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Abstract

Using data for a large sample of countries, we find a robust economic and quantitatively significant positive relationship between new firm density and house price volatility. A business cycle model with endogenous firm entry, housing, and housing finance constraints successfully replicates this new fact, both qualitatively and quantitatively. 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 factually-sharper house price fluctuations. We find broad empirical validation for this mechanism.

JEL Classification: E30, E32, E44

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

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1 Introduction

Economies that exhibit an above-average process of firm creation—a reflection of greater firm and economic dynamism—tended to experience some of the greatest collapses in their housing markets amid the Global Financial Crisis (GFC). Well known examples are the United Kingdom and Ireland where, from peak to trough, real house prices dropped by roughly 30 percent and by over 80 percent, respectively. This backdrop raises two important questions: is there a relationship between an economy's firm dynamism and house price volatility? If so, what are the economic characteristics and mechanisms that may explain this relationship? Given the macroeconomic relevance of housing in many economies, identifying the fundamental factors that drive the cyclical behavior of housing markets is critical.[1]

Using cross-country data on real house prices and new firm density (NFD) for a large sample of countries with available high-frequency data on house prices, we find a robust positive relationship between the average level of NFD (a proxy for firm dynamism) and the volatility of real house prices (relative to GDP). This relationship is robust to a host of control variables that may also contribute to explaining cross-country differences in the volatility of housing markets. Moreover, this relationship is quantitatively important: our benchmark results suggest that a 1 percent increase in average NFD can be associated with up to a 0.6 percent increase in the average relative volatility of house prices.

To understand the economic mechanisms behind this new fact, we build a small open economy (SOE) real business cycle (RBC) model with endogenous firm entry, housing, and housing-finance constraints. We take the model to the data and show that our framework can successfully generate the positive relationship between the relative volatility of house prices and average NFD, both qualitatively *and* quantitatively. Moreover, our model-based analysis shows that financial shocks that affect housing finance markets—in the model, shocks to borrowing households' housing-based loan-to-value (LTV) ratios—are critical for *quantitatively* generating an empirically-consistent link between house price volatility and average NFD. While our empirical analysis cannot establish direct causality, the model does point

[1] See Iacoviello (2005); Iacoviello and Neri (2010); Liu, Wang, and Zha (2013); Gete (2015); Guerrrieri and Uhlig, (2016); and Piazzesi and Schneider (2016), among others, for the importance of housing in macroeconomics.

to a non-negligible link *from* average firm entry *to* cyclical house market dynamics. This result is novel and highlights an additional factor that contributes to a better understanding of cross-country differences in house price dynamics.

Our framework features two household categories—entrepreneur and saver households. In our baseline framework, entrepreneur households use internal resources to cover the sunk entry costs of creating firms and face housing finance constraints whereby households borrow from monopolistically-competitive banks to cover a portion of their housing-stock purchases. As a baseline, saver households purchase housing without the need to borrow and supply funds to entrepreneur households via the banking system. Firms use capital and labor from both households to produce, and aggregate productivity and financial (housing-finance) shocks drive business cycles. To analyze the link between NFD and house price volatility, we generate increases in average (steady-state) new firm entry in the model over the NFD range in our country sample by exogenously reducing firms' sunk entry costs (this is consistent with a strong and negative empirical relationship between the cost of opening a firm and new firm density).

The economics behind our results is intuitive. A reduction in 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 also leads to higher average house prices, both in absolute terms and relative to income. Importantly, higher average house prices makes housing purchases moore expensive in the economy, implying that households now need larger average 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 borrowing rates—a component of households' cost of house purchases—which in turn makes 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 empirical evidence on NFD, average house prices, and the volatility of credit and lending spreads for our sample that provides strong support in favor of this mechanism. Indeed, in our sample, greater average firm entry is, on average, associated with: (1) greater average real house prices (both in absolute terms and relative to income); (2) greater volatility in bank credit; and (3) more volatile lending spreads.

This mechanism is also complemented by a secondary mechanism that works as follows. A rise in firm entry implies greater competition and puts downward pressure on steady-state individual-firm profits. With endogenous firm entry, 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). A reduction in individual-firm profits makes the value of households' assets, among which are firm-profits, more sensitive for a given set of shocks. This sensitivity spills over into other assets in the economy, including housing, thereby further contributing to more volatile house prices. We note, though, that the first mechanism unambiguously dominates from a quantitative standpoint.

More broadly, our results suggest that greater average firm entry—which is partly a reflection of an economy's dynamism—represents a powerful amplification mechanism of housing-finance shocks. The combination of housing finance constraints and these shocks can rationalize 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 housing price dynamics in aggregate fluctuations took center stage during the GFC, with such relevance extending beyond the U.S. For example, existing work has found that housing shocks in the U.S. 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 has also focused on the impact of housing markets on entrepreneurship and firm creation in particular economies (Adelino,

[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.

Schoar, and Severino, 2015; Decker, 2015; Schott, 2015; Schmalz, Sraer, and Thesmar, 2017), as well as on the evolution of overall economic dynamism as reflected in firm startup rates and firm creation (see Decker, Haltiwanger, Jarmin, and Miranda, 2014, for the U.S.; and Calvino et al., 2015, for cross-country OECD evidence).

Our work contributes 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 have analyzed 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 the *opposite* relationship: we study how differences in average firm formation across countries have implications for housing market dynamics. All told, our work uncovers a novel factor that further contributes to explaining cross-country differences in housing price volatility, and provides a plausible and empirically-supported economic mechanism that can quantitatively rationalize the cross-country link between firm dynamism and housing price dynamics.

The rest of the paper is structured as follows. Section 2 presents new evidence on average new firm density and the volatility of housing prices. Section 3 presents the model. Section 4 presents our main findings and discusses the intuition behind our results. Section 5 concludes.

2 Empirical Analysis

This section presents evidence of a robust positive relationship between average new firm density (NFD)—a proxy of firm dynamism—and the relative volatility of real house prices (i.e., the ratio of the volatility of real house prices to the volatility of real GDP). Importantly, we also characterize this relationship *conditional on other factors that may contribute to the*

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

cyclical variability of house prices to highlight the significance of this link.

2.1 Data in Baseline Analysis

Our country sample is based on data availability pertaining to our two main variables of interest, real house prices and NFD. The countries in our sample are: 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. Time coverage varies by country.[4]

NFD is obtained from the World Bank Entrepreneurship Report and is given by the number of newly registered private corporations per 1000 individuals ages 15-64. NFD is available at a yearly frequency from 2006 to 2016. We obtain average NFD by taking the average of NFD over years 2006-2016 for each country.[5]

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, and then computing the ratio of the standard deviation of the cyclical component of real house prices to the standard deviation of the cyclical component of GDP. 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

[4]Our measure of NFD is not available for the U.S. Moreover, Canada only has observations for 2015 and 2016 and as such is excluded from the sample used in our baseline specification. However, we note that including Canada in our analysis does not change any of our main conclusions.

[5]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. The Appendix shows 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.

alternative sample periods (more on this below).

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 determinants of 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 bank credit to the private sector-GDP ratio (*Bank Credit-GDP Ratio*), the average quarterly inflation rate (*Inflation Rate*), the cyclical correlation between global liquidity from banks and the country's real GDP (*Corr(Gl. Liquidity,GDP)*), and average household credit as a share of total (household and firm) credit (*Household Credit Share*).[7] We discuss how additional empirical specifications under alternative sets of controls, different detrending techniques, and alternative time periods, among other robustness checks, affect our main findings further below.

2.2 Empirical Specification and Baseline Results

To analyze the link between new firm density and real house price volatility, we run the following cross-section OLS regression:

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

where: Q_i is the relative *volatility* of house prices in country i; NFD_i is average new firm density in country i; $\mathbf{X}_i$ is a vector of country-specific control variables; and ε_i is an error term.

Table 1 presents our baseline results. The first row of this table implies that for the average country, a 1 percent increase in average NFD is associated with an increase in the relative volatility of house prices of between 0.12 percent and 0.62 percent, depending on the specification.[8]

[6]The details for 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. See the Data Appendix for more details.

[8]In our sample, average relative volatility of house prices is 2.42 and average NFD is 5.3. Increasing NFD by 1 unit implies an 18 percent increase in NFD. Take, for instance, the coefficient in the 7th column of the table. This 1 unit increase in NFD is associated with a 0.283 unit increase in relative volatility. For the

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

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Ave. New Firm Density	0.0901*	0.104*	0.124*	0.115*	0.130**	0.128**	0.283***
	(2.37)	(2.49)	(2.53)	(2.43)	(2.82)	(2.75)	(4.59)
Loan to Purchase Home		-0.0132	-0.00206	0.00776	0.0214	0.0273	-0.0456
		(-0.80)	(-0.09)	(0.36)	(0.99)	(1.14)	(-1.43)
Bank Credit-GDP Ratio			-0.00637	-0.00136	-0.00685	-0.00639	-0.00349
			(-0.78)	(-0.17)	(-0.83)	(-0.77)	(-0.34)
Inflation Rate				0.742*	0.552	0.497	-0.0922
				(2.26)	(1.68)	(1.44)	(-0.21)
Corr(Gl. Liquidity,GDP)					-1.911*	-1.738+	-2.490*
					(-2.13)	(-1.83)	(-2.24)
Advanced Econ.						-0.363	
						(-0.58)	
Household Credit Share							4.174*
							(2.19)
Constant	1.958***	2.128***	2.355***	1.217+	2.481**	2.540**	1.935
	(6.85)	(6.16)	(5.21)	(1.83)	(2.84)	(2.87)	(1.41)
Adjusted R^2	0.080	0.078	0.070	0.145	0.206	0.194	0.443
Observations	54	51	51	51	51	51	34

t statistics in parentheses
$^{+}p < 0.10$, $^{*}p < 0.05$, $^{**}p < 0.01$, $^{***}p < 0.001$

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: 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. See the Data Appendix for details regarding data sources, country sample, and definitions.

Furthermore, Table 1 shows that even after controlling for a host of factors that may influence the relative volatility of housing prices—including, among others, the share of individuals in the economy that have housing loans, average inflation, the level of financial development, and how global liquidity is cyclically correlated with a given country's GDP,

average country, this represents an increase in relative volatility of roughly 12 percent.

among others—*greater average new firm density is still associated with a higher relative volatility of house prices*.[9] Of note, the same results in Table 1 emerge if we consider *absolute* instead of relative real housing price volatility (even after controlling for the volatility of GDP). Thus, the positive relationship between relative house price volatility and average NFD is not driven by cross-country differences in the volatility of GDP. Also, while not shown, the link between housing price volatility and NFD in Table 1 continues to hold if we exclude potential outliers from our country sample—in fact, the relationship becomes stronger. Thus, our findings are not driven by countries that may have extreme values for relative house price volatility or average NFD.

2.3 Robustness and Caveats

Of course, other factors beyond the ones in Table 1 may influence the volatility of house prices. We briefly discuss how the findings in Table 1 are robust to alternative and additional controls, alternative sample periods and house price series, and different filtering methodologies.

Alternative Sample Periods Our baseline specification focuses on the period 2000Q1-2016Q4. The Appendix shows similar findings for the period 2006Q1-2016Q4, which is an important robustness check given that the series on NFD starts in 2006 (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 1990s (see Table A2). In addition, Table A3 in the Appendix performs the same analysis as the one in Table 1 using NFD in year 2006 (and not average NFD from 2006 to 2016) as the measure of firm dynamism. The results from Table 1 remain, with the estimated coefficients for NFD being somewhat larger and statistically stronger.

Additional and Alternative Controls Our results are also robust to controlling for the cyclical volatility of inflation as well as average population growth, both of which may affect

[9] The household credit share—that is, the share of total credit that corresponds to credit towards households—is only available for a limited set of countries. Hence the smaller number of observations when we control for the household credit share.

the cyclical variability of house prices (see Table A4 in the Appendix). Also, we note that all results continue to hold if we replace the average bank credit-GDP ratio with average real GDP per capita (results available upon request), suggesting that differences in economic development cannot explain the NFD-house price volatility nexus.

One non-trivial limitation of our data is that NFD only considers *registered* private corporations. This implies that (1) NFD may be underestimated in economies with a non-negligible informal sector (that is, economies where unregistered (both new and old) firms tend to be more prevalent), and (2) NFD may be capturing firms who had already entered the market and simply became formal by registering. We consider NFD as our main measure of firm dynamism since it is comparable across countries and, in contrast to other measures of firm dynamism, it is available for virtually all countries with available data on house prices. To address the potential shortcomings of the NFD measure, though, Table A4 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 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. Also, we note that, while comparable cross-country data on firm startup rates is limited to only a small 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 confirms a positive and strong relationship between house price volatility and firm startup rates.[10] Thus, the main facts in Table 1 are similar amid alternative measures of firm dynamism, despite the fact that these alternative measures are available for a limited set of countries.

Alternative Filtering Methodologies and Housing Price Series As an additional robustness check, we perform the same analysis presented in Table 1 using real house price and GDP series in first differences (see Table A5 in the Appendix for the results). In addition, we perform the same anlysis using the dataset on quarterly real housing prices from Cesa-

[10]Regressing relative house price volatility on the startup rate yields a coefficient of 0.08 (significant at the 5 percent level and, importantly, quantitatively similar to the results in Table 1 under a larger country sample and a different measure of firm dynamism). Controlling for other factors that may affect house price volatility does not change these results.

Bianchi et al. (2015), which goes back to 1990Q1 for a similar *though not identical* country sample. The findings with this alternative series are the same as those in Table 1 (see Table A6 in the Appendix).[11]

All told, our main results are robust to alternative sample periods for the volatility of house prices, different filtering methodologies, as well as the inclusion of other factors that may explain differences in housing price dynamics across countries.

In what follows, we present a tractable model that sheds light on the economic mechanisms behind the positive relationship between firm dynamism and relative house price volatility in Table 1.

3 The Model

Our baseline framework is a SOE 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. The total housing stock in the economy is fixed and normalized to 1. Households are divided into two categories—savers (s) and entrepreneurs (e). Each household derives utility from consumption, leisure, and housing.

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, accumulate capital, and borrow from abroad. Importantly, in contrast to s households, e households devote resources to the creation of (final goods) firms in the spirit of BGM. They also borrow from banks to finance the purchase of new housing.

[11] 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).

We follow Kydland et al. (2016) and assume that e households face a financing constraint such that a fraction of new housing purchased in the current period is financed with bank credit. Banks are monopolistically-competitive, which gives rise to a lending-deposit spread for housing loans. Finally, as a baseline, business cycles are driven by aggregate productivity shocks and housing-finance (or financial) shocks that affect e households' housing finance constraint.[12]

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 dynamics. The presence of housing finance constraints is standard in RBC models of housing. In turn, assuming a monopolistically-competitive banking system has two purposes. First, amid homogeneity in household discounting among e and s households, such banking structure introduces lending-deposit spreads and allows e households' financing constraints (and shocks) to have a bite. Second, this banking structure readily allows us to determine the extent to which household differences in housing finance affects the link between NFD and house price volatility without the need for a more complex environment that requires additional household heterogeneity.[13]

There are two differences between our framework and related models where entrepreneurs hold 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 financing constraint for e households is such that a fraction of current-period 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. Moreover, our data on new firm density refers to registered firms. As such, the likelihood that entrepreneur households are using

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

[13]The SOE assumption follows existing theoretical work on cross-country differences in housing market dynamics. Global liquidity has been shown to play a role in cross-country house price dynamics (Cesa-Bianchi, Cespedes, and Rebucci, 2015; Cesa-Bianchi, Ferrero, and Rebucci, 2016, 2017), and having a SOE allows us to account, in a reduced-form way, for these factors once foreign interest rate shocks are introduced in the model, which we do as part of our sensitivity analysis.

their residential properties to produce is much less likely relative to 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 in Section 2.

3.1 Final Goods Firms

Following the endogenous entry framework in BGM, there is a continuum of monopolistically-competitive 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 for 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: $\rho_t(\omega_j) = (\varepsilon/(\varepsilon - 1))\, mc_t$.

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 $N_t = (1-\delta)\,(N_{t-1} + N_{E,t-1})$. 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). 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.

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 $v_t(\omega) = \mathbb{E}_t \sum_{s=t+1}^{\infty} \Xi_{s|t}^{e} (1-\delta)^{s-t} \pi_{e,s}(\omega)$. As shown in e households' problem below, in equilibrium and after imposing symmetry across firms, the entry decision is characterized by $v_t(\omega) = v_t = \psi_e/(1-\delta)$. Of note, since our framework assumes a fixed population in the economy, $N_{E,t}$ is the model counterpart of new firm density 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. 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 mc_t is the price of intermediate goods, 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

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

where β 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 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 $\sigma, \sigma_h, \kappa, \xi, \gamma > 0$. We adopt GHH preferences since there is a positive and significant relationship between NFD and (population-adjusted) total hours worked in our country sample.[14] The first-order conditions yield standard optimal labor supply and housing demand expressions

$$\kappa n_{s,t}^{\xi} = w_t, \tag{2}$$

and

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

as well as a standard Euler equation over deposits

$$\mathbf{u}_{c_{s,t}} = \beta R_t \mathbb{E}_t \mathbf{u}_{c_{s,t+1}}, \tag{4}$$

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, and the marginal cost of saving one more unit of resources to the expected marginal benefit.

Entrepreneur (e) Households: Utility Maximization and Firm Creation There is a continuum of identical entrepreneur (e) households indexed by i over the interval $[0, 1]$.

[14]The correlation between average new firm density 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 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.

These households 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.[15] Specifically, 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[16]

$$\begin{aligned} & c_{e,t} + k_t + \psi_e N_{E,t} + Q_{h,t}(h_{e,t} - h_{e,t-1}) + R_{e,t-1} l_{e,t-1} + R^*_{t-1} b^*_{t-1} + \frac{\eta_b}{2} (b^*_t)^2 \\ = \; & w_t n_{e,t} + b^*_t + N_t \pi_{e,t} + \Pi_{i,t} + l_{e,t} + (1-\delta) k_{t-1} + r_{k,t} k_{t-1}, \end{aligned}$$

the evolution of final goods firms

$$N_{t+1} = (1-\delta)\left(N_t + N_{E,t}\right), \tag{5}$$

and the housing finance constraint

$$l_{e,t} = \phi_{h,t} Q_{h,t} h_{e,t}, \tag{6}$$

where $0 < \delta < 1$ is the depreciation rate of capital as well as the exogenous exit probability of firms.[17] Preferences over consumption and labor are also of the GHH form: $\mathbf{u}(c_{e,t}, n_{e,t}, h_{e,t}) = \left[\frac{1}{1-\sigma}\left(c_{e,t} - \frac{\kappa}{1+\xi} n_{e,t}^{1+\xi}\right)^{1-\sigma} + \frac{\gamma_h}{1-\sigma_h}\left(h_{e,t}\right)^{1-\sigma_h}\right]$ 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* real gross rate at which households borrow, R^* is the real gross foreign interest rate, and households face a convex

[15]The Appendix presents a richer version of the model where both households use bank credit to finance new housing purchases. Similarly, the Appendix also presents a version of the model where the sunk entry costs and a fraction of intermediate-goods firms' wage and capital bills are financed with bank credit. We discuss the results from these richer frameworks further below.

[16]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 expositional clarity.

[17]Assuming differences between the depreciation rate of physical capital and the exit probability of firms does not change any of our conclusions.

cost of adjusting foreign debt holdings whereby $\eta_b > 0$ induces stationarity.[18] The financing constraint follows Kydland et al. (2016) and specifies that households' borrowed funds for housing purchases are a fraction $\phi_{h,t}$ of households' current-period new housing purchases, where $\phi_{h,t}$ can be 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).

Plugging the housing finance constraint into the budget constraint, we obtain standard Euler equations for capital and foreign debt

$$1 = \mathbb{E}_t \Xi^e_{t+1|t} \left[r_{k,t+1} + 1 - \delta \right], \tag{7}$$

and

$$1 = R^*_t \mathbb{E}_t \Xi^e_{t+1|t} + \eta_b b^*_t, \tag{8}$$

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

$$\kappa n^{\xi}_{e,t} = w_t, \tag{9}$$

an optimal firm creation condition

$$v_t = \mathbb{E}_t \Xi^e_{t+1|t} \left[\pi_{e,t+1} + (1 - \delta) v_{t+1} \right], \tag{10}$$

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

$$v_t = \frac{\psi_e}{(1 - \delta)}, \tag{11}$$

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

$$Q_{h,t} = \frac{(h_{e,t})^{-\sigma_h}}{\mathbf{u}_{c_{e,t}}} + \mathbb{E}_t \Xi^e_{t+1|t} Q_{h,t+1} - Q_{h,t} \phi_{h,t} \left[\mathbb{E}_t \Xi^e_{t+1|t} R_{e,t} - 1 \right]. \tag{12}$$

[18] This is a standard assumption in SOE models. Alternative formulations of this adjustment cost, such as those that are only operative amid shocks (see, for example, Schmitt-Grohé and Uribe, 2003) do not change any of our conclusions.

Intuitively, e households equate the marginal cost of spending resources on the creation of an additional firm (adjusted for 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, and foreign debt holdings), which is a well-known feature of BGM models of endogenous firm entry. Finally, 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, where $\left[\mathbb{E}_t \Xi^e_{t+1|t} R_{e,t} - 1\right]$ represents the expected lending spread. 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 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

Symmetry across firms and banks implies that $Y_t = y_t N_t^{\frac{\varepsilon}{\varepsilon-1}}$ and $R_{e,t} = (\varepsilon_h/(\varepsilon_h - 1)) R_t$. 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 $h_{e,t} + h_{s,t} = 1$. Moreover, the economy's resource constraint is

$$Y_t = c_{s,t} + c_{e,t} + i_t + \psi_e N_{E,t} + R^*_{t-1} b^*_{t-1} - b^*_t, \tag{13}$$

where physical capital investment $i_t = k_t - (1-\delta)k_{t-1}$. Section A.5 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).

4 Quantitative Analysis

4.1 Operationalization

Parameters from Literature and Shocks A period is a quarter. Following the business cycle literature, we set $\alpha = 0.32, \beta = 0.985, \delta = 0.025, \sigma = 2, \sigma_h = 2$, 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 $\xi = 1.33$.[19] R^* is set to 1.009, which is consistent with the real gross return on U.S. 3-month Treasury bills for our sample period. We set the steady-state LTV ratio $\psi_h = 0.80$ based on evidence on average LTV ratios in our country sample. 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 all 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 $x = z, \phi_h$.[20] Without loss of generality, we normalize aggregate productivity to $z = 1$ and set $\sigma_z = 0.01$.[21]

Calibrated Parameters The parameters $\kappa, \psi_e, \eta_b, \gamma_h, \phi_k$, and ε_h are chosen to match: a total time allocation to work of 0.33 (a standard target in the business cycle models), a steady-state measure of new firms N_E of 0.09 (consistent with the lowest country-average NFD in our country sample), a household credit-GDP ratio of 33 percent and a foreign debt-GDP ratio of 60 percent (consistent with the 2000-2016 averages 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 over 2000-2016 in our country sample).[22] This yields: $\kappa = 21.9289, \psi_e = 1.338, \eta_b = 0.0088, \gamma_h = 0.0503, \phi_k = 0.4125$, 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 Finally, we calibrate the volatility of housing-finance shocks as follows. Klapper and Love (2010) document that the cost of starting a business is an important determinant of NFD. Figure A1 in the Appendix confirms a strong and significant negative relationship between different measures of the average cost of starting a business and average NFD for the period for which data on new firm density is

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

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

[21] We discuss the consequences of introducing foreign interest rate shocks and housing demand shocks further below. Results with these shocks are presented in the Appendix and confirm that our main conclusions remain unchanged.

[22] We find no significant relationship between lending-deposit spreads and NFD in our data, implying that these spreads do not change with NFD.

available (2006-2016). Recall that since population in our model is fixed, NFD in our model corresponds to N_E.

In light of these facts and given our focus on the relationship between NFD and housing price volatility, we change 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 25, which corresponds to the highest average NFD in our country sample.[23] The change in ψ_e (and hence steady-state N_E) generates *endogenous* changes in the steady state and cyclical behavior of other variables, including house prices, amid aggregate productivity and housing-finance shocks in the model. Specifically, this exercise yields a cross-section of steady-state N_E and the relative volatility of house prices (that is, the volatility of housing prices relative to the volatility of output) associated with each value of steady-state N_E in the range outlined above. We then calibrate the volatility of housing-finance shocks such that regressing the model-generated relative volatility of house prices on model-generated steady-state N_E delivers *the same intercept* as in the *data-based* regression of relative housing price volatility on average NFD. *Importantly, we stress that this calibration strategy does not imply that the model-generated slope will match the data-based slope by construction; while the data-based and model-based trend lines do have the same intercept, the model-generated slope is endogenous as new firm density changes.*. All told, this yields $\sigma_{\phi_h} = 0.0343$. 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) house price volatility.

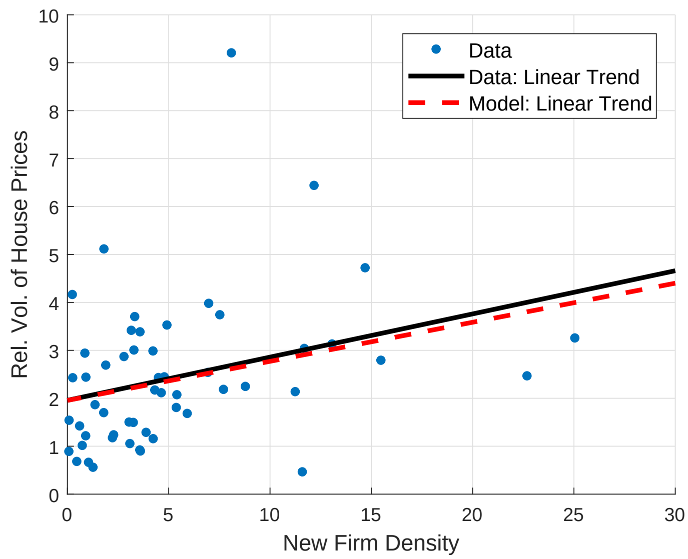
4.2 New Firm Density and House Price Volatility: Data vs. Model

Figure 1 plots the relationship between average NFD and the relative volatility of house prices in the data against the model-generated (endogenous) relationship between these two variables that comes from varying the sunk cost of entry, as described above. Once again, as noted in the description of the calibration, the model-based and empirical-based

[23] In the benchmark calibration, this implies a reduction in the sunk entry cost ψ_e from 1.3122 to 0.087.

regression lines have the same intercept by construction, *but the slope—which provides a graphical representation of the extent to which the model can quantitatively capture the cross-country relationship between new firm density and housing price volatility in the data—is an endogenous outcome in the model.* Under the benchmark calibration, the model successfully replicates the positive relationship between average NFD and housing price volatility in the data exceedingly well.[24]

Figure 1: Average New Firm Density and Housing Price Volatility: Data vs. Model



In what follows, we discuss the economic mechanisms that allow the model to replicate this relationship. As we illustrate further below, housing-finance shocks play a key role in quantitatively replicating the empirical link between NFD and house price volatility.

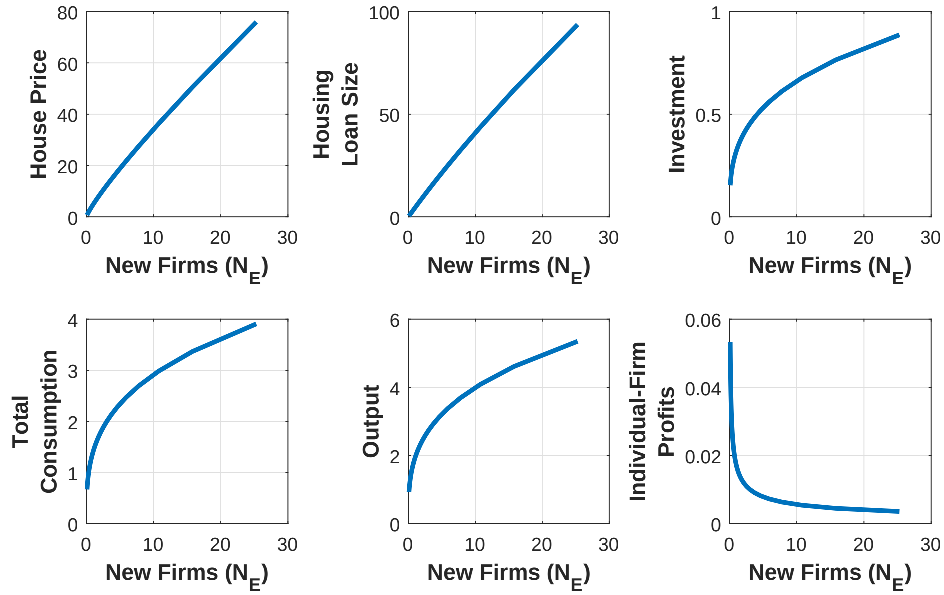
[24]As we discuss further below, the Appendix shows that: (1) allowing all households to borrow to finance new housing purchases or (2) allowing e households to also finance a portion of sunk entry costs as well as intermediate-goods-firms' wage and capital bills with bank credit does not change our main findings.

4.3 Economic Mechanisms

4.3.1 Steady State

First consider how the steady state changes as we reduce ψ_e, which in turn increases steady-state firm entry N_E (or NFD). Intuitively, e households have the choice of allocating resources across several asset classes: housing (via the purchase of new housing), firms (via investment in new firms), physical capital, and foreign assets (via the purchase of foreign debt). For the sake of transparency, 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. The fall in housing demand from these households initially puts downward pressure on the price of housing. In turn, this downward pressure pushes s households to increase their housing demand. Importantly, *in equilibrium*, the greater demand by s households dominates the fall in demand by e households, resulting in a non-negligible and unambiguous increase in equilibrium steady-state housing prices. Of note, the rise in steady-state house prices occurs not only in absolute terms, but also relative to income. In addition, the resulting reallocation of resources towards firm creation eventually results in greater capital accumulation and labor demand among intermediate-goods firms, while the rise in firm entry depresses *individual-firm* profits π_e. However, both households' labor income and e households' *total* income from ownership of final goods firms ($N\pi_e$) rise, which ultimately leads to higher consumption across households, as well as higher equilibrium total consumption and output. All told, economies with greater average (or steady-state) firm entry exhibit: higher steady-state house prices, investment, consumption, output, labor income, and lower individual-firm profits. At the same time, the resulting rise in house prices implies that the steady-state size of housing loans, $l_e = \psi_h Q_h * h_e$. These results are summarized in Figure 2.

Figure 2: Steady State Results–New Firm Entry and Select Variables in Benchmark Model



4.3.2 Effect of NFD on Cyclical Dynamics

To better understand how endogenous firm entry acts as an amplification mechanism of house-market-based financial shocks in our model, consider e households' housing finance constraint, $l_{e,t} = \phi_{h,t}Q_{h,t}h_{e,t}$, once again. In particular, it is easy to see that *for a given housing stock held by e households*, the higher steady-state house price in economies with greater steady-state firm entry naturally implies that the housing loan size that e households need to purchase new housing (l_e) is higher.[25] Critically, this also implies that all else equal the sensitivity of housing loans *to a given set of housing-finance shocks* is greater in these economies. Since in equilibrium the amount of deposits d is equal to housing loans l_e, the greater response of l_e to housing-finance shocks ultimately translates into a greater response in borrowing rates R_e.[26] 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

[25]As noted earlier, greater firm entry reduces the equilibrium housing stock holdings by e households. However, from a quantitative standpoint, this reduction is more than offset by the rise in steady-state house prices.

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

rates (which ultimately affect lending spreads) to housing-finance shocks. 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.

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

$$\hat{v}_t = \left(\frac{\pi_e}{v}\right) \Xi^e \mathbb{E}_t \left[\widehat{\Xi}^e_{t+1|t} + \hat{\pi}_{e,t+1}\right] + \Xi^e \mathbb{E}_t \left[\widehat{\Xi}^e_{t+1|t} + \hat{v}_{t+1}\right]. \quad (14)$$

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

$$\Xi^e \mathbb{E}_t \widehat{\Xi}^e_{t+1|t} = \left[\frac{v}{v + \pi_e}\right] \left[\hat{v}_t - \Xi^e \mathbb{E}_t \hat{v}_{t+1}\right] - \left[\frac{\pi_e}{v + \pi_e}\right] \Xi^e \mathbb{E}_t \hat{\pi}_{e,t+1}. \quad (15)$$

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.[27] 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

$$\mathbb{E}_t \widehat{\Xi}^e_{t+1|t} = -\left[\frac{[1-(1-\delta)\beta]}{\beta + [1-(1-\delta)\beta]}\right] \mathbb{E}_t \hat{\pi}_{e,t+1}. \quad (16)$$

Now, consider both households' housing demand conditions

$$Q_{h,t} = \frac{\mathbf{u}_{h_{s,t}}}{\mathbf{u}_{c_{s,t}}} + \mathbb{E}_t \Xi^s_{t+1|t} Q_{h,t+1}, \quad (17)$$

and

$$Q_{h,t} = \frac{\mathbf{u}_{h_{e,t}}}{\mathbf{u}_{c_{e,t}}} + \mathbb{E}_t \Xi^e_{t+1|t} Q_{h,t+1} - Q_{h,t}\phi_{h,t} \left[\mathbb{E}_t \Xi^e_{t+1|t} R_{e,t} - 1\right]. \quad (18)$$

where $\mathbf{u}_{h_{j,t}}$ denotes the marginal utility of housing for household $j \in \{e, s\}$. The log-linear

[27] 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.

versions of these expressions can be expressed as

$$\Xi^s Q_h \mathbb{E}_t \widehat{Q}_{h,t+1} = Q_h \widehat{Q}_{h,t} - \frac{\mathbf{u}_{h_s}}{\mathbf{u}_{c_s}} \left[\widehat{\mathbf{u}}_{h_s,t} - \widehat{\mathbf{u}}_{c_s,t} \right] - \Xi^s Q_h \mathbb{E}_t \widehat{\Xi}^s_{t+1|t}, \tag{19}$$

and

$$\begin{aligned} \Xi^e Q_h \mathbb{E}_t \widehat{Q}_{h,t+1} &= \left[1 - \phi_h \left(1 - \Xi^e R_e\right)\right] Q_h \widehat{Q}_{h,t} - \frac{\mathbf{u}_{h_e}}{\mathbf{u}_{c_e}} \left[\widehat{\mathbf{u}}_{h_e,t} - \widehat{\mathbf{u}}_{c_e,t} \right] \\ &\quad - Q_h \Xi^e \left[1 - \phi_h R_e\right] \mathbb{E}_t \widehat{\Xi}^e_{t+1|t} + Q_h \phi_h \Xi^e R_e \mathbb{E}_t \widehat{R}_{e,t} - Q_h \phi_h \left[1 - \Xi^e R_e\right] \widehat{\phi}_{h,t}. \end{aligned} \tag{20}$$

Noting that $\Xi^e = \Xi^s = \beta$, we can use both expressions to solve for $\widehat{Q}_{h,t}$:

$$\begin{aligned} \widehat{Q}_{h,t} &= \left(\frac{1}{\phi_h Q_h \left(1 - \Xi^e R_e\right)} \right) \left[\frac{\mathbf{u}_{h_s}}{\mathbf{u}_{c_s}} \left(\widehat{\mathbf{u}}_{h_s,t} - \widehat{\mathbf{u}}_{c_s,t} \right) - \frac{\mathbf{u}_{h_e}}{\mathbf{u}_{c_e}} \left(\widehat{\mathbf{u}}_{h_e,t} - \widehat{\mathbf{u}}_{c_e,t} \right) \right] \\ &\quad + \frac{\Xi^s}{\phi_h \left(1 - \Xi^e R_e\right)} \mathbb{E}_t \widehat{\Xi}^s_{t+1|t} - \frac{\Xi^e \left[1 - \phi_h R_e\right]}{\phi_h \left(1 - \Xi^e R_e\right)} \mathbb{E}_t \widehat{\Xi}^e_{t+1|t} + \frac{\Xi^e R_e}{\left(1 - \Xi^e R_e\right)} \mathbb{E}_t \widehat{R}_{e,t} - \widehat{\phi}_{h,t}. \end{aligned} \tag{21}$$

Finally, inserting the expression for $\mathbb{E}_t \widehat{\Xi}^e_{t+1|t}$ obtained earlier 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:

$$\begin{aligned} \widehat{Q}_{h,t} &= \Phi_1 \left[\frac{\mathbf{u}_{h_s}}{\mathbf{u}_{c_s}} \left(\widehat{\mathbf{u}}_{h_s,t} - \widehat{\mathbf{u}}_{c_s,t} \right) - \frac{\mathbf{u}_{h_e}}{\mathbf{u}_{c_e}} \left(\widehat{\mathbf{u}}_{h_e,t} - \widehat{\mathbf{u}}_{c_e,t} \right) \right] + \Phi_2 \mathbb{E}_t \widehat{\Xi}^s_{t+1|t} \\ &\quad + \Phi_3 \mathbb{E}_t \hat{\pi}_{e,t+1} + \Phi_4 \mathbb{E}_t \widehat{R}_{e,t} - \widehat{\phi}_{h,t}. \end{aligned} \tag{22}$$

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 $\Phi_4 \equiv \frac{\Xi^e R_e}{(1 - \Xi^e R_e)} < 0$. We note that in our baseline calibration, $\Phi_3 < \Phi_4$, so fluctuations in the borrowing rate (and ultimately the lending spread) have a larger impact on house price fluctuations relative to movements in firm profits.[28]

The last expression above shows that, all else equal, greater steady-state deviations in borrowing rates (or lending spreads) and individual-firm profits—both of which are more volatile when average firm entry is higher—contribute to greater steady-state deviations in house prices. In turn, this implies greater fluctuations in house prices in absolute terms *and*

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

relative to fluctuations in output. 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 below, the shocks affecting housing finance—are critical for explaining the positive connection between average new firm density (i.e. new firm entry) and house price fluctuations.

4.3.3 Economic Intuition

The channel through which this occurs in the model is intuitive: by boosting household income, economies with higher average firm entry exhibit higher average (or steady state) house prices (both in absolute terms and relative to income). In the presence of housing finance constraints, this implies that the average (or steady-state) loan size is greater for a given amount of housing. 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 higher volatility in firm profits (which embody the value of firms) that results from greater average firm entry, the volatility in housing-related borrowing rates and spreads ultimately contributes to more volatile asset prices, *including house prices.*

Figure 3 compares the response to a positive housing-finance (or LTV) shock in the model under the baseline calibration to the response in an otherwise identical economy where, for illustrative purposes, the sunk entry cost is only half of the one in the benchmark economy (this implies that steady-state firm entry N_E is higher in this second economy; note that the reduction in the sunk entry cost is only a small fraction of the total change we consider to match the range of NFD in the data). The shocks and parameter values other than ψ_e are the same across economies. In turn, Figure 4 plots the response to a positive aggregate productivity shock for the same two economies.

Figure 3: Response to Positive Housing-Finance Shock (Quarters After Shock)

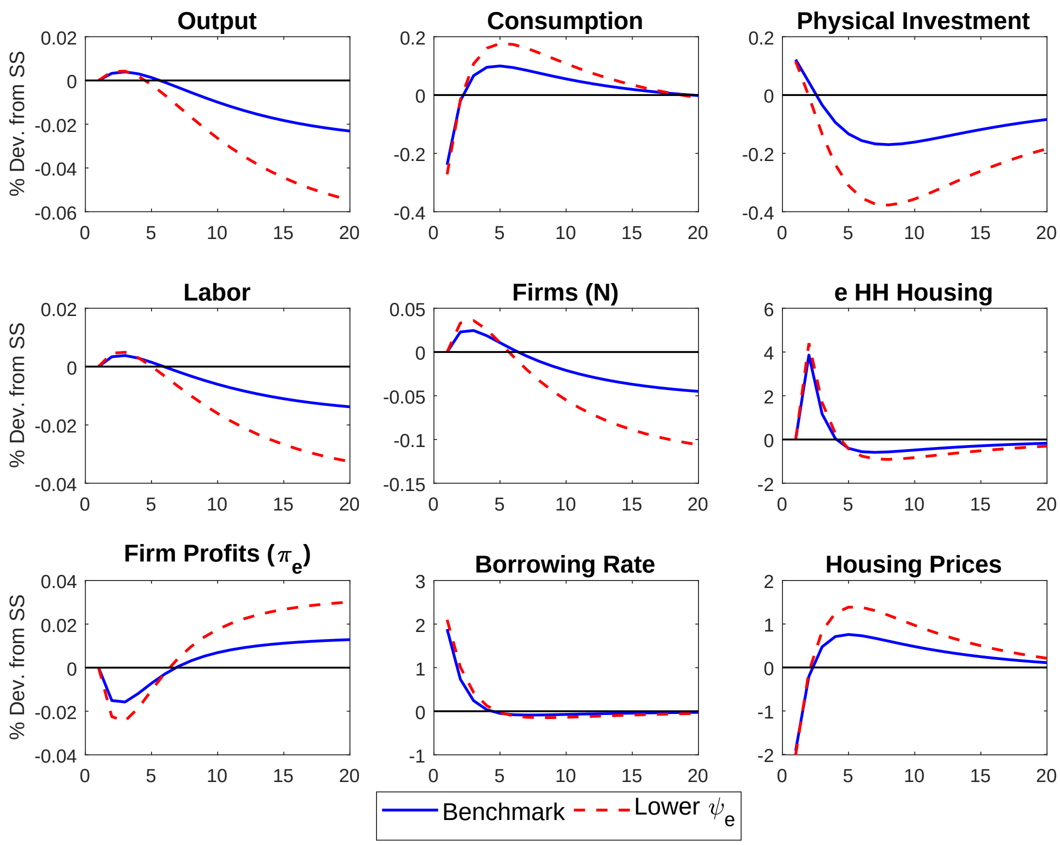
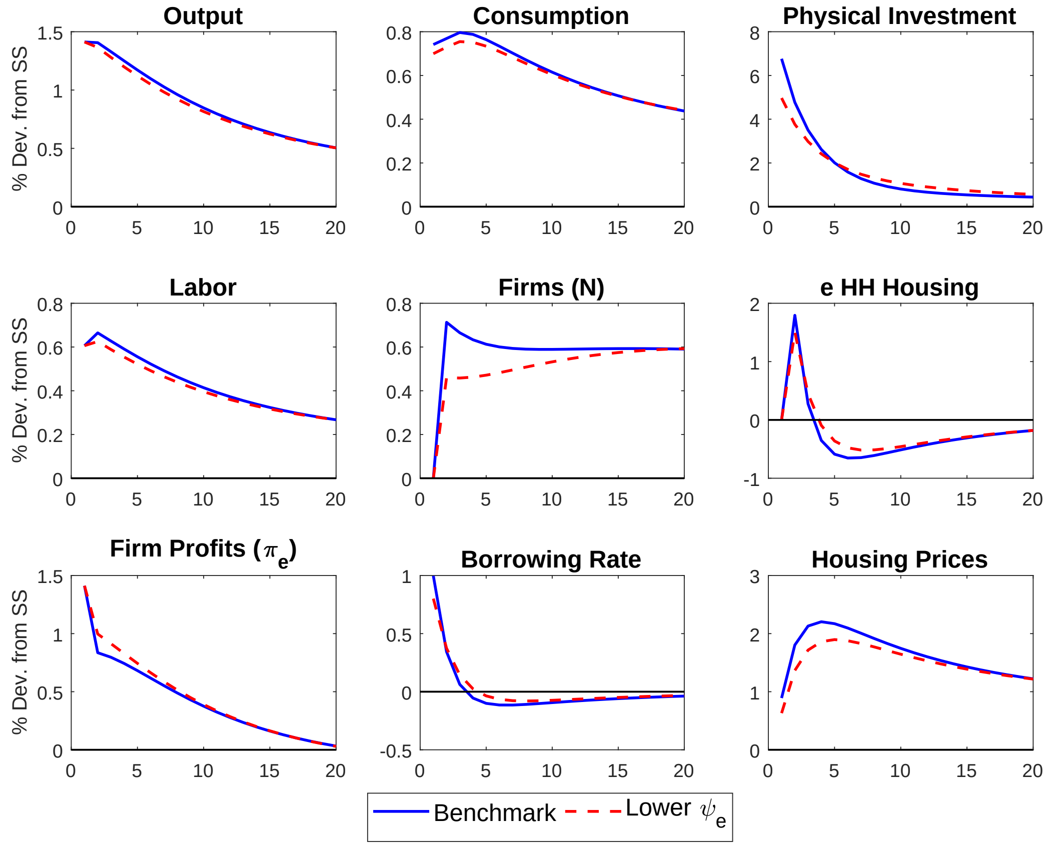


Figure 4: Response to Positive Aggregate Productivity Shock (Quarters After Shock)



First, note that amid aggregate productivity shocks, an economy with a lower ψ_e—and therefore an economy with higher average new firm entry—exhibits *smoother* responses to these shocks. Thus, aggregate productivity shocks alone *cannot* rationalize the empirical link between NFD and house price volatility. In contrast, the response to housing-finance shocks confirms the intuition and channels described above.

Specifically, in response to a positive housing-finance shock, output, labor, and firm entry all rise, while consumption and physical investment fall (with a lag) as resources are reallocated away from consumption and into the purchase of housing *and* the creation of firms. Of particular importance for our purposes is the fact that, for a given set of shocks, housing prices become more responsive in the economy with a lower ψ_e. As discussed above and as shown in Figure 4, 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 1. Thus, the differential response in borrowing rates and firm profits relative to the baseline (low NFD) calibration are bound to be larger the lower ψ_e (and hence the higher NFD) is). Moreover, note that while the responsiveness of both output and housing prices increases, the response of house prices is greater than that of output, ultimately resulting in greater variability of house prices (relative to the variability of output) compared to an economy with lower average firm entry.

4.4 The Role of Housing-Finance Shocks

To stress the role of housing-finance (or LTV) shocks in generating a non-negligible increase in house price volatility as a result of greater average firm entry, we perform the same experiments shown in Figure 1 for two variants of the benchmark model. First, a model without housing finance constraints (and therefore without housing-finance shocks) (Figure 5 below). Second, a version of the benchmark model without housing-finance shocks (Figure 6 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-state firm entry.[29]

[29] Otherwise, absent housing market shocks (either preference or housing-finance shocks), the model with only aggregate productivity shocks generates too little volatility in house prices, both in absolute and relative terms (see Figure A2 in the Appendix). Thus, for the purposes of comparability, we introduce housing preference shocks. Section A.7 in the Appendix presents the calibration details for the housing preference shocks for the two alternatives in Figures 5 and 6. For completeness, Figure A3 in the Appendix 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 1, housing-finance shocks can already generate the empirical link between NFD and house price volatility well.

Figure 5: New Firm Density and Housing Price Volatility: Data vs. Model without Housing Finance Constraints

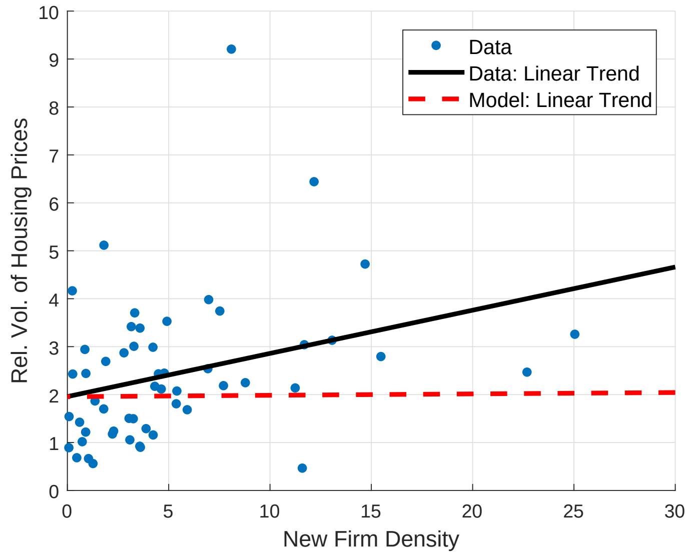
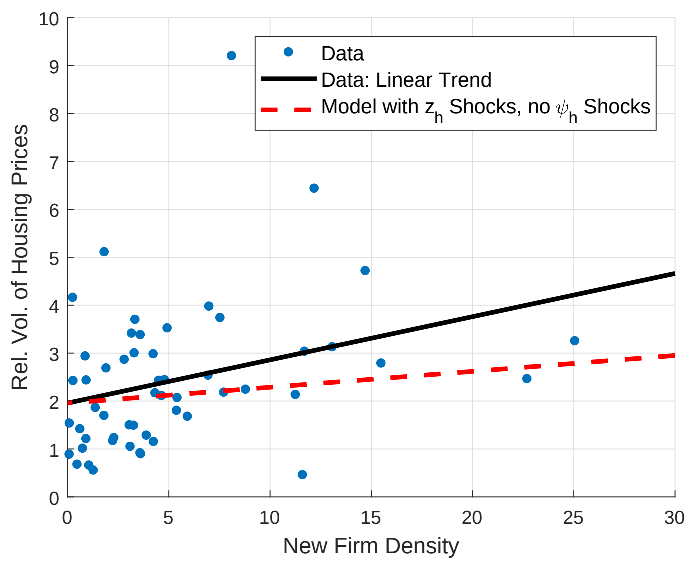


Figure 6: New Firm Density and Housing Price Volatility: Data vs. Benchmark Model without Housing Finance Shocks



Absent housing finance constraints (*and therefore housing-finance shocks*), the model generates a positive *qualitative* relationship between new firm density 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 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 mechanisms described above.

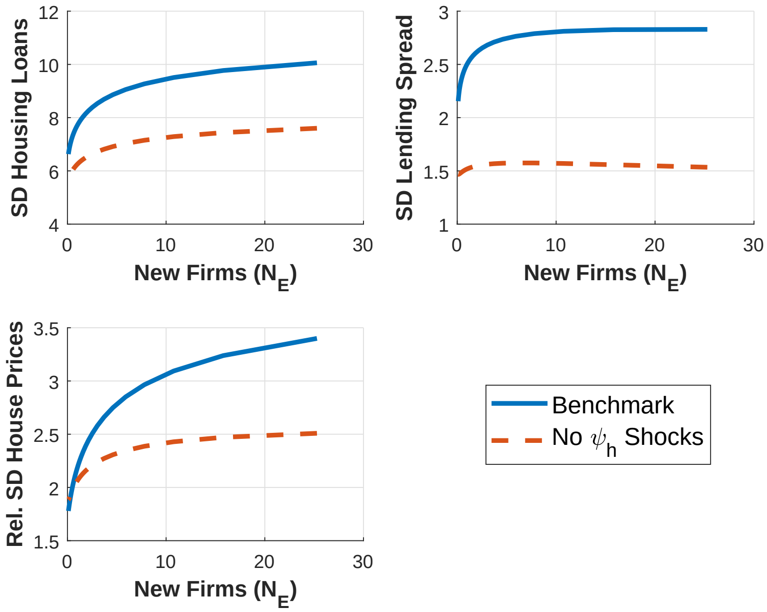
A similar claim holds in a version of the benchmark model where housing preference shocks replace housing-finance shocks. The model does generate a positive relationship between new firm density and the relative volatility of house prices, but the model still falls short of fully capturing the *quantitative* change in house price volatility as new firm entry 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 below, 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 NFD-house price volatility nexus in the data.

To summarize the main mechanism and the importance of housing-finance shocks graphically, Figure 7 plots average new firm entry against (1) the volatility of e households' loans; (2) the volatility of lending-deposit spreads; 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 latter.[30] In the absence of housing-finance shocks, the increase in the volatility of both housing loans and

[30] As noted earlier, for comparability, we consider a model with housing preference shocks so that both models have the same *initial* relative volatility of house prices (i.e. the same relative volatility of house prices for the lowest steady-state N_E. Absent both housing preference and housing-finance shocks, the volatility of house prices would be too low compared to the benchmark model.

borrowing rates due to greater average firm entry is smaller, which ultimately results in a smaller increase in the relative volatility of house prices.

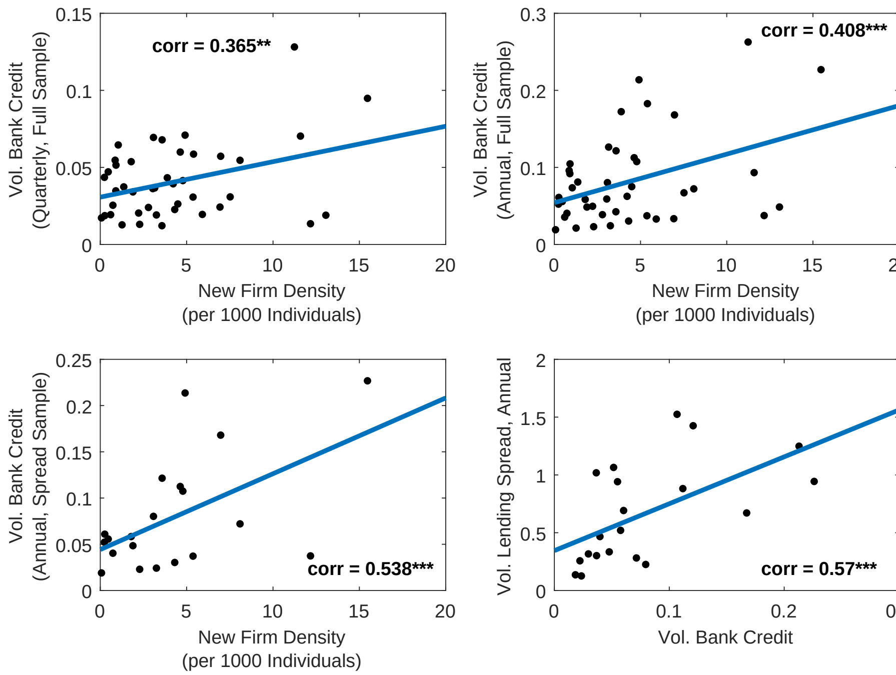
Figure 7: New Firm Density, Housing-Loan and Lending-Spread Volatility, and Relative Housing Price Volatility



4.5 Empirical Validation of Model's Main Mechanism

As noted earlier, greater average new firm entry generates an equilibrium increase in average house prices. By increasing the average size of housing loans, greater average new firm entry makes housing loans (and therefore bank credit), borrowing rates, and lending spreads 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. If this mechanism is indeed operative in the data, we should observe that greater average NFD is associated with greater bank-credit volatility, and that bank-credit volatility is positively associated with volatility in lending spreads in the data.

Figure 8: 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 8 plots average NFD in the data against the volatility of bank credit, and the volatility of bank credit against the volatility of lending spreads.[31] For completeness, the

[31]Data on 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 bank credit. However, as shown in two upper subpanels in Figure 8, the positive relationship between average NFD and the volatility of 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

upper subpanels of Figure 8 plot the volatility of bank credit at both quarterly and annual frequencies against average NFD for the sample of economies in our sample that have available data. In turn, the lower subpanels of Figure 8 plot the volatility of 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* (hence the smaller number of observations for bank-credit volatility). All told, this evidence suggests that the main mechanism in our model is supported by the data, which gives further validation to our framework.

4.6 Heterogeneity in Housing Finance and Foreign Financial Shocks

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.

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).[32] Figure A4 in the Appendix shows that our results remain unchanged when, in addition to the value of new housing, final goods

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 samples in Figure 8.

[32] 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 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 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.

firms' sunk entry costs and intermediate-goods firms' wage and capital bills are part of e households' financing constraints. In turn, Figure A5 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 in 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 A5 should be seen as an upper bound for the model-based link between NFD and house price volatility. All told, the results in Figures A4 and A5 confirm that the strength of the model mechanism reflected in Figure 1 is robust to alternative shock specifications and richer specifications of e and s households' financing constraints.

Finally, recent work has shown that 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 A6 in the Appendix shows that including foreign interest rate shocks does not affect the model's success in quantitatively explaining our new stylized fact. 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, as shown in Figure A7 in the Appendix. In other words, greater average firm entry *lessens* the impact of external financial shocks on house price dynamics. These results suggest that housing-market (financial) shocks *specifically* are critical for generating the cross-country relationship between average NFD and house price volatility. In other words, not all financial shocks are created equal when it comes to their impact on house price volatility.

5 Conclusion

Using a large sample of countries with available high-frequency data on housing prices, we show that in economies with greater average new firm density (NFD), house price volatility is greater as well, even after controlling for other factors that may influence housing price dynamics. This relationship is quantitatively important: our benchmark results suggest that a 1 percent increase in average new firm density can be associated with up to a roughly 0.6 percent increase in the average relative volatility of house prices. We build a small open economy real business cycle model with endogenous firm entry and housing with housing finance constraints to explore the economic mechanisms through which the NFD-house price volatility nexus may arise.

Our framework can successfully replicate the average increase in the relative volatility of housing prices as new firm density 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 supported 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 of International Settlements (BIS) and new business density by the World Bank Entrepreneurship Report and 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.

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 Business Density New business entry density is given by the number of newly registered private corporations 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. 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.

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.

Real House Prices (BIS) Real 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: 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 Labour 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: 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.

Lending Spread Difference between lending and deposit rate (percent). Available at annual frequency from 1990 to 2016 (*uninterrupted* coverage varies by country). Countries: Australia, Brazil, Bulgaria, Canada, Chile, Colombia, Croatia, Czech Republic, Estonia, Hungary, Indonesia, Israel, Japan, Korea, Latvia, Macedonia, Malaysia, Mexico, Netherlands, New Zealand, Peru, Philippines, Romania, Russia, Singapore, South Africa, Switzerland, and Thailand. Source: World Bank Development Indicators.

A.2 Robustness Checks: New Firm Formation and Housing Price Volatility Across Countries

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

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Ave. New Firm Density	0.0812**	0.0911**	0.119**	0.110**	0.114**	0.110**	0.173**
	(2.75)	(2.81)	(3.30)	(3.04)	(3.14)	(3.05)	(3.35)
Loan to Purchase Home		-0.00849	0.00591	0.0128	0.0185	0.0300	-0.0150
		(-0.66)	(0.39)	(0.82)	(1.10)	(1.64)	(-0.59)
Bank Credit-GDP Ratio			-0.0105	-0.00691	-0.00905	-0.00713	-0.000639
			(-1.64)	(-1.04)	(-1.29)	(-1.01)	(-0.07)
Inflation Rate				0.0887	0.0878	0.0772	0.106
				(1.63)	(1.61)	(1.42)	(1.12)
Corr(Gl. Liquidity,GDP)					-0.718	-0.257	-0.134
					(-0.97)	(-0.32)	(-0.15)
Advanced Econ.						-0.709	
						(-1.47)	
Household Credit Share							2.594
							(1.65)
Constant	1.873***	1.991***	2.380***	1.832***	2.223**	2.156**	0.560
	(8.43)	(7.42)	(6.72)	(3.78)	(3.52)	(3.45)	(0.52)
Adjusted R^2	0.111	0.107	0.137	0.167	0.165	0.186	0.294
Observations	54	51	51	51	51	51	34

t statistics in parentheses
$^{+}p < 0.10$, $^{*}p < 0.05$, $^{**}p < 0.01$, $^{***}p < 0.001$

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. See the Data Appendix for details regarding data sources, country sample, and definitions.

Table A2: Relative Volatility of House Prices and New Firm Density (2006Q1-2016Q4)

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Ave. New Firm Density	0.0664*	0.0677*	0.0908*	0.0838*	0.0853*	0.0833*	0.194***
	(2.32)	(2.14)	(2.35)	(2.18)	(2.16)	(2.10)	(3.71)
Loan to Purchase Home		-0.000422	0.0102	0.0177	0.0188	0.0254	-0.0233
		(-0.03)	(0.63)	(1.05)	(1.06)	(1.32)	(-0.92)
Bank Credit-GDP Ratio			-0.00612	-0.00412	-0.00444	-0.00393	0.00308
			(-1.04)	(-0.69)	(-0.71)	(-0.62)	(0.40)
Inflation Rate				0.612	0.600	0.415	0.417
				(1.44)	(1.39)	(0.87)	(0.91)
Corr(Gl. Liquidity,GDP)					-0.162	0.108	0.533
					(-0.21)	(0.13)	(0.52)
Advanced Econ.						-0.500	
						(-0.94)	
Household Credit Share							2.106
							(1.33)
Constant	1.836***	1.859***	2.103***	1.429*	1.531+	1.672*	-0.0192
	(8.55)	(7.10)	(5.98)	(2.45)	(1.98)	(2.12)	(-0.02)
Adjusted R^2	0.078	0.060	0.061	0.083	0.063	0.060	0.315
Observations	53	50	50	50	50	50	33

t statistics in parentheses
$^{+}p < 0.10$, $^{*}p < 0.05$, $^{**}p < 0.01$, $^{***}p < 0.001$

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. See the Data Appendix for details regarding data sources, country sample, and definitions.

Table A3: Relative Volatility of House Prices and New Firm Density, New Firm Density 2006 (2000Q1-2016Q4)

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
New Firm Density 2006	0.106**	0.127**	0.154**	0.142**	0.148**	0.150**	0.253***
	(3.02)	(3.17)	(3.25)	(2.96)	(3.24)	(3.26)	(4.35)
Loan to Purchase Home		-0.0109	0.00277	0.00771	0.0228	0.0296	-0.0408
		(-0.68)	(0.13)	(0.37)	(1.09)	(1.29)	(-1.22)
Bank Credit-GDP Ratio			-0.00811	-0.00481	-0.0101	-0.00996	-0.00465
			(-1.05)	(-0.59)	(-1.26)	(-1.23)	(-0.44)
Inflation Rate				0.457	0.187	0.109	-0.0823
				(1.20)	(0.49)	(0.28)	(-0.19)
Corr(Gl. Liquidity,GDP)					-2.117*	-1.898*	-2.109+
					(-2.40)	(-2.02)	(-1.83)
Advanced Econ.						-0.434	
						(-0.71)	
Household Credit Share							4.355*
							(2.24)
Constant	1.819***	1.948***	2.256***	1.600*	3.023**	3.114**	1.819
	(6.87)	(5.92)	(5.13)	(2.28)	(3.39)	(3.44)	(1.31)
Adjusted R^2	0.137	0.146	0.148	0.157	0.239	0.230	0.443
Observations	52	49	49	49	49	49	33

t statistics in parentheses
$^{+}p < 0.10$, $^{*}p < 0.05$, $^{**}p < 0.01$, $^{***}p < 0.001$

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. See the Data Appendix for details regarding data sources, country sample, and definitions.

Table A4: Relative Volatility of House Prices and New Firm Density, Alternative Specifications (2000Q1-2016Q4)

	(1)	(2)	(3)	(4)	(5)
Ave. New Firm Density	0.132**	0.119**	0.122*	0.135**	0.129*
	(2.93)	(3.08)	(2.53)	(2.92)	(2.65)
Loan to Purchase Home	0.0241	0.0307	0.0175	0.0252	0.0258
	(1.13)	(1.48)	(0.76)	(1.05)	(1.07)
Bank Credit-GDP Ratio	-0.00965		-0.00666	-0.00840	-0.00692
	(-1.26)		(-0.80)	(-1.00)	(-0.84)
Inflation Volatility	0.670*	0.638+			
	(2.07)	(2.00)			
Corr(Gl. Liquidity,GDP)	-2.115*	-1.360	-2.033*	-2.063*	-2.456*
	(-2.47)	(-1.59)	(-2.18)	(-2.26)	(-2.42)
ave_log_gdppc_ppp_2000_2016		-0.859+			
		(-1.80)			
Inflation Rate			0.554	0.282	0.516
			(1.67)	(0.72)	(1.55)
Own-Account-Worker Share			-0.0114		-0.00109
			(-0.53)		(-0.05)
Informal Sector Size				0.00929	
				(0.37)	
Pop. Growth					-0.333
					(-1.07)
Constant	2.784***	10.25*	2.804*	2.545*	2.945**
	(3.98)	(2.30)	(2.62)	(2.04)	(2.73)
Adjusted R^2	0.229	0.256	0.193	0.169	0.195
Observations	51	51	51	50	51

t statistics in parentheses
$^{+}p < 0.10$, $^{*}p < 0.05$, $^{**}p < 0.01$, $^{***}p < 0.001$

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. See the Data Appendix for details regarding data sources, country sample, and definitions.

Table A5: Relative Volatility of House Prices and New Firm Density, Data in First Differences (2000Q1-2016Q4)

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Ave. New Firm Density	0.0578*	0.0695**	0.0825**	0.0800**	0.0902**	0.0912**	0.147**
	(2.45)	(2.76)	(2.79)	(2.70)	(3.02)	(3.05)	(3.63)
Loan to Purchase Home		-0.00704	0.000253	0.00302	0.00301	0.0102	-0.0122
		(-0.71)	(0.02)	(0.22)	(0.23)	(0.67)	(-0.61)
Bank Credit-GDP Ratio			-0.00416	-0.00275	-0.00366	-0.00384	0.00186
			(-0.85)	(-0.54)	(-0.73)	(-0.76)	(0.31)
Inflation Rate				0.209	0.293	0.232	0.359
				(1.01)	(1.40)	(1.06)	(1.38)
Corr(Gl. Liquidity,GDP)					1.045	1.201+	1.544*
					(1.62)	(1.80)	(2.08)
Advanced Econ.						-0.364	
						(-0.94)	
Household Credit Share							0.942
							(0.77)
Constant	1.688***	1.793***	1.941***	1.620***	1.307**	1.433**	0.261
	(9.49)	(8.60)	(7.12)	(3.88)	(2.87)	(3.02)	(0.37)
Adjusted R^2	0.086	0.102	0.096	0.097	0.127	0.125	0.253
Observations	54	51	51	51	51	51	34

t statistics in parentheses
$^{+}p < 0.10$, $^{*}p < 0.05$, $^{**}p < 0.01$, $^{***}p < 0.001$

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 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 A6: Relative Volatility of House Prices and New Firm Density, Cesa-Bianchi et al. (2015) House Price Data (2000Q1-2012Q4)

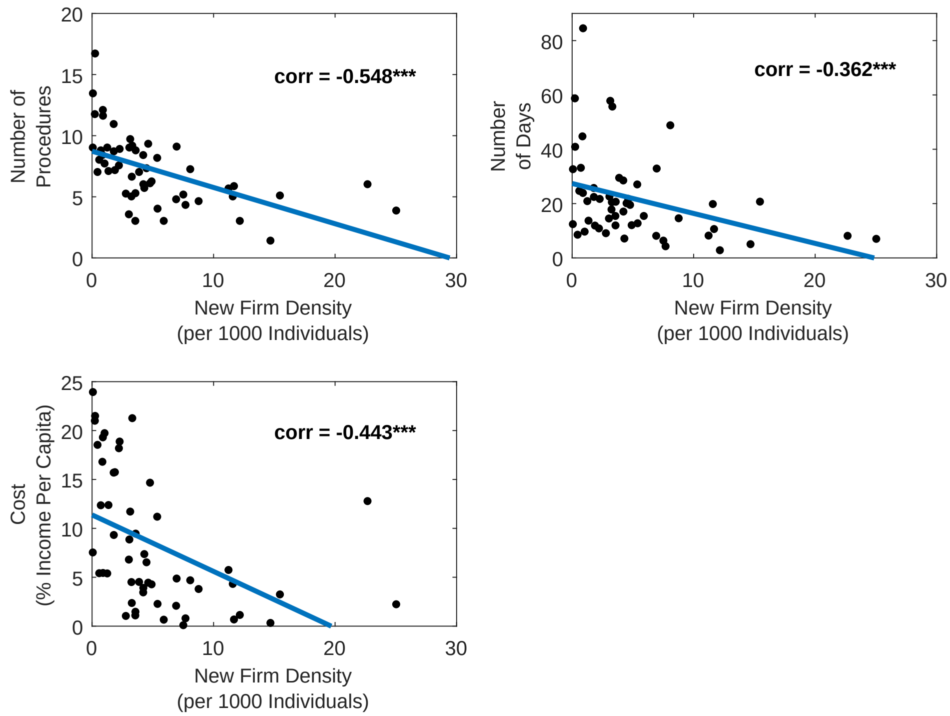
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Ave. New Firm Density	0.0628	0.0913^{+}	0.119^{*}	0.112^{*}	0.110^{*}	0.108^{*}	0.202^{*}
	(1.43)	(1.94)	(2.38)	(2.32)	(2.26)	(2.20)	(2.49)
Loan to Purchase Home		-0.0291^{+}	-0.00598	0.000304	-0.00322	0.00726	-0.0502
		(-1.72)	(-0.26)	(0.01)	(-0.14)	(0.28)	(-1.25)
Bank Credit-GDP Ratio			-0.0128	-0.00777	-0.00631	-0.00587	-0.00489
			(-1.49)	(-0.90)	(-0.70)	(-0.65)	(-0.38)
Inflation Rate				0.677^{+}	0.696^{*}	0.615^{+}	0.258
				(2.00)	(2.03)	(1.73)	(0.33)
Corr(Gl. Liquidity,GDP)					0.702	1.011	0.790
					(0.66)	(0.90)	(0.51)
Advanced Econ.						-0.582	
						(-0.92)	
Household Credit Share							3.322
							(1.38)
Constant	2.265^{***}	2.633^{***}	3.120^{***}	2.051^{**}	1.621	1.707^{+}	1.023
	(7.28)	(7.18)	(6.40)	(2.88)	(1.67)	(1.75)	(0.50)
Adjusted R^2	0.021	0.063	0.088	0.148	0.136	0.133	0.129
Observations	50	47	47	47	47	47	32

t statistics in parentheses
$^{+}p < 0.10$, $^{*}p < 0.05$, $^{**}p < 0.01$, $^{***}p < 0.001$

Sources: 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.

A.3 Entry Costs and New Business Density Across Countries

Figure A1: Cost of Starting a Business and New Business Density



Source: World Bank Enterprise Surveys. The average cost of starting a business *for a given year* is the average of such cost for men and women *in that year*. All variables above are time averages for the period 2006-2016 (a limited number of countries does not have observations for all years). 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.

A.4 Equilibrium Conditions: Benchmark Model

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

$$\rho_t = (\varepsilon/(\varepsilon-1))\, mc_t, \tag{23}$$

$$N_t = (1-\delta)\left(N_{t-1} + N_{E,t-1}\right), \tag{24}$$

$$v_t = \frac{\psi_e}{(1-\delta)}, \tag{25}$$

$$v_t = \mathbb{E}_t \Xi^e_{t+1|t} \left[\underbrace{\left[\rho_{t+1} - mc_{t+1}\right] y_{t+1}}_{\pi_{e,t+1}} + (1-\delta)\, v_{t+1} \right], \tag{26}$$

$$r_{k,t} = \alpha mc_t z_t n_t^{1-\alpha} k_t^{\alpha-1}, \tag{27}$$

$$w_t = (1-\alpha) mc_t z_t n_t^{-\alpha} k_t^{\alpha}, \tag{28}$$

$$c_{s,t} + Q_{h,t}(h_{s,t} - h_{s,t-1}) + d_t = w_t n_{s,t} + R_{t-1} d_{t-1}, \tag{29}$$

$$\kappa n_{s,t}^{\xi} = w_t, \tag{30}$$

$$Q_{h,t} = \frac{(h_{s,t})^{-\sigma_h}}{\mathbf{u}_{c_{s,t}}} + \mathbb{E}_t \Xi^s_{t+1|t} Q_{h,t+1}, \tag{31}$$

$$\mathbf{u}_{c_{s,t}} = \beta R_t \mathbb{E}_t \mathbf{u}_{c_{s,t+1}}, \tag{32}$$

$$l_{e,t} = \phi_{h,t} Q_{h,t} h_{e,t}, \tag{33}$$

$$1 = \mathbb{E}_t \Xi^e_{t+1|t} \left[r_{k,t+1} + 1 - \delta\right], \tag{34}$$

$$1 = R_t^* \mathbb{E}_t \Xi^e_{t+1|t} + \eta_b b_t^*, \tag{35}$$

$$R_{e,t} = \left(\frac{\varepsilon_h}{\varepsilon_h - 1}\right) R_t, \tag{36}$$

$$\kappa n_{e,t}^{\xi} = w_t, \tag{37}$$

$$Q_{h,t} = \frac{(h_{e,t})^{-\sigma_h}}{\mathbf{u}_{c_{e,t}}} + \mathbb{E}_t \Xi^e_{t+1|t} Q_{h,t+1} - Q_{h,t}\phi_{h,t}\left[\mathbb{E}_t \Xi^e_{t+1|t} R_{e,t} - 1\right], \tag{38}$$

$$d_t = l_{e,t}, \tag{39}$$

$$n_{e,t} + n_{s,t} = n_t, \tag{40}$$

$$z_t n_t^{1-\alpha} k_t^{\alpha} = N_t y_t, \tag{41}$$

$$h_{e,t} + h_{s,t} = 1, \tag{42}$$

$$i_t = k_t - (1-\delta) k_{t-1}, \tag{43}$$

$$Y_t = y_t N_t^{\frac{\varepsilon}{\varepsilon-1}}, \tag{44}$$

$$Y_t = c_{s,t} + c_{e,t} + i_t + \psi_e N_{E,t} + R^*_{t-1} b^*_{t-1} - b^*_t, \tag{45}$$

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 $l_{e,t}$, foreign debt holdings b_t^*, the number of new firms $N_{E,t}$, and the desired number of future firms N_{t+1} to maximize

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

subject to the budget constraint[33]

$$\begin{aligned} & c_{e,t} + \psi_e N_{E,t} + Q_{h,t}(h_{e,t} - h_{e,t-1}) + R_{e,t-1} l_{e,t-1} + R^*_{t-1} b^*_{t-1} + \frac{\eta_b}{2} (b^*_t)^2 \\ = \;& w_t n_{e,t} + b^*_t + N_t \pi_{e,t} + \left[mc_t z_t n_t^{1-\alpha} k_{t-1}^{\alpha} - w_t n_t - (k_t - (1-\delta) k_{t-1}) \right] + l_{e,t}, \end{aligned}$$

the evolution of final goods firms

$$N_{t+1} = (1-\delta)\left(N_t + N_{E,t}\right), \tag{46}$$

and the financing constraint

$$l_{e,t} = \phi_{h,t} Q_{h,t} h_{e,t} + \phi_e \psi_e N_{E,t} + \phi_n w_t n_t + \phi_k r_{k,t} k_t. \tag{47}$$

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

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 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 and foreign debt, as well as optimal housing demand, remain unchanged relative to those in the main text:

$$1 = \mathbb{E}_t \Xi_{t+1|t}^{e}\left[r_{k,t+1} + 1 - \delta\right], \tag{48}$$

$$1 = R_t^* \mathbb{E}_t \Xi_{t+1|t}^{e} + \eta_b b_t^*, \tag{49}$$

and

$$Q_{h,t} = \frac{\left(h_{e,t}\right)^{-\sigma_h}}{\mathbf{u}_{c_{e,t}}} + \mathbb{E}_t \Xi_{t+1|t}^{e} Q_{h,t+1} - Q_{h,t}\phi_{h,t}\left[\mathbb{E}_t \Xi_{t+1|t}^{e} R_{e,t} - 1\right], \tag{50}$$

where $\Xi_{t+1|t}^{e} \equiv \beta_e \mathbf{u}_{c_{e,t+1}}/\mathbf{u}_{c_{e,t}}$ is the household's stochastic discount factor and we can define $r_{k,t} \equiv \alpha mc_t z_t n_t^{1-\alpha} k_{t-1}^{\alpha-1}$. Similarly, the labor supply condition is still

$$\kappa n_{e,t}^{\xi} = w_t. \tag{51}$$

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

$$w_t\left[1 - \phi_n + \phi_n \mathbb{E}_t \Xi_{t+1|t}^{e} R_{e,t}\right] = (1-\alpha) mc_t z_t n_t^{-\alpha} k_{t-1}^{\alpha}, \tag{52}$$

and

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

The optimal firm creation condition is

$$v_t = \mathbb{E}_t \Xi_{t+1|t}^{e}\left[\pi_{e,t+1} + (1-\delta)\, v_{t+1}\right], \tag{53}$$

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

$$v_t = \frac{\psi_e \left[1 - \phi_e + \phi_e \mathbb{E}_t \Xi^e_{t+1|t} R_{e,t}\right]}{(1-\delta)}. \tag{54}$$

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

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

subject to the budget constraint

$$c_{s,t} + Q_{h,t}(h_{s,t} - h_{s,t-1}) + d_t + R_{s,t-1} l_{s,t-1} = l_{s,t} + w_t n_{s,t} + R_{t-1} d_{t-1} + \Pi_{b,t}, \tag{55}$$

and the financing constraint

$$l_{s,t} = \phi_{h,t} Q_{h,t} h_{s,t}, \tag{56}$$

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: $\mathbf{u}(c_{s,t}, n_{s,t}, h_{s,t}) = \left[\frac{1}{1-\sigma}\left(c_{s,t} - \frac{\kappa}{1+\xi} n_{s,t}^{1+\xi}\right)^{1-\sigma} + \frac{\gamma_h}{1-\sigma_h}(h_{s,t})^{1-\sigma_h}\right]$ 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:

$$\kappa n_{s,t}^{\xi} = w_t, \tag{57}$$

and

$$Q_{h,t} = \frac{(h_{s,t})^{-\sigma_h}}{\mathbf{u}_{c_{s,t}}} + \mathbb{E}_t \Xi_{t+1|t}^{s} Q_{h,t+1} - Q_{h,t}\phi_{h,t}\left[\mathbb{E}_t \Xi_{t+1|t}^{s} R_{s,t} - 1\right], \tag{58}$$

as well as a standard Euler equation over deposits

$$\mathbf{u}_{c_{s,t}} = \beta R_t \mathbb{E}_t \mathbf{u}_{c_{s,t+1}}, \tag{59}$$

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

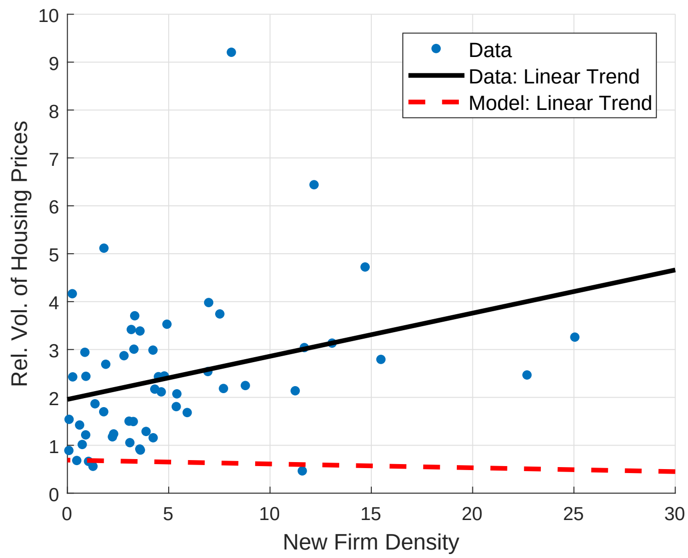
Banks The banking sector has a measure $[0,1]$ of banks. Banks are monopolistically competitive in the market for loans but perfectly competitive in the market for deposits. They turn all their profits to s households. Each bank j chooses its gross real loan rate $R_{je,t}$ and $R_{js,t}$ to maximize 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. Note that 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, the implied volatility of housing preference shocks is $\sigma_{z_h} = 0.211$. Note that the model-generated slope arises endogenously.

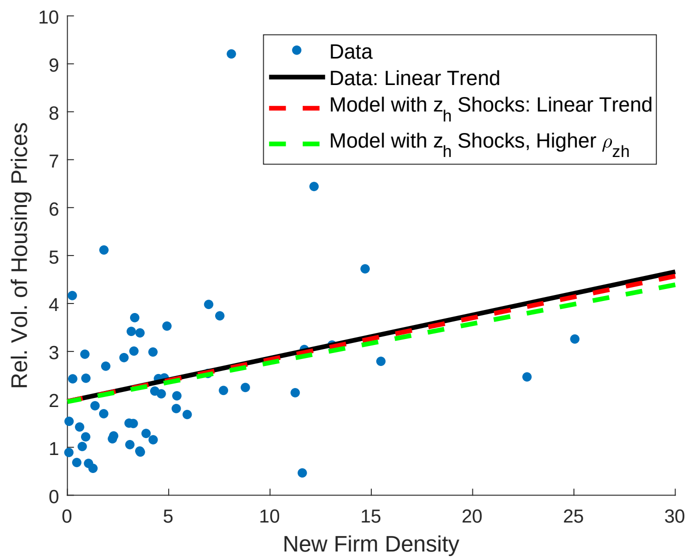
For completeness, Figure A2 below presents the results from the model without housing finance constraints in the absence of housing preference shocks. As should be expected, absent these shocks, the relative volatility of house prices is lower than in the data, even for low levels of NFD. Moreover, the model fails to match the positive relationship between house price volatility and NFD.

Figure A2: 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 A3 plots new firm density against the relative volatility of housing 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. In the model calibration, we assume that the volatility of housing-finance (or LTV) and housing preference shocks is the same. Consistent with our approach 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 $\sigma_{z_h} = \sigma_{\phi_h} = 0.03$). 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-based 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

Figure A3: New Firm Density and Housing Price Volatility: Data vs. Benchmark Model with z_h Shocks



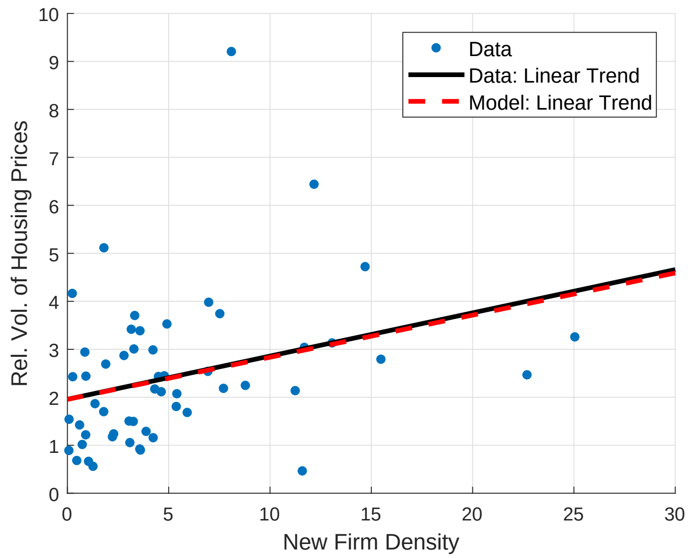
by construction.

Benchmark Model with Sunk Entry Costs, the Wage Bill, and Investment in e Households' Financing Constraint Figure A4 plots new firm density against the relative volatility of housing 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 Subsection A.6 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 $\phi_n = \phi_k = 1$.[34] The implied volatility of housing-finance shocks so that the trend line in the data and the trend line from the model have the same intercept is $\sigma_{\phi_h} = 0.0628$. Once again, recall that the model-generated slope arises endogenously and is

[34] 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.

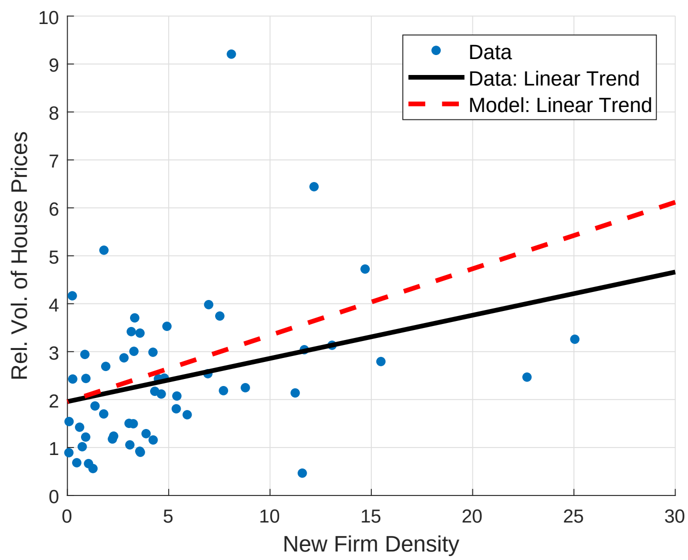
not matched by construction.

Figure A4: New Firm Density and Housing Price Volatility: Data vs. Model with Sunk Entry Costs, Wage Bill, and Capital Bill in Financing Constraint



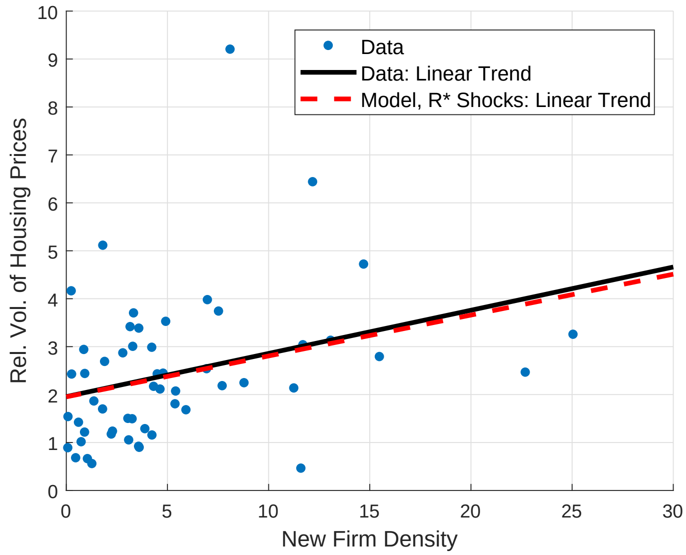
Benchmark Model where All Households Borrow Figure A5 plots new firm density against the relative volatility of housing prices as well as the implied trend line in the data and compares the trend in the data to the predictions of a version of our benchmark model where both e and s households borrow to 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 $\sigma_{\phi_h} = 0.0453$. As Figure A6 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.

Figure A5: New Firm Density and Housing Price Volatility: Data vs. Model where All Households Borrow



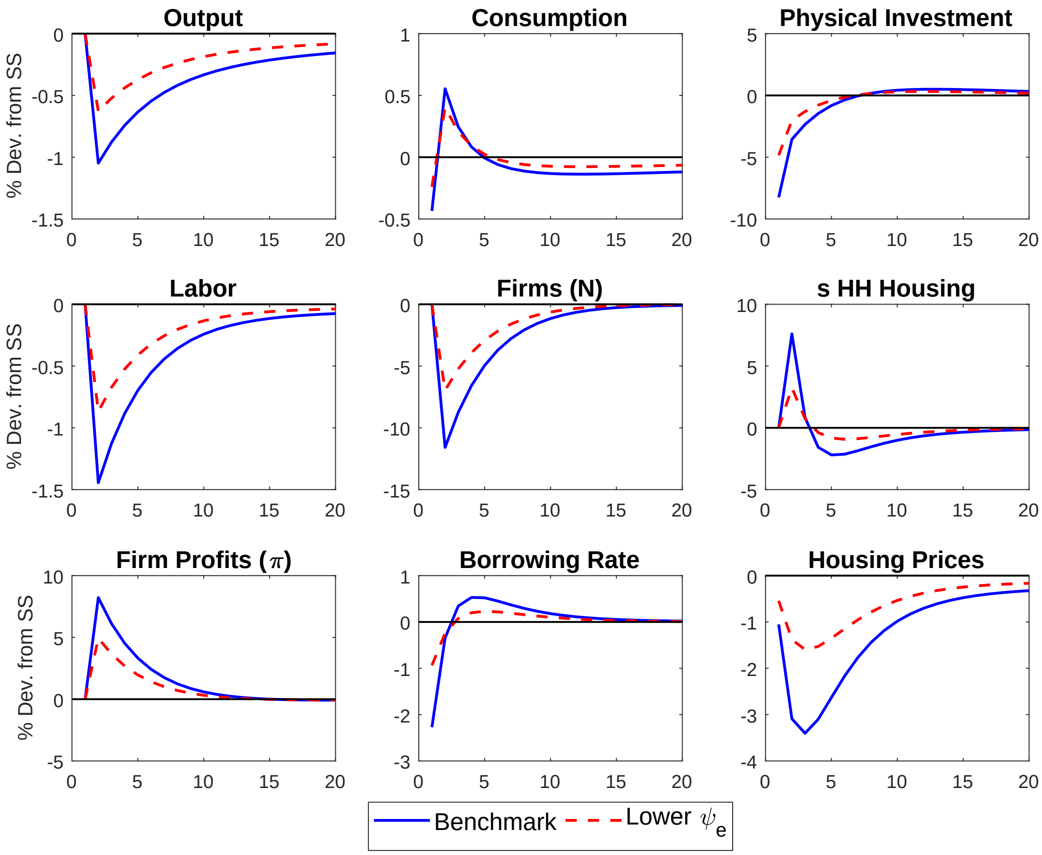
Benchmark Model with Foreign Interest Rate Shocks Figure A6 plots new firm density against the relative volatility of housing prices as well as the implied trend line in the data and compares the trend in the data to the predictions of a version of our benchmark model that includes foreign interest rate shocks, which we consider as a proxy for international credit supply shocks. We assume that R^* follows an AR(1) process. We set the autoregressive parameter $\rho_{R^*} = 0.76$ and the volatility $\sigma_{R^*} = 0.0084$. These values are consistent with an estimated AR(1) process for U.S. real interest rates using the inflation-adjusted 3-month Treasury bill as our measure of U.S. 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 $\sigma_{\phi_h} = 0.0335$. Once again, recall that the model-generated slope arises endogenously and is not matched by construction.

Figure A6: New Firm Density and Housing Price Volatility: Data vs. Model with Foreign Interest Rate Shocks



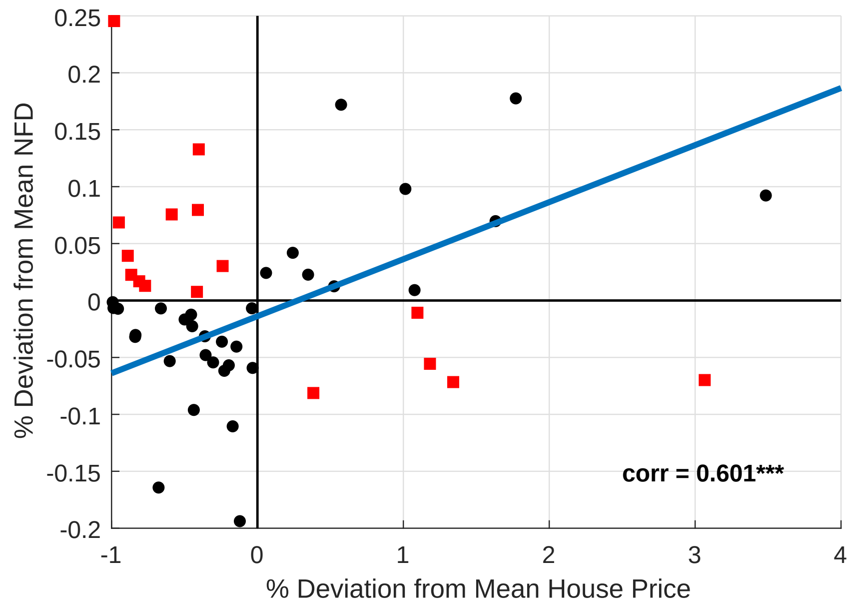
Finally, Figure A7 shows the response of the economy to a temporary, exogenous increase in foreign interest rates (the impulse responses for aggregate productivity and housing-finance shocks look similar to those in Figures 2 and 3 in the main text).

Figure A7: 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 A8: Average New Firm Density and House Prices



Sources: (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) to 2016.