum_{t=0}^{\infty} \beta^t \mathbf{u}(c_{e,t}, n_{e,t}, h_{e,t}) \tag{35}$$

subject to the budget constraint[38]

$$
\begin{aligned}
& c_{e,t} + \psi_e N_{E,t} + Q_{h,t}(h_{e,t} - h_{e,t-1}) + R_{e,t-1} l_{e,t-1} \\
= \;& w_t n_{e,t} + N_t \pi_{e,t} + \left[mc_t z_t n_t^{1-\alpha} k_{t-1}^{\alpha} - w_t n_t - (k_t - (1-\delta) k_{t-1}) \right] + l_{e,t},
\end{aligned}
$$

the evolution of final goods firms

$$
N_{t+1} = (1-\delta)\left(N_t + N_{E,t}\right), \tag{36}
$$

and the financing constraint

$$
l_{e,t} = \phi_{h,t} Q_{h,t} h_{e,t} + \phi_e \psi_e N_{E,t} + \phi_n w_t n_t + \phi_k r_{k,t} k_t. \tag{37}
$$

where intermediate-goods-firms profits $\Pi_{i,t} = \left[mc_t z_t n_t^{1-\alpha} k_{t-1}^{\alpha} - w_t n_t - (k_t - (1-\delta) k_{t-1}) \right]$, $(k_t - (1-\delta) k_{t-1})$ denotes physical capital investment, mc_t is the price of intermediate goods, z is exogenous aggregate productivity, and $0 < \alpha < 1$. Preferences continue to be of the GHH form over consumption and labor: $\mathbf{u}(c_{e,t}, n_{e,t}, h_{e,t}) = \left[\frac{1}{1-\sigma} \left(c_{e,t} - \frac{\kappa}{1+\xi} n_{e,t}^{1+\xi} \right)^{1-\sigma} + \frac{\gamma}{1-\sigma_h} \left(h_{e,t} \right)^{1-\sigma_h} \right]$ with $\sigma, \sigma_h, \kappa, \xi, \gamma > 0$. The financing constraint now specifies that total borrowed funds is a fraction ϕ_h of new housing purchases, a fraction ϕ_e of the firm sunk entry costs, a fraction ϕ_n of the wage bill, and a fraction ϕ_k of the capital bill, where $0 \leq \phi_e, \phi_n, \phi_k \leq 1$.

The Euler equations for capital as well as optimal housing demand remain unchanged relative to those in the main text:

$$
1 = \mathbb{E}_t \Xi^e_{t+1|t} \left[r_{k,t+1} + 1 - \delta \right], \tag{38}
$$

and

$$
Q_{h,t} = \frac{\left(h_{e,t} \right)^{-\sigma_h}}{\mathbf{u}_{c_{e,t}}} + \mathbb{E}_t \Xi^e_{t+1|t} Q_{h,t+1} - Q_{h,t} \phi_{h,t} \left[\mathbb{E}_t \Xi^e_{t+1|t} R_{e,t} - 1 \right], \tag{39}
$$

where $\Xi^e_{t+1|t} \equiv \beta_e \mathbf{u}_{c_{e,t+1}} / \mathbf{u}_{c_{e,t}}$ is the household's stochastic discount factor and we can define

[38] We include standard capital adjustment costs as part of our quantitative analysis.

$r_{k,t} \equiv \alpha mc_t z_t n_t^{1-\alpha} k_{t-1}^{\alpha-1}$. Similarly, the labor supply condition is still

$$\kappa n_{e,t}^{\xi} = w_t. \tag{40}$$

In contrast to the model in the main text, labor and capital demand are now given by

$$w_t \left[1 - \phi_n + \phi_n \mathbb{E}_t \Xi^e_{t+1|t} R_{e,t}\right] = (1-\alpha) mc_t z_t n_t^{-\alpha} k_{t-1}^{\alpha}, \tag{41}$$

and

$$r_{k,t} \left[1 - \phi_k + \phi_k \mathbb{E}_t \Xi^e_{t+1|t} R_{e,t}\right] \equiv \alpha mc_t z_t n_t^{1-\alpha} k_{t-1}^{\alpha-1}. \tag{42}$$

The optimal firm creation condition is

$$v_t = \mathbb{E}_t \Xi^e_{t+1|t} \left[\pi_{e,t+1} + (1-\delta) v_{t+1}\right], \tag{43}$$

where v_t denotes the value of creating a new firm and, and the entry condition is characterized by

$$v_t = \frac{\psi_e \left[1 - \phi_e + \phi_e \mathbb{E}_t \Xi^e_{t+1|t} R_{e,t}\right]}{(1-\delta)}. \tag{44}$$

The rest of the model remains the same relative to the one in the main text.

A.6 Model where All Households Borrow

In what follows, we discuss the modifications of the benchmark model that allows for both households to borrow to finance new housing purchases. The problems for e households and firms remain unchanged relative to those described in the main text.

Saver (s) Households There is a continuum of identical saver (s) households over the interval $[0,1]$. They choose consumption $c_{s,t}$, housing demand $h_{s,t}$, bank deposits d_t, their own labor supply $n_{s,t}$, and total borrowed funds $l_{s,t}$ to maximize

$$\mathbb{E}_0 \sum_{t=0}^{\infty} \beta^t \mathbf{u}(c_{s,t}, n_{s,t}, h_{s,t}) \tag{45}$$

subject to the budget constraint

$$c_{s,t} + Q_{h,t}(h_{s,t} - h_{s,t-1}) + d_t + R_{s,t-1}l_{s,t-1} = l_{s,t} + w_t n_{s,t} + R_{t-1}d_{t-1} + \Pi_{b,t}, \tag{46}$$

and the financing constraint

$$l_{s,t} = \phi_{h,t} Q_{h,t} h_{s,t}, \tag{47}$$

where $Q_{h,t}$ is the real price of housing, $R_{s,t}$ is the real gross lending rate, w_t is the real wage, R_t is the gross real interest rate on deposits, and $\Pi_{b,t} = \int_0^1 \pi_{jb,t} dj$ denotes total bank profits (defined below). Households have GHH preferences over consumption and labor: $\mathbf{u}(c_{s,t}, n_{s,t}, h_{s,t}) = \left[\frac{1}{1-\sigma}\left(c_{s,t} - \frac{\kappa}{1+\xi} n_{s,t}^{1+\xi}\right)^{1-\sigma} + \frac{\gamma_h}{1-\sigma_h}\left(h_{s,t}\right)^{1-\sigma_h}\right]$ with $\sigma, \sigma_h, \kappa, \xi, \gamma > 0$. Replacing the financing constraint in the household's budget constraint, the first-order conditions yield standard optimal labor supply and housing demand expressions:

$$\kappa n_{s,t}^{\xi} = w_t, \tag{48}$$

and

$$Q_{h,t} = \frac{(h_{s,t})^{-\sigma_h}}{\mathbf{u}_{c_{s,t}}} + \mathbb{E}_t \Xi^s_{t+1|t} Q_{h,t+1} - Q_{h,t}\phi_{h,t}\left[\mathbb{E}_t \Xi^s_{t+1|t} R_{s,t} - 1\right], \tag{49}$$

as well as a standard Euler equation over deposits

$$\mathbf{u}_{c_{s,t}} = \beta R_t \mathbb{E}_t \mathbf{u}_{c_{s,t+1}}, \tag{50}$$

where $\Xi^s_{t+1|t} \equiv \beta \mathbf{u}_{c_{s,t+1}} / \mathbf{u}_{c_{s,t}}$. Similar to e households in the main text, s households' demand for differentiated borrowed funds is given by $l_{js,t} = \int_0^1 l_{ijs,t} di = \int_0^1 \left(\frac{R_{js,t}}{R_{s,t}}\right)^{-\varepsilon_h} l_{is,t} di$.

Banks The banking sector has a measure $[0,1]$ of banks. Banks are monopolistically competitive in the market for loans but perfectly competitive in the market for deposits. They turn all their profits to s households. Each bank j chooses its gross real loan rate $R_{je,t}$ and $R_{js,t}$ to maximize profits $\pi_{jb,t} = R_{je,t} l_{je,t} + R_{js,t} l_{js,t} - R_t d_{j,t} - l_{je,t} - l_{js,t} - d_{jt}$ subject to the balance sheet constraint $l_{je,t} + l_{js,t} = d_{jt}$ and the bank's loan demand condition from e and s households. We assume that loans for e and s households are perfect substitutes.

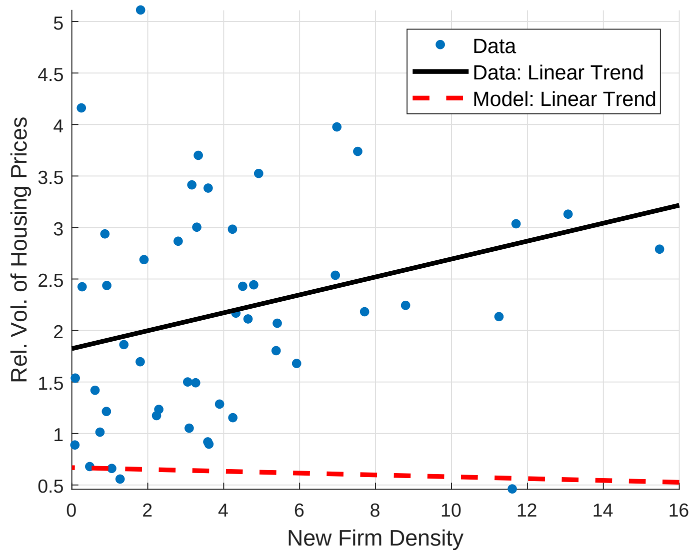
The optimal loan rate for bank j is a standard markup over the deposit rate $R_{je,t} = R_{js,t} = (\varepsilon_h/(\varepsilon_h - 1))\, R_t$.

A.7 Main Results Under Alternative Parameterizations

Benchmark Model without Housing Finance Constraints: Calibration Details Absent housing finance constraints in the benchmark model, and in the presence of housing preference shocks to match *the intercept* of a regression of relative house price volatility on NFD in the data (as we do in the main text but using housing-finance shocks), the implied volatility of housing preference shocks is $\sigma_{z_h} = 0.1955$. Note that the model-generated slope arises endogenously.

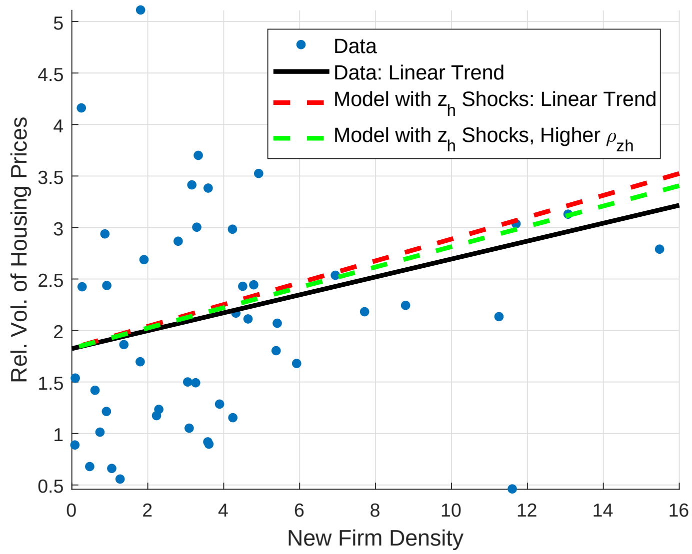
For completeness, Figure A4 below presents the results from the model without housing finance constraints *in the absence of housing preference shocks.* As should be expected, absent these shocks, the relative volatility of house prices is lower than in the data, even for low levels of NFD. Moreover, the model fails to match the positive relationship between house price volatility and NFD, further highlighting the importance of housing-market shocks for the volatility of house prices.

Figure A4: New Firm Density and Housing Price Volatility: Data vs. Benchmark Model without Housing Finance Constraints, No Housing Preference Shocks



Benchmark Model with z_h Shocks Figure A5 plots NFD against the relative volatility of house prices as well as the implied trend line in the data and compares the trend in the data to the predictions of a version of our benchmark model that includes housing preference shocks alongside the other two shocks in the main text (aggregate productivity and housing-finance shocks). In the model calibration, we assume that the volatility of housing-finance (or LTV) and housing preference shocks is the same. Consistent with the approach we adopt and describe in the main text, we choose this volatility such that we match *the intercept* of a regression of relative price volatility on average new firm density (this yields $\sigma_{z_h} = \sigma_{\phi_h} = 0.0275$). For completeness, we also show the results for an alternative calibration where the persistence of housing preference shocks is higher than the persistence of housing-finance shocks ($\rho_{z_h} = 0.95$ instead of $\rho_{z_h} = 0.90$). Once again, recall that the model-generated slope arises endogenously and is *not* matched by construction.

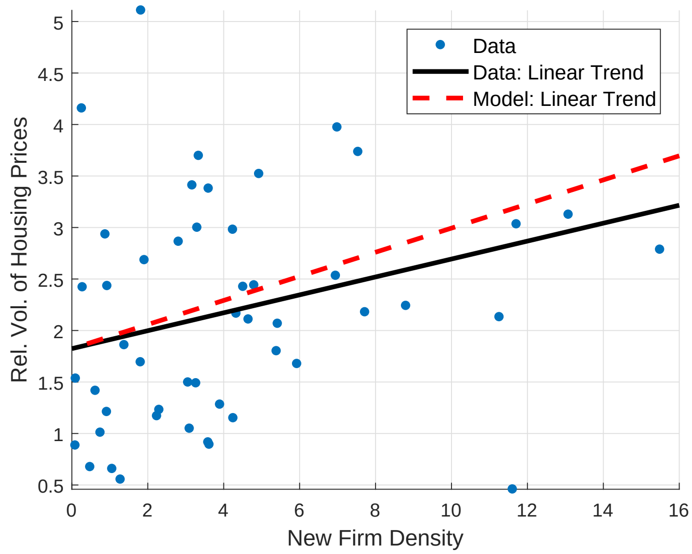
Figure A5: New Firm Density and Housing Price Volatility: Data vs. Benchmark Model with z_h Shocks



Benchmark Model with Sunk Entry Costs, the Wage Bill, and Investment in e Households' Financing Constraint Figure A6 plots new firm density against the relative volatility of house prices as well as the implied trend line in the data and compares the trend in the data to the predictions of a version of our benchmark model where final goods firms' sunk entry costs and intermediate goods firms' wage and capital bills are a component of e households' financing constraint (see Section A.5 above for the model details). For illustrative purposes, we choose the share of sunk entry costs financed with bank credit to be $\phi_e = 0.80$. In turn, following Iacoviello (2015) and the literature on working capital constraints, we set $\phi_n = \phi_k = 1$.[39] The implied volatility of housing-finance shocks so that the trend line in the data and the trend line from the model have, by consruction, *the same intercept* is $\sigma_{\phi_h} = 0.0568$. Once again, recall that the model-generated slope arises endogenously and is *not* matched by construction.

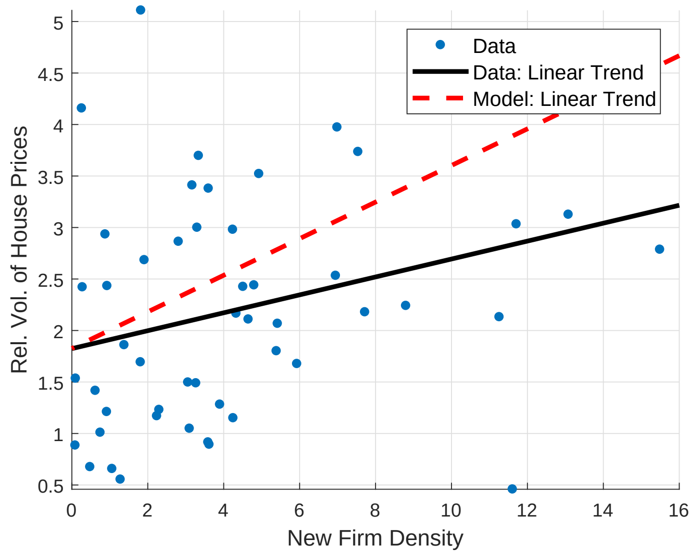
[39] Iacoviello (2015) does not assume that the capital bill is financed with credit. Our assumption is for completeness, but our results do not depend on the inclusion of the capital bill in households' financing constraint. A similar comment applies to alternative values for ϕ_n and ϕ_k.

Figure A6: New Firm Density and Housing Price Volatility: Data vs. Model with Sunk Entry Costs, Wage Bill, and Capital Bill in Financing Constraint



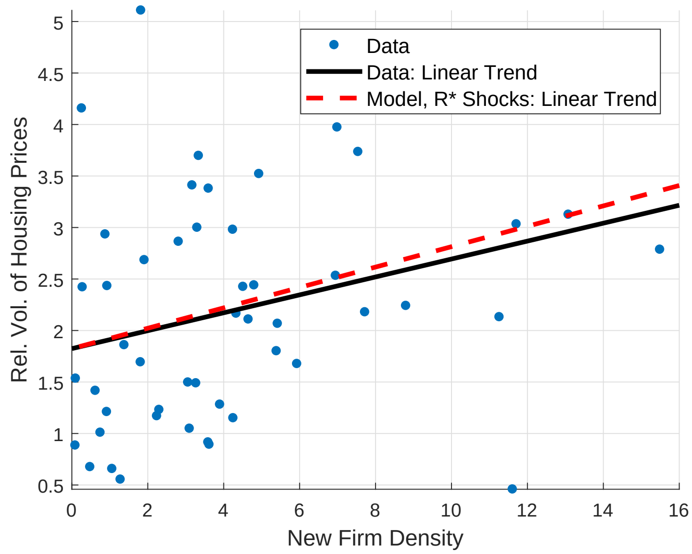
Benchmark Model where All Households Borrow Figure A7 plots NFD against the relative volatility of house prices as well as the implied trend line in the data and compares the trend in the data to the predictions of a version of our benchmark model where both e and s households borrow to finance their new housing purchases. We set the volatility of housing-finance shocks so that the trend line in the data and the trend line from the model have *the same intercept*. This yields $\sigma_{\phi_h} = 0.0433$. As Figure A7 shows, allowing for both households to borrow leads to a stronger positive relationship between average new firm density and relative housing price volatility. This result is consistent with the amplification mechanism described in the model being greater the more households participate in housing-finance markets.

Figure A7: New Firm Density and Housing Price Volatility: Data vs. Model where All Households Borrow



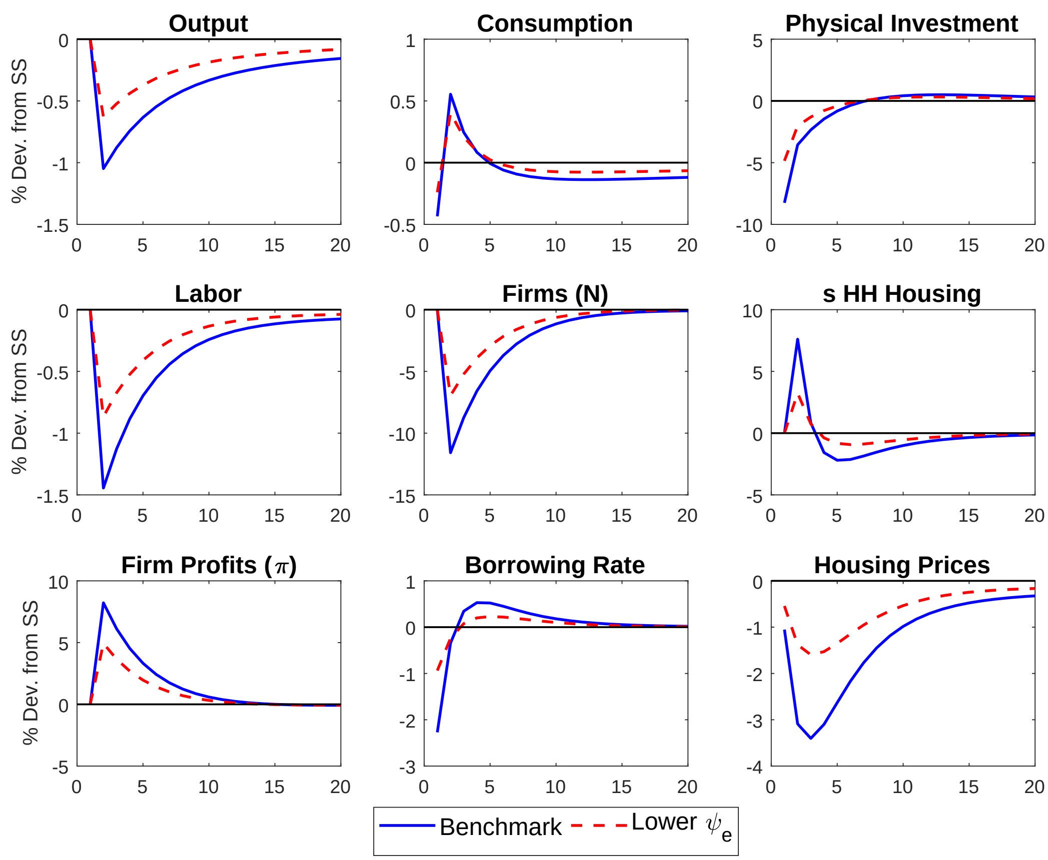
Benchmark Model with Foreign Interest Rate Shocks Figure A8 plots NFD against the relative volatility of house prices as well as the implied trend line in the data and compares the trend in the data to the predictions of a small-open-economy (SOE) version of our benchmark model that includes foreign interest rate shocks, which we consider as a proxy of international credit supply (or global liquidity) shocks. In particular, we assume that in addition to borrowing from domestic banks, e households hold foreign debt (subject to adjustment costs) at an exogenous foreign interest rate R^*, which follows an AR(1) process. We set the autoregressive parameter $\rho_{R^*} = 0.76$ and the volatility of foreign interest rate shocks $\sigma_{R^*} = 0.0084$. These values are consistent with an estimated AR(1) process for US real interest rates using the inflation-adjusted 3-month Treasury bill as our measure of US rates for the period 2000Q1-2016Q4. We set the volatility of housing-finance shocks so that the trend line in the data and the trend line from the model have the same *intercept*. This yields $\sigma_{\phi_h} = 0.0303$. Once again, recall that the model-generated slope arises endogenously and is *not* matched by construction.

Figure A8: New Firm Density and Housing Price Volatility: Data vs. Model with Foreign Interest Rate Shocks



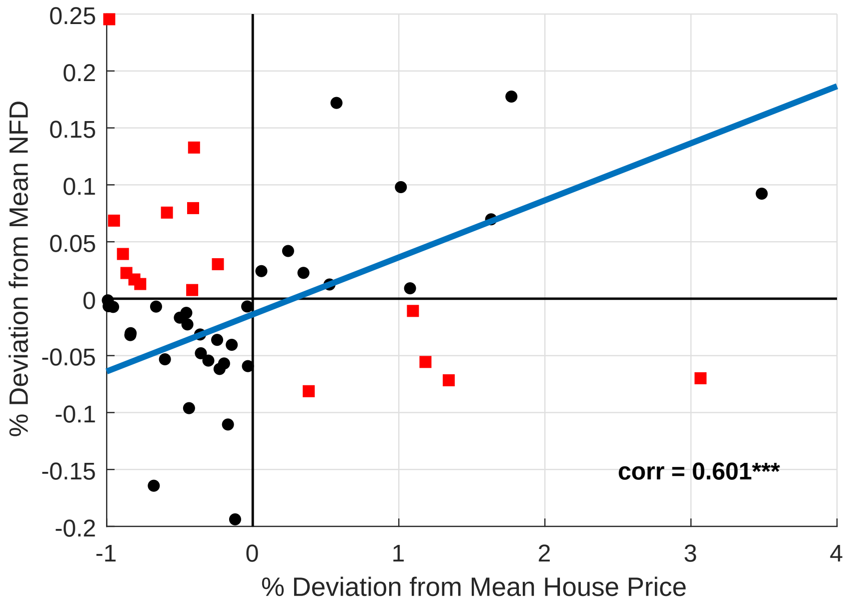
Finally, Figure A9 shows the response of the economy to a temporary, exogenous increase in foreign interest rates (in the SOE version of our model, the impulse responses for aggregate productivity and housing-finance shocks look similar to those in Figures 4 and 5 in the main text).

Figure A9: Response to Adverse Foreign Interest Rate Shock (Quarters After Shock), Model with Foreign Interest Rate Shocks



A.8 Average New Firm Density and Average House Prices: Evidence

Figure A10: Average New Firm Density and House Prices



Sources: World Bank Entrepreneurship Survey (New Firm Density, NFD) and Bank for International Settlements (Real House Prices). Notes: Figure based on annual data covering 2006 (the first year available for NFD) through 2016.

A.9 Derivation of House-Price Expression in Log-Deviations from Steady State

To formally see how these new firm entry and housing finance have implications for house-price dynamics in our framework, first consider e households' optimal firm creation condition in log-linear form:

$$\hat{v}_t = \left(\frac{\pi_e}{v}\right) \Xi^e \mathbb{E}_t \left[\widehat{\Xi}^e_{t+1|t} + \hat{\pi}_{e,t+1}\right] + \Xi^e \mathbb{E}_t \left[\widehat{\Xi}^e_{t+1|t} + \hat{v}_{t+1}\right]. \tag{51}$$

where hatted variables denote variables in log-deviations from steady-state and variables without time subscripts denote these same variables in steady state. Solving for $\Xi^e \mathbb{E}_t \widehat{\Xi}^e_{t+1|t}$, we can write

$$\Xi^e \mathbb{E}_t \widehat{\Xi}^e_{t+1|t} = \left[\frac{v}{v+\pi_e}\right]\left[\hat{v}_t - \Xi^e \mathbb{E}_t \hat{v}_{t+1}\right] - \left[\frac{\pi_e}{v+\pi_e}\right]\Xi^e \mathbb{E}_t \hat{\pi}_{e,t+1}. \tag{52}$$

Moreover, recall that the equilibrium value of a new firm is given by $v_t = \psi_e/(1-\delta)$. If ψ_e and δ are time-invariant (which they are in our benchmark model), $v = \psi_e/(1-\delta)$ and in equilibrium $\hat{v}_t = 0$ for all t.[40] Furthermore, in steady state, the firm creation condition delivers a clear link between the sunk entry cost ψ_e and individual-firm profits π_e: $\psi_e\left[1-(1-\delta)\beta\right] = (1-\delta)\beta\pi_e$. Taken together, these facts imply that the above expression collapses to

$$\mathbb{E}_t \widehat{\Xi}^e_{t+1|t} = -\left[\frac{[1-(1-\delta)\beta]}{\beta + [1-(1-\delta)\beta]}\right]\mathbb{E}_t \hat{\pi}_{e,t+1}. \tag{53}$$

Note that the log-linear versions of households' housing demand conditions can be expressed as

$$\Xi^s Q_h \mathbb{E}_t \widehat{Q}_{h,t+1} = Q_h \widehat{Q}_{h,t} - \frac{\mathbf{u}_{h_s}}{\mathbf{u}_{c_s}}\left[\widehat{\mathbf{u}}_{h_{s,t}} - \widehat{\mathbf{u}}_{c_{s,t}}\right] - \Xi^s Q_h \mathbb{E}_t \widehat{\Xi}^s_{t+1|t}, \tag{54}$$

and

$$\begin{aligned} \Xi^e Q_h \mathbb{E}_t \widehat{Q}_{h,t+1} &= \left[1-\phi_h\left(1-\Xi^e R_e\right)\right] Q_h \widehat{Q}_{h,t} - \frac{\mathbf{u}_{h_e}}{\mathbf{u}_{c_e}}\left[\widehat{\mathbf{u}}_{h_{e,t}} - \widehat{\mathbf{u}}_{c_{e,t}}\right] \\ &\quad - Q_h \Xi^e\left[1-\phi_h R_e\right]\mathbb{E}_t \widehat{\Xi}^e_{t+1|t} + Q_h \phi_h \Xi^e R_e \mathbb{E}_t \widehat{R}_{e,t} - Q_h \phi_h\left[1-\Xi^e R_e\right]\widehat{\phi}_{h,t}. \end{aligned} \tag{55}$$

where $\mathbf{u}_{h_{j,t}}$ denotes the marginal utility of housing for household $j \in \{e,s\}$. Noting that $\Xi^e = \Xi^s = \beta$, we can solve for $\widehat{Q}_{h,t}$:

$$\begin{aligned} \widehat{Q}_{h,t} &= \left(\frac{1}{\phi_h Q_h\left(1-\Xi^e R_e\right)}\right)\left[\frac{\mathbf{u}_{h_s}}{\mathbf{u}_{c_s}}\left(\widehat{\mathbf{u}}_{h_{s,t}} - \widehat{\mathbf{u}}_{c_{s,t}}\right) - \frac{\mathbf{u}_{h_e}}{\mathbf{u}_{c_e}}\left(\widehat{\mathbf{u}}_{h_{e,t}} - \widehat{\mathbf{u}}_{c_{e,t}}\right)\right] \\ &\quad + \frac{\Xi^s}{\phi_h\left(1-\Xi^e R_e\right)}\mathbb{E}_t \widehat{\Xi}^s_{t+1|t} - \frac{\Xi^e\left[1-\phi_h R_e\right]}{\phi_h\left(1-\Xi^e R_e\right)}\mathbb{E}_t \widehat{\Xi}^e_{t+1|t} + \frac{\Xi^e R_e}{\left(1-\Xi^e R_e\right)}\mathbb{E}_t \widehat{R}_{e,t} - \widehat{\phi}_{h,t}. \end{aligned} \tag{56}$$

[40] Allowing ψ_e to be time-varying (say, a function of the real wage and aggregate productivity, as in BGM) does not change our main conclusions or the general intuition below.

Finally, inserting the expression for $\mathbb{E}_t\widehat{\Xi}^e_{t+1|t}$ into this last condition yields an explicit expression for $\widehat{Q}_{h,t}$ as a function of key variables related to firm entry *and* housing finance:

$$\begin{aligned}\widehat{Q}_{h,t} &= \Phi_1\left[\frac{\mathbf{u}_{h_s}}{\mathbf{u}_{c_s}}\left(\widehat{\mathbf{u}}_{h_{s,t}}-\widehat{\mathbf{u}}_{c_{s,t}}\right)-\frac{\mathbf{u}_{h_e}}{\mathbf{u}_{c_e}}\left(\widehat{\mathbf{u}}_{h_{e,t}}-\widehat{\mathbf{u}}_{c_{e,t}}\right)\right]+\Phi_2\mathbb{E}_t\widehat{\Xi}^s_{t+1|t} \\ &\quad +\Phi_3\mathbb{E}_t\hat{\pi}_{e,t+1}+\Phi_4\mathbb{E}_t\widehat{R}_{e,t}-\widehat{\phi}_{h,t}.\end{aligned} \tag{57}$$

where $\Phi_1 \equiv \left(\frac{1}{\phi_h Q_h(1-\Xi^e R_e)}\right) < 0$, $\Phi_2 \equiv \frac{\Xi^s}{\phi_h(1-\Xi^e R_e)} < 0$, $\Phi_3 \equiv \frac{\Xi^e[1-\phi_h R_e]}{\phi_h(1-\Xi^e R_e)}\left[\frac{[1-(1-\delta)\beta]}{\beta+[1-(1-\delta)\beta]}\right] < 0$, and $\Phi_4 \equiv \frac{\Xi^e R_e}{(1-\Xi^e R_e)} < 0$.