Crawford School of Public Policy

CAMA

Centre for Applied Macroeconomic Analysis

Holes in the Dike: the global savings glut, U.S. house prices and the long shadow of banking deregulation

CAMA Working Paper 6/2016
February 2016

Mathias Hoffmann
University of Zurich and
Centre for Applied Macroeconomic Analysis (CAMA), ANU

Iryna Stewen
Johannes Gutenberg University Mainz

Abstract

We show how capital inflows into and financial deregulation within the United States interacted in driving the recent boom and bust in U.S. housing prices. Interstate banking deregulation during the 1980s cast a long shadow: in states that opened their banking markets to out-of-state banks earlier, house prices were more sensitive to aggregate U.S. capital inflows during 1990-2012. Capital inflows relaxed the value-at-risk constraints of geographically diversified ('integrated') U.S. banks more than those of local banks. Therefore, integrated banks absorbed a larger share of capital inflows and expanded mortgage lending more. This drove up housing prices.

Keywords

house prices, global imbalances, interstate banking deregulation

JEL Classification

G10, G21, G28, F20, F32, F40

Address for correspondence:

(E) cama.admin@anu.edu.au

ISSN 2206-0332

Holes in the Dike: the global savings glut, U.S. house prices and the long shadow of banking deregulation*

Mathias Hoffmann (University of Zurich)
Iryna Stewen (Johannes Gutenberg University Mainz)†

January 20, 2016

Abstract

We show how capital inflows into and financial deregulation within the United States interacted in driving the recent boom and bust in U.S. housing prices. Interstate banking deregulation during the 1980s cast a long shadow: in states that opened their banking markets to out-of-state banks earlier, house prices were more sensitive to aggregate U.S. capital inflows during 1990-2012. Capital inflows relaxed the value-at-risk constraints of geographically diversified ('integrated') U.S. banks more than those of local banks. Therefore, integrated banks absorbed a larger share of capital inflows and expanded mortgage lending more. This drove up housing prices.

Keywords: HOUSE PRICES, GLOBAL IMBALANCES, INTERSTATE BANKING DEREGULATION

JEL *classification:* G10, G21, G28, F20, F32, F40

*We thank Allen Berger, Ralf Fendel, Christa Hainz, Pierre-Olivier Gourinchas, Thomas Steger, Jaume Ventura and seminar participants at the international economics committee of the German Economics Association (VfS), the annual conferences of the VfS and the European Economic Association, the ASSA 2016 meetings, at IWH Halle, at University of Mainz, University of Leipzig, at WHU–Otto Beisheim School of Management, the CESifo macro area conference, the University of Geneva, the Bank of Japan, Keio University, University of Kobe , University of Warwick and the Federal Reserve Bank of San Francisco for comments and discussions.

†Mathias Hoffmann is at the University of Zurich, Dept. of Economics, International Trade and Finance Group, Zürichbergstrasse 14, CH-8032 Zürich. He is also affiliated with University of Zurich's Research Priority Program in Financial Market Regulation (URPP FinReg), the CESifo Munich and the Centre for Applied Macroeconomic Analysis (CAMA) at the Australian National University. E-mail: mathias.hoffmann@uzh.ch.
Iryna Stewen is at Gutenberg School of Management and Economics, Johannes Gutenberg University Mainz, Jakob-Welder-Weg 4, D-55128 Mainz, Germany. She is also an affiliate researcher at the URPP FinReg. E-mail: iryna.stewen@uni-mainz.de

1 Introduction

In this paper, we investigate empirically how the interaction between financial liberalization and capital inflows contributed to the rise (and subsequent decline) in the valuations of U.S. residential housing. Our analysis makes use of *ex ante* differences in financial openness between US federal states. During the late 1970s and 1980s, federal states lowered the legal barriers to access to their local banking markets (see Kroszner and Strahan (1999); Jayaratne and Strahan (1996)). We show that house prices in states that had lowered these barriers earlier were more sensitive to the impact of international capital flowing into the United States in the second half of the 1990s. Over the decade between 1995 and 2005 the U.S. was running a current account deficit of 3.5 percent of GDP on average. Our estimates imply that due to these capital inflows house price–income ratios at the peak of the housing boom in 2005 were almost 30 percent higher in a state that liberalized, say, in 1980 than in a state that liberalized ten years later, in 1990.

Already prior to the global financial crisis of 2007/2008, some analysts saw global imbalances in capital flows—the high savings rates of emerging economies and the large current account deficits of the U.S. economy—as a major threat to global economic stability (Obstfeld and Rogoff (2009)). As early as 2005, Federal Reserve Chairman Ben Bernanke argued that a global glut of savings flowing into the U.S. was lowering long-term interest rates and thus contributing to a run-up in asset prices (Bernanke (2005)). However, when the financial crisis eventually struck in 2007, it emanated from what at first appeared as the least globalized part of the U.S. financial system—the housing market and the market for residential mortgages. In their quest to explain the crisis, many policymakers and academics therefore singled out the financial liberalization and deregulation of the last two decades before 2007 as the main causes. Only recently research has started to rigorously investigate the possibility that global imbalances in capital flows could themselves have contributed to the boom and bust in asset prices, notably in the price of housing (Justiniano, Primiceri and Tambalotti (2013); Ferrero (2015); Aizenman and Jinjarak (2009); Favilukis et al. (2012)).

Our empirical contribution is to exploit the *interaction* between state-level histories of financial liberalization and aggregate U.S. capital inflows to identify the channels through which global imbalances affected housing prices. The intuition underlying our analysis is simple: when U.S. federal states deregulated during the 1980s, they effectively poked holes in the dikes that shielded their local banking markets from banking flows from outside the state. After liberalization, out-of-state banks started to enter these freshly liberalized local banking markets. States that started to lower barriers earlier had a larger presence of banks operating in several states (referred to in what follows as 'integrated' banks) when global imbalances started to hit the U.S. from the mid-1990s onwards, amidst a wave of financial globalization that was characterized by the appearance of China and other emerging economies on the world economic stage (see Obstfeld and Rogoff (2009)). We show that the savings glut was a positive funding shock to the entire U.S. banking system. Integrated and local banks reacted differently to this shock: geographically diversified banks increased their leverage more, thus absorbing a larger share of the international demand for U.S. assets. States with a stronger presence of integrated banks — i.e. states that had poked bigger holes into their dikes by liberalizing earlier during the 1980s —therefore were more exposed to the savings glut.

Our identification strategy builds on two key assumptions. First, aggregate inflows into the U.S. are arguably exogenous with respect to house prices in individual states or counties—the two levels of aggregation at which we conduct our analysis. Our analysis therefore does not have to make use of state-level capital inflows which could be plagued by endogeneity (and on which data do not exist in any case). Secondly, the wave of cheap capital in hunt for safe assets that hit the U.S. in the second half of the 1990s could not have been anticipated by state regulators in the 1980s, when most of the liberalization of the interstate banking regime took place. Thus, our primary measure of *ex ante* financial openness—the number of years that had passed since a state liberalized its interstate banking regime until 1995—is clearly predetermined. Our findings therefore allow the interpretation that U.S. aggregate capital inflows were indeed causal for house price developments at the state level.

Documenting causality from aggregate capital inflows to state-level housing prices does not yet answer the question to what extent aggregate capital inflows reflect an aggregate shock to demand for borrowing or a global supply shock in the availability of loanable funds. To structure the empirical analysis of the transmission channel between capital inflows, bank lending and house prices, we use a simple theoretical model based on Shin (2010) in which banks' lending supply is determined by a value-at-risk (VaR) constraint. Due to geographic diversification, integrated banks' perceived loan portfolio risk in the model is lower than that of local banks, consistent with the the widely-held view in the years before 2007 that the U.S.-wide housing market—in spite of some regional declines—would never decline in aggregate. In this framework, we then interpret the savings glut as a positive deposit supply shock to the U.S. banking system. Capital inflows drive down banks' refinancing rates which in turn relaxes their VaR constraints. Because integrated banks' perceived portfolio risk is lower, their leverage is higher and—importantly —also more sensitive to declines in refinancing rates than that of local banks. Thus, the model predicts that integrated banks' loan supply is effectively more elastic to capital inflows and lower refinancing rates than that of local banks.

We find strong empirical support for this transmission mechanism in the data: consistent with the view that capital inflows were a liquidity supply shock for the entire financial system, capital inflows drive down refinancing rates for both local and integrated banks. Integrated banks reacted to this decline by expanding their balance sheets (mainly via wholesale funding) and by increasing mortgage lending while lowering lending margins at the same time. Conversely, local banks mainly increased their margins, hardly expanding lending. Since, as we show, states that had been open for longer also had a stronger presence of integrated banks, total mortgage lending in early-open states increased more in response to capital inflows, driving up housing prices.

Our results are robust to various ways of measuring international capital flows and they hold in both state-level and county-level data. One important advantage of using county-level data is that it allows us to account for differences in housing supply elasticities at the local level. Our analysis also controls for indicators of domestic credit supply, such as monetary policy tightness or interest rates. Taylor (2007) and Borio and Zhu (2012) have emphasized the role of these factors in the context of the risk-taking channel and Jorda, Schularick and Taylor (2015) provide long-run historical evidence for housing markets. In all our specifications, capital inflows dominate these other credit supply factors when interacted with state-level financial openness. These results suggest that, in states that liberalized earlier, increased risk taking in housing markets seems to have been possible because these states could more easily tap into a global demand for U.S. assets.

We also consider to what extent capital inflows may have contributed to financial instability by fueling excessive lending and house price increases in the run-up to the financial crisis. Starting with Mian and Sufi (2009), the literature has documented that the securitization of mortgage debt provided lenders with perverse incentives for lax screening and excessive lending. We find some evidence that capital inflows contributed to more securitization in areas in which growth expectations for house prices were limited (because housing supply elasticities were high). However, this pattern appears weaker in states in which integrated banks had a stronger and more long-standing presence, suggesting that a long history of openness may have helped improve the screening of credit quality in a state.

Our analysis relates closely to the recent work by Favara and Imbs (2015) and by Landier, Sraer and Thesmar (2013). Favara and Imbs (2015) document that state-level branching deregulation in the second half of the 1990s impacted house prices. Their analysis emphasizes the role that better geographical diversification of banks' deposit base had on banks' mortgage lending. Our analysis complements theirs along several dimensions: first, we draw attention to the role of international capital flows in driving house price developments. Secondly, we focus on a different channel by emphasizing how better diversification of the asset side of their balance sheets allowed integrated banks to tap the global demand for U.S. safe assets. Third, we document that the impact of capital inflows on house prices in the second half of the 1990s was largely pre-determined by a state's liberalization history a decade earlier.

Landier, Sraer and Thesmar (2013) show that liberalization of state-level banking markets increased the synchronization of housing prices between states. They identify the granularity in the size distribution of banks and the fact that big banks tend to operate in several states as the source of this comovement. We add to their findings by showing that global imbalances were a major common factor in the lending decisions of integrated banks and thus contributed significantly to the synchronization of house price developments between states. We also show that the impact of capital inflows differs across states because state banking markets differ in the market share of integrated banks.

The idea that a huge global demand for safe assets was a key driver in global imbalances was first articulated theoretically in seminal work by Caballero, Farhi and Gourinchas (2008). Alfaro, Kalemli-Ozcan and Volosovych (2014) provide empirical support for the view that global imbalances are indeed driven by official flows and reserve accumulation. Caballero and Krishnamurthy (2009) discuss a model in which the global demand for safe assets drives the prices of risky assets by allowing the domestic financial sector to increase leverage. Our results lend strong empirical support to a particular variant of this mechanism: integrated banks benefited from the global demand for safe assets to leverage up on risky assets (mortgages) because their geographical diversification allowed them to effectively turn their balance sheets into private label safe assets backed by the entire U.S. housing market. Our findings, therefore, suggest that the intra-national liberalization of U.S. banking markets during the 1980s cast a long shadow: it helped lay the foundation for the ability of the U.S. financial system to provide more safe assets when the demand of emerging economies for these assets surged roughly a decade later, triggered by the aftermath of the Asian crisis.

Borio and Disyatat (2011), Adrian and Shin (2010) and Shin (2012) have pointed at the role of international gross banking flows in the build-up of leverage in the financial system in the years before the subprime crisis. European banks heavily borrowed short-term in dollars through their U.S. subsidiaries while buying long-term U.S. mortgage-backed securities. This 'banking glut' was reflected in huge gross international banking positions—a growth in international leverage—but had a relatively modest effect on international net positions. At first glance, this may appear as a challenge to the view that net capital inflows may have had a major impact on housing prices in the United States. However, as our analysis shows, net capital inflows contributed significantly to the increase in the leverage of geographically diversified banks. This suggests that global imbalances in net flows and the build-up in international gross positions may be closely linked: global imbalances contributed to the availability of cheap dollar funding which in turn also allowed international banks to lengthen their balance sheets by investing into a geographically diversified portfolio of (securitized) U.S. mortgages. As an extension to our analysis we provide some results that suggest that net capital inflows indeed changed banks' incentives for geographical diversification—be it directly through an expansion of branch networks or indirectly through securitization and increased international cross-holdings of securitized assets.

The paper is structured as follows. Section two provides some historical background on state-level banking deregulation in the United States and a first descriptive look at the data. Section three presents our empirical framework and describes the preparation of the data. Section four presents our baseline results and robustness checks while section five offers a detailed discussion of the transmission mechanism between capital flows and housing prices. Section six concludes.

2 Some historical background and a first look at the data

2.1 State-level segmentation of U.S. banking markets: a brief history

Our analysis exploits the gradual dismantling of geographical restrictions on interstate bank expansion in the United States during the 1980s and early 1990s. These restrictions dated back to the 19th century, when states acquired the right to levy bank-licensing fees and generally prohibited out-of-state banks from operating in their territories. The McFadden Act of 1927 reaffirmed the authority of states over national banks' branching within their borders. However, at the same time it opened the possibility for geographic expansion through means of a 'bank holding company' (BHC): a BHC can, in principle, operate banks in several states, as long as these banks remain separately capitalized legal entities.[1]

The Douglas Amendment to the Bank Holding Company Act of 1956 gave states even stronger authority to prohibit out-of-state banks from acquiring banks outside the state where they were headquartered. Since all states implemented this prohibition, interstate banking in the U.S. was effectively barred from the mid-1950s until the late 1970s, when this regulation was gradually starting to be diluted. Beginning with Maine in 1978, state legislatures began to enact laws that allowed out-of-state BHCs to control banks in their state. Initially, such statutes authorized out-of-state acquisition only on a reciprocal basis with like-minded states or insisted that acquirers be headquartered in a neighboring state. Furthermore, federal legislators amended the Bank Holding Company Act in 1982 to allow failed banks to be acquired by any holding company, regardless of state laws. Over the following 13 years, states removed entry restrictions for bank holding companies by unilaterally opening their state borders and allowing out-of-state banks to enter, or by signing reciprocal bilateral and multilateral agreements with other states to allow interstate banking. As the last state, Hawaii passed reciprocal entry laws in 1995.

It is important to note that all of these deregulations still did not allow full bank branching but only the ownership and operation of local banks by out-of-state BHCs. Full branching was only implemented with the Riegle-Neal Interstate Banking and Branching Efficiency Act of 1994— and which became effective in 1997. Even from the Riegle-Neal Act, states could opt out—and many did. In a separate subsection below we analyze the impact of interstate bank-branching deregulation during the 1990s in the context of our analysis.

Since states deregulated in waves, or cohorts, rather than all at once, the staggered timing of interstate banking deregulation provides an ideal laboratory to explore empirically how these regulatory differences in openness to a bank entry affected the real economy. In our empirical analysis, we generally measure a state's banking openness as the number of years that have passed between the year in which the state allowed full interstate banking (through BHCs) and

[1] The Banking Act of 1933 brought all holding companies which owned a member bank under the Federal Reserve supervision. The reforms dealing with the bank structure were aimed at separating banks from their security affiliates but were criticized for limiting competition and thereby encouraging an inefficient banking industry.

1995. The important feature of our analysis is that the era of interstate liberalization in the 1980s largely precedes the era of global imbalances which started in the 1990s and reached its peak between 1997 and 2008, when in particular Asian economies started to accumulate international reserves on a gigantic scale in the wake of the region's 1996/1997 financial crisis. Our measure of openness therefore is clearly predetermined and plausibly exogenous with respect to the major wave of capital that hit the U.S. from the mid 1990s onwards. As we will see, the liberalization history of individual states in the era before the rise of global imbalances left a long shadow on how state economies—notably real estate prices—reacted to capital inflows in the late 1990s and 2000s.

2.2 A first look at the data

We provide a detailed description of our data below. In this section, we document some first stylized facts. Figure 1 illustrates how the correlation between capital inflows and housing prices varies depending on the liberalization history of state. The figure plots capital inflows (the negative current account balance relative to GDP) and the average of house price—income ratios for states that opened their banking markets early (before 1984) and those that liberalized late (after 1987). In both groups, house valuations started to increase from the mid-1990s, together with rising capital inflows into the U.S.. They also reached their peaks at the same time as do capital inflows, in 2005 and 2006. Strikingly, however, the increase in valuations before the crisis and their fall during the crisis is considerably stronger in states that deregulated early.

Panel A of Figure 2 presents a plot of the U.S. current account–GDP ratio along with the first principal component extracted from the time series of the growth rates in state-level ratios of housing prices to personal income (measured relative to the country-wide average). This first principal component explains 25 percent of the variance of the house price—income ratios. The correlation between the principal component and the U.S. current account is 0.4. While correlations between principal components and observable time series should be interpreted with some caution, the figure and the correlation suggest that capital inflows could indeed be an important factor in the cross-section of state-level house prices.

For each state, Figure 2 Panel B plots the loadings on the first principal component in state-level housing price—income ratios against the year, in which a state allowed the entry of out-of-state banks to its local banking market. The plot shows a clear negative relation: changes in post-1990 housing price income ratios load more strongly on the first principal component in states that opened their banking market earlier. As we saw in Panel A, this principal component is highly correlated with capital inflows. Hence, housing valuations in states that had open banking markets for longer prior to the savings glut, also were more exposed to international capital inflows. We now turn to a more formal empirical analysis of this link.

3 Empirical Framework

Our main specification is a panel regression in which capital inflows into the U.S. are allowed to load differently on different states as a function of a state's *ex ante* financial openness:

$$\Delta\text{HV}_t^k = \alpha \times \text{OPEN}^k \times \text{CAPFLOW}_t + \text{CONTROLS}_t^k + \tau_t + \delta_k + \epsilon_{k,t} \tag{1}$$

The dependent variable, ΔHV_t, is the change in housing valuation in state k at time t. In our estimations, we generally measure HV as the house price–income ratio (abbreviated with *hpy*) or the price–rent ratio (*hpr*). On the right hand side of equation (1), OPEN^k is our (*ex ante*) measure of openness of the state's banking market and CAPFLOW_t is a measure of aggregate capital inflows into the United States at time t. We also include a range of control variables and time (τ_t) and state fixed effects (δ_k) along with a vector of controls that vary by time and state. We discuss the choice of variables in equation (1)—and in particular our capital inflow measure—in the main text below. A detailed description of the data is provided in Appendix A. Our empirical analysis is based on a panel of variables for the 47 contiguous U.S. states excluding Delaware for the period 1991-2012.

A couple of remarks are in order. First, recall that our simple principal component analysis above suggested that international capital flows are an important driving factor behind house price valuations in the U.S.. But it also suggests a considerable degree of heterogeneity in the extent to which different states are exposed to this common factor. This heterogeneity seems to be related to the openness of a state to entry by out-of-state banks. The specification above captures this idea: aggregate capital inflows into the U.S. load differently on different states. In particular, we would conjecture that financially more open states are also more exposed to the tide of capital in the sense that these states see a stronger impact of capital inflows on housing valuations: in states with low barriers ('dikes') to capital, the glut of capital makes a bigger impact on housing valuations than in states with higher barriers.[2]

We note, secondly, our use of aggregate capital inflows as a driver of housing valuations. To the extent that aggregate inflows into the U.S. are big relative to state-level inflows they should be reasonably exogenous with respect to developments at the level of individual states. As we will argue in more detail below, our results therefore also allow us to document a causal link between aggregate capital inflows and state-level outcomes that would not be possible if we were to focus on state-level inflows (even if reliable data on those existed, which is not the case).

Third, we emphasize that our main specifications are all based on *ex ante* measures of openness. As our primary *ex ante* measure of openness we use the number of years passed between the liberalization of a state's banking market in the 1980s and 1995, one of the first years when

[2]In the appendix, we provide a rigorous theoretical foundation for the above regression equation in a model of bank lending supply in which individual banks differ in their exposure to an aggregate funding shock, depending on their geographical diversification. We return to discussing this model and its implications for the construction of the openness measure $open^k$ in a separate subsection below.

the global savings glut started to hit the United States. We illustrate below that the use of an *ex ante* measure is important in this context: consistent with e.g. the findings in Rice and Strahan (2010), states with a stronger presence of nationwide banks were more likely to liberalize their bank branching regimes during the 1990s. In addition, we conjecture that the incentive to lobby for a liberalization of a state's branching regime would seem particularly strong during a period when capital from outside the state is cheaply available due to a global savings glut. In section 5.3 below, we provide some evidence to support this view. This suggests that using any concurrent (to capital inflows) changes in state-level regulation in our regressions would lead us to underestimate the causal effect of capital inflows on house prices.

4 Results

4.1 Baseline results

Table 1 presents our baseline results which are based on our primary measure of state-level financial openness — the years passed since deregulation—-and on the (negative) U.S. current account to GDP-ratio as the plausibly most straightforward measure of capital inflows. Consistent with our conjecture and with our preliminary analysis in Figures 1 and 2, we find that housing valuations in more open states are significantly more exposed to aggregate capital inflows into the U.S.. This is true for both measures of housing valuation that we consider throughout the paper: the house price to income ratio (in panel A) as well as for the house price to rent ratio (panel B).

In each panel, column I presents the results in a regression without controls (except time and state effects). Columns II-III show that our results are robust to the inclusion of both lagged changes in the valuation ratio as well as to past levels of that variable and lagged population growth. To control for the possibility that capital just flowed into those states with the housing markets that already had the highest valuations at the outset, we also include, in column IV, an interaction between capital flows and the initial housing valuation.[3]

None of this affects our basic results: though including past valuations reduces the estimate of our coefficient of interest by around a half, α stays highly significant and, with a value of around 0.07, also economically important. To appreciate the magnitude of this effect, note that in our sample, the first state (Maine) liberalized roughly 15 years before the last state (Montana). This implies that ceteris paribus house price valuations in Maine would react to a 1 percentage point increase in capital inflows (relative to GDP) with a $15 \times 0.07 = 1.05$ percentage point

[3]Including *ex ante* housing valuations in the interaction with capital flows also is likely to capture the time-invariant part of differences in housing supply elasticities (which are not directly observed at the state-level). To the extent that increasing the supply of housing is more difficult in some states than in others due to geographical reasons or due to regulations that do not change much over time, we would expect this to be reflected in higher housing prices at the outset. Clearly, we would expect capital inflows to have a bigger impact on housing prices in states with a low supply elasticity.

higher annual increase than in Montana.[4] For a hypothetical pair of states of which one was liberalizing in 1980 and one in 1990, the 1995-2005 average U.S. current account deficit of 3.5 percent of GDP translates into a $(1990 - 1980) \times 0.07 \times 0.035 = 0.0245 = 2.45$ percent annual difference in the growth rate of housing valuations. Compounded over the ten year period from 1995-2005, this amounts to an almost 28 percent difference in house price–income ratios.[5]

Alternative measures of capital inflows Table 2 presents results for alternative measures of capital inflows. The current account could misrepresent actual inflows into the U.S. money and capital markets for various reasons. First, it neglects valuation changes on foreign asset holdings. Clearly, such valuation changes could impact demand and supply for credit in the mortgage market by affecting private household wealth and the balance sheets of financial intermediaries. Following Favilukis et al. (2012), we therefore look at the change in the net holding of U.S. securities owned by foreigners as a first alternative measure of capital inflows. Different from the current account, this variable takes on board potential valuation effects and also excludes foreign direct investment inflows which we would not expect to have a direct impact on the supply of dollar liquidity and the mortgage market.

Arguably, a large share of U.S. capital inflows over the late 1990s and early 2000s was motivated by global demand for U.S. safe assets. As a second alternative measure of capital inflows, we therefore focus on the change in foreigners' net holdings of *safe* U.S. securities, defined here as changes in the holdings of U.S. government bonds and mortgage-backed securities issued by government sponsored enterprises such as Freddie Mac and Fannie Mae.

As a third measure of availability of inflows we use the *nxa* measure by Gourinchas and Rey (2007). This is essentially a cointegrating residual between the U.S. trade balance and U.S. foreign assets that again allows to control for the impact of valuation changes on the U.S. net external asset position.

As can be seen from Table 2, the interaction of all three alternative measures of capital inflows with our openness measure remains highly significant in all our specifications, suggesting that the particular choice of capital inflow measure does not strongly affect our results.

Net versus gross flows and the banking glut Borio and Disyatat (2011) and Shin (2012) have argued that to understand the vulnerabilities that had built up in the financial sector in the years before the financial crisis, it is important to consider gross investment positions of foreign banks in the U.S.. Before 2008, U.S. affiliates (subsidiaries and branches) of foreign banks borrowed heavily in the U.S. money market. At the same time, the foreign parents of these

[4]For convenience, throughout the paper, we measure the variable CAPFLOW_t as quarterly capital flows relative to annualized GDP so that the reported coefficients on the term $\text{CAPFLOW}_t \times \text{OPEN}^k$ are directly interpretable as the annualized impact of capital inflows on the left hand side variable.

[5]The standard deviation of liberalization years is 2.65, so that considering a pair of states that liberalized ten years apart roughly amounts to comparing a change from plus to minus two standard deviations in terms of liberalization dates.

affiliates built considerable long-term positions in the U.S. mortgage market. Shin (2012) calls this feature of global imbalances the banking glut (as opposed to the savings glut) and argues that it played a major role in the excessive risk taking in the U.S. financial sector by effectively enhancing the intermediation capacity of the U.S. financial system. When short-term dollar financing dried up in 2008, the balance sheets of international banks operating in the U.S. were therefore extremely vulnerable and became a major factor in the international transmission of the crisis. This transmission was so forceful because it got amplified through high leverage (large gross positions) even though the net position of foreign banks vis-à-vis the U.S. was actually quite small.

In Table 3, we therefore also examine the possibility that the build-up in international banking sector positions contributed to house price increases and that they did so more strongly in states that were financially more open. We focus in three alternative measures of the banking glut: the sum of all claims of foreign banks on U.S. assets as well as the banks' net and the gross positions vis-à-vis the U.S.. In our empirical specifications, we consider all three measures in both levels and in changes. All measures are normalized with U.S. GDP.

Of all specifications, only the change in the gross position of foreign banks is strongly significant individually, consistent with the argument of Borio and Disyatat (2011)and Shin (2012). However, as for the other banking glut measures, changes in the gross positions of international banks are insignificant once we also control for the interaction of our baseline measure of capital inflows (the negative current account relative to GDP) with state-level openness. By contrast, the size of the coefficient on our baseline measure and its significance remain unchanged relative to our earlier specifications. In our regressions here, net inflows rather than the development of gross positions appear as main driver of house price developments. We will come back to this point in our detailed analysis of the transmission mechanism below. Specifically, we will argue that the global demand for safe assets, reflected in net capital inflows, was an important factor behind the increase in leverage of the U.S. banking system. This also includes the increase in cross-border leverage reflected in gross banking positions.

Capital inflows or lax monetary policy? A leading competitor to the view that capital inflows into the U.S. were the driver of U.S. housing valuations is the hypothesis that monetary policy after the 2001 recession kept interest rates too low for too long, thus encouraging risk taking and fueling excessive valuations in asset markets, including housing (see Taylor (2007)). In the same way as we have shown it to be the case for capital flows, one could therefore conjecture that favorable lax monetary policy—and favorable domestic credit supply conditions more generally—had a stronger bearing on housing valuations in states that were more open financially.

This would suggest to run regressions analogue to our baseline specification but with broad measures of credit availability as the common factor driving valuations:

$$\Delta \text{HV}_t^k = \alpha_{CC} \times \text{OPEN}^k \times \text{CREDIT}_t + \text{CONTROLS} + \tau_t + \delta_k + \epsilon_{k,t},$$

where CREDIT stands for general credit conditions. The first two columns of Table 4 present such regressions for various measures of monetary policy tightness: the real short rate (column I) and the (negative) deviation of the federal funds rate from its optimal value as implied by a Taylor rule (column II). In columns III-V, we also investigate whether the broader measures of credit supply suggested by Favilukis et al. (2012), such as the long-term corporate bond rate (column III) , the responses from the senior loan officers survey (column IV) and the default spread (column V) affect housing valuations differently in states of different degrees of financial liberalization.

The regressions clearly show that all of these measures of monetary policy looseness and of credit availability more generally are individually significant in their interaction with financial openness. Table 5 repeats this exercise, but now we also control for capital inflows in the regressions, i.e. we run the horse-race

$$\Delta \text{HV}_t^k = \alpha \times \text{OPEN}^k \times \text{CAPFLOW}_t + \alpha_{CC} \times \text{OPEN}^k \times \text{CREDIT}_t + \text{CONTROLS} + \tau_t + \delta_k + \epsilon_{k,t},$$

Columns I-V show the regressions for a pairwise horse race between capital inflows and each of the monetary policy and credit availability measures. Column VI shows the comparison between capital inflows and all of these measures taken together. The coefficient on the capital inflows measure remains stable and significant whereas the credit-supply measures with the exception of the default spread and the long-term bond rate are not. These findings suggest that capital inflows into the U.S. seem to be more strongly and consistently linked to interstate variation in house price valuations than most broad measures of domestic credit availability or monetary policy.[6]

4.2 Robustness

Different housing supply elasticities: county-level evidence

If housing supply elasticities differ across locations (e.g. due to different building and zoning laws or differences in physical terrain that affect the ease with which land can be developed), the savings glut could have differential effects on housing prices for reasons that are unrelated to a state's financial openness. State-level data on housing supply elasticities do not exist. Our earlier specifications controlled for them by interacting capital inflows with initial housing valuations: different supply elasticities should ceteris paribus be reflected in long-term

[6] Favilukis et al. (2012) find that capital inflows are not robustly correlated with aggregate U.S. house prices once domestic credit supply factors are controlled for. The panel results here suggest that this is the case because the impact of capital inflows is heterogenous: capital inflows affected house prices more strongly in states that liberalized earlier.

price differentials. Note also that the state-level house price data set that we use here is constructed using the Davis-Heathcote method which goes to considerable length to account for cross-state differences in the quality of land. Still, state-level average prices could mask heterogeneity within states. We therefore also provide some results based on the county-level data set provided by Favara and Imbs (2015). This data set contains house prices and a rich set of county-level controls for urban counties in the US for the period 1995-2005. Specifically, the data set also includes a measure of housing supply elasticities.

Table 6 provides county-level results. In column I, we replicate our baseline regression. The interaction $\text{OPEN}^{k(c)} \times \text{CAPFLOW}_t$ (where c denotes the county and $k(c)$ the county's state) remains positive and significant. The specification in column II adds interactions with county-level housing supply elasticities and the one in column 3 , in addition, the full set of controls suggested by Favara and Imbs (2015). In line with economic intuition, the triple interaction of elasticities with $\text{OPEN}^{k(c)} \times \text{CAPFLOW}_t$ is significantly negative, suggesting that conditional on a state's financial openness, the impact of capital inflows on prices is mitigated in counties with high supply elasticities. However, our main coefficient of interest remains positive and significant for itself throughout. By contrast, the interaction between county-level elasticities and aggregate capital inflows is insignificant and small. This suggests that capital inflows are indeed modulated to local housing markets via the state's level of *ex ante* financial openness and not simply through differences in local housing supply conditions.

De facto measures of financial openness

We check the robustness of our results using a range of different *de facto* measures of state-level openness. As we show in Appendix B, aggregating individual banks' lending decisions to the state-level implies that a *de facto* openness measure should have the general form

$$\text{OPEN}^k_{t-1} = \sum_{n=1}^{N} \lambda_{n,t} \omega^k_{n,t-1}$$

where the parameter $\lambda_{n,t} \in \left[\ 0,\ \ 1\ \right]$ captures the extent to which bank n is diversified across states and $\omega^k_{n,t-1}$is the share of bank n in total bank mortgage lending in state k at time $t-1$ and N denotes the number of banks.

To construct $\lambda_{n,t}$ and $\omega^k_{n,t-1}$, we obtain data from the call reports published by the Federal Reserve Bank of Chicago over the period 1984 to 1995. For each bank, we then identify whether it is affiliated with a bank holding company that owns banks also in other states. If it is, we call it an integrated bank, otherwise we call it a local bank. We then construct four different versions of OPEN^k. The first is just a dummy indicating if a bank is integrated or not. In this case, OPEN^k equals the interstate asset ratio proposed by Morgan, Rime and Strahan (2004). Second, analogous to the construction of the interstate asset ratio, we use a dummy indicating if a bank belongs to a BHC that holds mortgage assets in another state. This gives rise to what we call the interstate mortgage ratio.[7] Third, we use the number of states in which the BHC to which an integrated bank belongs is active as an indicator of bank-level diversification. To obtain a measure of $\lambda_{n,t}$ between zero and one, we divide this number by the number of states in our sample. Our fourth measure of $\lambda_{n,t}$ is the Herfindahl index of a BHC's asset holdings across states.

We expect our main measure of openness—the years passed since interstate-liberalization—to be a very good proxy of a states' average *de facto* openness over the sample: first, in states that have been open for longer, out-of-state banks had a longer time to establish themselves. Secondly, since interstate liberalization often took place on a mutual basis (i.e. banks were only allowed to enter if their home states allowed entry), local banks in early-liberalizing states had more opportunities to diversify to other states. Both effects should lead to higher local market shares of banks with a high level of diversification, which is exactly what the theory-based openness indicator above is capturing. We check this conjecture in Figure 3 which plots pre-1995 averages of the four *de facto* measures against the years of interstate-liberalization. As can be seen from the figure and the associated cross-sectional regressions, the year of interstate liberalization is a very strong predictor of all four measures of *de facto* openness. In Table 7, we also perform versions of our baseline regressions based on the pre-1995 averages of the *de facto* measures themselves. Our earlier results remain: capital inflows load more strongly on house prices in states with more integrated banking sectors, again consistent with our basic hypothesis and the stylized model to which we turn in our final section.

5 Transmission mechanism

5.1 A theoretical model

We have established that global imbalances have a stronger bearing on house prices in states with more integrated banking markets. In this section, we examine the transmission mechanism between capital flows and house prices in more detail. We propose a simple model in which we interpret the savings glut as a positive refinancing shock that, *a priori*, affects all banks equally. However, due to their geographical diversification, integrated banks can take fuller advantage of this refinancing shock to expand their lending.

The model builds on Shin (2012) and assumes that banks are risk neutral but face a value-at-risk (VaR) constraint that is imposed by the regulator. The value at risk constraint stipulates that the bank maintain a constant probability of default. We present details of the setup of the model and the derivation of the main equations in Appendix C. A key implication of the model is that – as in Shin (2012) – the VaR constraint leads the bank to implement a constant leverage

[7] In this case, for consistency, we use the share of a banks' mortgage lending in all state-level mortgages as the weights instead of total assets.

given the risk and expected excess return on its loan portfolio. Specifically, the bank's leverage ratio can be written as

$$\text{LVG}_t \equiv \frac{A_t}{E_t} = \frac{(1 + r_t^d)}{\phi\sigma_n - \boldsymbol{E}\left(r_{t+1}^l - r_t^d\right)} \tag{2}$$

where A_t is the value of the banks' total assets (that we assume is composed only of mortgage loans, L_t) and E_t its equity. The banks' lending activities generate a return r_{t+1}^l while the bank pays its lenders a deposit rate r_t^d. The risk of the banks' portfolio is measured by the standard deviation of the return, r_{t+1}^l which we denote by σ_n to indicate that it will decline with the number of locations (states) n in which a bank is doing business so that $\sigma_{n_1} < \sigma_{n_2}$ for $n_1 > n_2$. The parameter ϕ measures the bank's (constant) distance to default expressed here in multiples of the standard deviation of its loan portfolio.

It is now interesting to consider how leverage is affected by a banks' degree of regional diversification. To this end, we compare an integrated bank I to a local bank L. Bank I is geographically diversified and operates in $n > 1$ states with low portfolio risk $\sigma^I = \sigma_n$. The local bank L operates only in $n = 1$ states and thus has a high portfolio risk $\sigma^L = \sigma_1$, so that $\sigma^I < \sigma^L$. It is clear from equation (2) that the more diversified bank should have higher leverage *ceteris paribus*. It is also easy to see that leverage should increase for both banks as r^d drops. Importantly, however, the leverage of the I-bank is more sensitive to a drop in the refinancing rate r^d than leverage of the L-bank, $\frac{\partial \text{LVG}^I}{\partial r^d} > \frac{\partial \text{LVG}^L}{\partial r^d}$. Keeping equity constant, this implies that a drop in the refinancing rate r^d will lead to larger increase in lending for the integrated bank than for the local bank.

We follow Caballero and Krishnamurthy (2009) and model the savings glut as an exogenous increase in the supply of funds deposited into the U.S. banking system. These deposits are safe from the point of view of the international investor. Keeping the degree of regional banking integration fixed – an assumption that we will relax below — equilibrium in the market for deposits requires

$$\frac{\Delta D_t^{US}}{E_t^I + E_t^L} = \left(\frac{\partial \text{LVG}^I}{\partial r^d}\lambda_t + \frac{\partial \text{LVG}^L}{\partial r^d}\left(1 - \lambda_t\right)\right)\Delta r_t^d \tag{3}$$

where ΔD_t^{US} denotes the change in funds deposited in the U.S. banking system, E^I and E^L denote the equity of integrated and local banks respectively, and $\lambda_t = \frac{E_t^I}{E_t^I + E_t^L}$ is the share of total U.S. banking equity that is invested in integrated banks. We can think of $\frac{\Delta D_t^{US}}{E_t^I + E_t^L}$ as the model counterpart of our capital inflow measures and λ_t as an indicator of regional banking integration. The model then implies that the global demand for U.S. safe assets (i.e. deposits into the banking system) leads to a decline in the refinancing rate for U.S. banks. This decline just relaxes banks' VaR constraints sufficiently to allow them to absorb the additional foreign demand for U.S. safe assets. Since integrated banks' leverage is more sensitive to the drop in refinancing rates (i.e. $\frac{\partial \text{LVG}^I}{\partial r^d} > \frac{\partial \text{LVG}^L}{\partial r^d}$) they end up absorbing a larger share of these capital inflows, thus increasing lending more than local banks. By implication we expect to see that, for a given drop in the refinancing rate, aggregate lending increases more strongly in states where integrated banks have a higher market share to start with.[8]

Figure 4 illustrates the mechanics of the model. In the upper panel, the graph on the right shows the impact of the savings glut shock to the loan supply on the integrated bank, the one on the left on the local bank. Both banks have zero loan supply if the lending rate r_t^a is lower than the refinancing rate. Note that the integrated bank's loan supply is more elastic to variations in the lending rate than that of the local banks. This is because lower portfolio risk allows the *I*-bank to provide relatively more loans for any level of interest rates.

Now consider the drop in refinancing cost caused by the capital inflow. For both banks, the intercept of the loan supply function shifts downwards by Δr^d. Both loan supply curves also tilt downwards, but the tilt is more pronounced for the integrated bank, reflecting the higher sensitivity of leverage (and thus lending supply) to changes in r^d. Hence for a given drop in refinancing cost Δr (and assuming that both banks face the same demand curve), the net effect on the lending supplied and the interest rate charged by the local bank is small in comparison to the integrated bank, reflecting the fact that the local banks' VaR constraint keeps it from leveraging up (because of the bank's non-diversified exposure to the local property market). The take-away from the model is twofold. First, if capital inflows into the U.S. reflect a general liquidity supply shock we should see that this affects integrated banks asymmetrically: integrated banks should increase their lending and lower their mortgage rates more than local banks.[9] Clearly, states that have a higher share of integrated banks to begin with should see higher credit growth and lower average lending rates in response to shocks to capital inflows. Also, while both types of banks should see a drop in their refinancing rates, lending rates should decline in particular for integrated banks.

In the lower panel of Figure 4, we contrast these predictions with the case of a positive loan demand shock. It is easy to see that in our model a positive demand shock should still be associated with an increase in lending that would predominately be provided by integrated banks. However, lending rates should increase and on impact they should increase more for the local banks (due to their lower supply elasticity). Importantly, unlike in the case of the supply shock, deposit rates should not be directly affected by a loan demand shock since both banks' loan supply curves remain constant.

[8] We assume that adjustments in leverage take place exclusively via adjustments in debt, i.e. equity is not actively managed by the bank. Adrian and Shin (2010) show that this is a very good empirical characterization of the actual behavior of U.S. commercial banks. Under this assumption, variation in leverage directly translates into variation in loan supply, since banks' lending supply L_t is given by $L_t = A_t = \text{LVG}_t \times E_t$. Shocks to equity then only act as exogenous shifters of the loan supply function.

[9] We make two remarks. First, it is noteworthy that the 'flattening' out of the integrated banks' loan supply following the savings glut shock may lead to a decline in the banks' lending spread, $\boldsymbol{E}(r_{t+1}^a) - r_t^d$ if the loan demand faced by the bank is not too elastic. Second, if borrowers can switch between banks within the state, over time interest rates should start to decline also for the local banks. This is sketched in the graph by the inward shift of the demand function faced by the local bank and the concomitant outwards shift of the demand curve faced by the integrated bank (marked with a dashed line respectively).

5.2 Empirical evidence

To test the hypotheses derived from the model, we compile aggregates of state-level mortgage lending from the quarterly Call Reports for the period 1984-1999.[10] To distinguish between lending by integrated and local banks within a state, we identify banks as integrated if they are owned by a bank holding company that operates in several states. We also construct state-level measures of mortgage interest rates for both types of banks using the variable "interest and fee income from mortgages" and dividing it through the stock of outstanding mortgage loans. Since the interest rate series at the state-level is very noisy, we take a four-quarter moving average and divide it by the moving average of lending over the same period.

Table 8 provides empirical evidence on the theoretical mechanism. It first shows results for our baseline regression, but now with the growth rate of total state-level mortgage lending as the dependent variable. The results clearly suggest that capital inflows led to higher lending growth primarily in open states. The following regressions distinguish between the lending by local and integrated banks. They show that capital inflows in more open states mainly increase the lending of integrated banks, whereas the effect on local banks' mortgage lending is insignificant. The same pattern is apparent from regressions of mortgage rates on the interaction between capital inflows and financial openness. The mortgage lending rates of integrated banks decline with capital inflows, suggesting that capital inflows into the U.S. are indeed mainly a supply phenomenon, consistent with the 'savings glut' interpretation. Again, there is no significant response in the mortgage rates charged by local banks, in line with the supply shock scenario in the model. Also consistent with the supply shock scenario above, deposit rates drop to almost the same extent for both local and integrated banks. We also find that aggregate capital inflows lead to a decline in the spread between mortgage rates and deposit rates that, again, is not present for local banks : diversified portfolios allowed integrated banks to expand their lending volume by lowering the risk premium they charge on mortgages because, unlike local banks, they can tap into the global demand for safe assets.[11]

In the last two sets of columns of Table 8, we also examine how the liability side of banks balance sheets reacts to the the savings glut shock. Consistent with our previous results for lending and for interest rates, we again find significant effects only for integrated banks. Importantly, the increase in integrated banks' balance sheets is financed predominantly by an increase in wholesale funding and to a lesser extent in deposits.[12] Again, this pattern is consistent with the supply shock scenario in the model: the global demand for safe assets has increased the supply of wholesale funding for banks (e.g. through the rise in money market funds which are in turn funded by international investors) and only to a lesser extent through

[10] After around 1999, the data no longer allow a clean distinction between local and integrated banks since changes in regulation allowed banks to report consolidated data at the holding company level. See the discussion in Landier, Sraer and Thesmar (2013).

[11] This decline in the the spread on the risky investment in housing in response to an increase in demand for safe assets is also consistent with the model of Caballero and Krishnamurthy (2009).

[12] We construct wholesale funding as total liabilities less equity and deposits.

the supply of call deposits (which for most banks would mainly be of domestic origin).

In Figure 5, we examine the dynamics of interest rates and lending in more detail. Here, for each bank type, we run forecasting regressions of the form

$$x^k_{t+h} = \alpha_h \text{OPEN}^k_t \times \text{CAPFLOW}_t + \delta^k + \tau_t + \varepsilon^k_{t+1}$$

where x^k_{t+h} is the h-period ahead interest rate in state k or the cumulated lending growth difference between these states between period t and $t+h$. We then collect the estimated coefficients α_h for different forecasting horizons h to describe the dynamic responses of these variables to current account fluctuations. This local-linear-projection method was first suggested by Jorda (2005) and has the advantage that the response of x to fluctuations in CAPFLOW can be potentially non-linear in the time horizon h.

Our findings confirm the intuition from our model and our earlier conclusion that capital inflows impacted house prices via the lending policies of integrated banks: an increase in aggregate capital inflows leads to a stark increase in mortgage lending of integrated banks and to an immediate decline in mortgage rates. By contrast, there is virtually no impact on the lending of local banks and only a very muted response of the interest rate charged by these banks. Also, in keeping with the supply shock scenario above, both local and integrated banks experience very similar and persistent declines in deposit rates.

5.3 *Extensions: endogenous geographical diversification*

The previous subsection showed how the savings glut affected induced banks to lend more in the geographic locations where they were already present. However, an increase in the demand for U.S. safe assets also may change banks' incentives for geographical diversification itself. Once we allow the parameter of regional banking integration, λ, in our model to vary, equilibrium in the market for bank deposits after the shock implies

$$\frac{\Delta D^{US}_t}{E^I_t + E^L_t} = \left(\frac{\partial \text{LVG}^I}{\partial r^d} \lambda_t + \frac{\partial \text{LVG}^L}{\partial r^d} (1 - \lambda_t) \right) \Delta r^d + \left(\text{LVG}^I - \text{LVG}^L + \frac{\partial \text{LVG}^I}{\partial \sigma^I} \frac{\partial \sigma^I}{\partial \lambda_t} \right) \Delta \lambda_t \qquad (4)$$

As equation (3) before, this condition states that the positive deposit supply shock ΔD^{US}_t has to absorbed by the U.S. financial system. The first term on the right hand side captures what one might call the 'intensive margin' of absorption that we emphasized in the previous section: refinancing rates drop, allowing banks to absorb deposits and lend more in places where they already are. The second term captures the extensive margin, i.e. the additional absorption capacity of the financial system that comes from also allowing geographical diversification to increase, $\Delta\lambda > 0$. An increase in λ has two different effects. The first is increased average leverage in the economy as local banks turn into integrated banks. It is is captured by the term $\left(\text{LVG}^I - \text{LVG}^L\right) \Delta\lambda_t$ which is positive because $\text{LVG}^I > \text{LVG}^L$. The second effect is that an increase in λ lowers the risk of the average integrated banks' portfolio through wider geographical diversification ($\frac{\partial \text{LVG}^I}{\partial \sigma^I} \frac{\partial \sigma^I}{\partial \lambda_t}$ is positive). An important feature of the model here is that the extensive and the intensive margin will reinforce each other: as refinancing rates start to drop, the effect of a decrease in σ_I on leverage increases. This will make an increase in λ more worthwhile in particular for already integrated banks — regional financial integration becomes an endogenous reaction to the funding shock ΔD^{US}.[13]

Equation (4) has several implications for our empirical analysis. First, it is important to condition the empirical analysis on *ex ante* measures of financial openness—as we have done throughout the paper. If geographical diversification is endogenous, using contemporaneous (to capital inflows) measures of financial openness in the empirical analysis would lead us to underestimate the impact of capital inflows on outcomes such as lending growth or housing prices relative to that of financial integration.

Secondly, the model suggests that capital inflows interacted with states' *ex ante* openness should be good predictors of subsequent trends in regional financial integration. In our empirical analysis we focus on two such trends that earlier literature has argued have been particularly important for housing markets in the years before 2007: i) the geographical expansion of banks' branching networks which as made possible by a wave of deregulations during the late 1990s and early 2000s. ii) the rise in securitization which allowed banks to lower their balance sheet risk by bundling assets in off-balance sheet special vehicles and selling them on to domestic and — importantly — international investors.

Interstate Branching deregulation and the geographical expansion of branch networks

We emphasize that the wave of interstate liberalization during the 1980s that we have exploited in our empirical analysis so far allowed bank holding companies from other states to acquire local banks. But acquired banks had to remain separate legal entities. Only later, and concurrently with the huge capital inflows hitting the U.S. from the second half of the 1990s onwards, the U.S. banking sector saw a second major wave of state-level financial liberalization: the gradual dismantling of remaining interstate bank-branching restrictions.[14] In this section, we show that conditional on a states' liberalization histories during the first liberalization wave in the 1980s, capital inflows had a major impact on the extent to which branching regimes got liberalized (and thus: banks branch networks could expand) during the late 1990s and early 2000s. In our analysis, we directly build on Rice and Strahan (2010) and Favara and Imbs (2015). Rice and Strahan (2010) have argued that states with a strong presence of big, nation-

[13]To see this note that the cross-derivative $\frac{\partial^2 \text{LVG}_t}{\partial \sigma \partial r}$ is negative. Independently of a specific model of banks' geographical expansion strategies, this implies that for a given marginal cost of lowering σ, the bank is now confronted with a higher marginal benefit in the form of increased leverage. Again this effect will be particularly strong for integrated banks, i.e. those with low σ to start with. Hence, unless integrated banks have systematically higher marginal cost of diversification than local banks (which seems unlikely), we should see that integrated banks increase diversification relatively more.

[14]While the Riegle-Neal Act already stipulated that interstate branching restrictions had to be dismantled by 1995, states could opt out from this legislation and most did so, thus maintaining barriers that were only gradually dismantled over the following decade.

wide banks also saw the most forceful political lobbying for liberalization and eventually an earlier and more complete relaxation of restrictions. Branching liberalization in the 1990s could therefore have been foreshadowed by interstate banking deregulation during the 1980s in the sense that integrated banks could have lobbied for branching deregulation more successfully in states where they had a big market share. Favara and Imbs (2015) show that the liberalization of the branching regime had a big impact on the growth rate of mortgage loans and, on housing prices. Our point is complementary to these two papers: we suggest that the political pressure to remove geographical restrictions on bank branching is likely to have increased as capital inflows into the U.S. financial system made geographical diversification more attractive for integrated banks. We proceed in two steps. First, we examine to which extent our previous results are affected by controlling for interstate branching liberalizations. Second, we ask to what extent these liberalizations themselves might have been triggered by international capital inflows.

As indicator of interstate branching liberalization we use the index proposed by Rice and Strahan (2010), abbreviated here as IB_t^k. For each state, we normalize it to vary between zero (no branching at all) and one (no restrictions to interstate branching) .

We start by examining to what extent the inclusion of bank branching indicators in our baseline regression affects our earlier conclusions. In Table 9 we present versions of these regressions that control for interstate branching, both at the state and county levels. Our coefficient of interest remains significant and in the order or magnitude of our previous estimates.

Note also that the coefficients on IB_t^k generally remain in the order of magnitude reported by Favara and Imbs (2015). This suggests capital inflows and branching affect housing valuations at least partly through different channels. Favara and Imbs (2015) emphasize that interstate branching deregulation allowed banks to improve the diversification of their deposit base, allowing them to lend more. By contrast, our analysis emphasizes how banks that started out with a more geographically diversified asset side of their balance sheets benefited more from the global demand for U.S. assets, providing an additional and distinct motive for integrated banks to increase lending and to widen their geographical presence.

At the bottom of Table 9 we report two regressions that shed some light on the question to what extent the liberalization of the bank branching regime might itself have been induced by global capital inflows. The first is a regression of the post-1995 state-level average value of IB_t^k (denoted by $\overline{IB}^k = \frac{\sum_{t>1995} IB_t^k}{T_{>1995}}$) on our pre-1995 measure of financial openness. The coefficient is significant with a t-statistics of 4.12 and an R^2 of around 74 percent. This lends further support to the point made by Rice and Strahan (2010) that states that were more open already were more likely to dismantle remaining branching restrictions. The second regression is of the time-varying index IB_t^k on the interaction of *ex ante* measure of openness, OPEN^k, and capital inflows. This coefficient is also positive and highly significant, in line with the prediction of our model that global savings glut may have increased the benefits from the geographical diversification of banks' lending, thus contributing to increased political pressure in states with many integrated banks to liberalize the branching regime and allow the geographical expansion of the branch network.

Capital inflows and securitization

Very much as bank branching, securitization of mortgage loans may help banks reduce their exposure to locally concentrated risks, thus allowing the bank to lower its notional portfolio risk, absorb additional debt and increase lending. Therefore, global imbalances may also have contributed to the rise in securitization. Again we make use of the county-level data set compiled by Favara and Imbs (2015) which also contains information about the number of loans sold by bank type: all banks, local banks and out-of-state (integrated) banks without and with branches in the local state.

The regressions in Table 10 correlate the number of loans sold with the interaction of our openness measure with capital inflows. Mian and Sufi (2009) suggested that banks may have a stronger incentive to securitize loans in areas where supply elasticities are high, since expectations for future price increases are likely to be limited in such areas. The regressions in Table 10 therefore again interact openness and capital flows with housing supply elasticities.

Column I shows the regressions for all banks. Indeed, the coefficient on $\text{OPEN}^k \times \text{CAPFLOW}_t$ is positive and close to 10 percent significant. Column II shows the regression for banks that are headquartered in the state.[15] Here the coefficient on the interaction of openness and capital inflows and capital inflows is much smaller and clearly insignificant, suggesting that integrated banks from other states must account for the positive and (near-) significant coefficient found for all banks. The Favara and Imbs (2015) data set allows to further categorize banks from other states into those banks that do have local branches and those that do not. Interestingly, the coefficient on $\text{OPEN}^k \times \text{CAPFLOW}_t$ is positive and – though not significant – actually higher than for the average of all banks when the securitization behavior of out-of-state banks without local branches is considered (column III). Conversely, the coefficient for out-of-state banks with local branches (column IV) is significantly negative: banks that already have local branches do less securitization in those markets that have been open for long. Our interpretation of these findings is that out-of-state banks with (without) local branches are arguably more (less) committed to and more (less) informed about a local market and may therefore be less (more) inclined to diversify their portfolios by securitizing. Consistent with our model, this pattern suggests that securitization and branching are two alternative margins of adjustment that allow banks to reduce the notional risk in their mortgage portfolios and thus enable them to lengthen their balance sheets by absorbing U.S. capital inflows.

Note finally that the interaction between supply elasticities and U.S. capital inflows is positive for all groups of banks and generally also significant (at the 10 percent level). Capital inflows induced all types of banks to do more securitization in counties with high supply elastic-

[15]Note that in Favara and Imbs (2015) the group of local banks also includes some locally headquartered banks with branches in other states.

ities, consistent with the story of Mian and Sufi (2009). However, the triple interaction between elasticities and $\text{OPEN}^k \times \text{CAPFLOW}_t$ is negative throughout. This suggests that openness limited (rather than exacerbated) the extent to which mortgage loans in areas with limited expectations for house price increases were securitized.

Capital inflows and the rise in international gross positions

We wrap up with some remarks on how net capital inflows may be related to the increase in international gross banking positions in the run-up to the financial crisis — the banking glut. As documented by Shin (2012), falling refinancing rates in the U.S. interbanking markets encouraged European banks to borrow in U.S. dollars and to invest the funds in to the U.S. housing market. However, European banks did not generally originate mortgage loans themselves. They usually bought securities backed by a geographically diversified portfolio of mortgages from U.S. financial intermediaries. In so doing, foreign banks effectively mimicked the behavior of regionally diversified U.S. banks. In the context of our model, we can think of this as an increase in E_t^I, the equity of geographically diversified (domestic and foreign) banks and (given E^L) an increase in λ. This entry of foreign banks increases the capital base of the U.S. financial system ($E^{US} = E^I + E^L$) against which leverage can be taken, which should dampen the effects of net inflows on banks' refinancing rates, leverage, lending and house prices that we have documented in this paper. However, through their purchases of mortgage-backed-securities, foreign banks also increased the de facto geographical diversification of the U.S.financial system, allowing U.S. banks to relax their VaR constraints and originate new loans. Hence, the increase in cross-border gross banking positions may, at least in part, have been another margin of adjustment that allowed the U.S. financial system to absorb big net inflows in capital.

6 Conclusion

In this paper, we studied the interaction between global imbalances in capital flows and interstate banking deregulation in the United States. We have argued that huge capital inflows that started to hit the United States from the middle of the 1990s onwards had a bigger impact on house prices in states that opened up their banking markets earlier during the 1980s and that therefore had a stronger presence of integrated banks, operating in several states, by the mid-1990s. Since aggregate inflows are reasonably exogenous with respect to state-level outcomes and since we use *ex ante* measures of financial integration — the number of years elapsed until 1995 since a state liberalized its local banking market to access from other states — this result allows us to establish a causal link between aggregate capital inflows and state-level housing prices. Our results are robust to controlling for other common factors that could have affected house prices differentially in different states such as low monetary interest rates, gross banking flows or other indicators of credit availability.

To explain our findings, we turn to the literature that has interpreted global imbalances as a the reflection of a global demand for safe assets — as a savings glut. We argue that this global demand for U.S. safe assets constituted a funding shock to the U.S. banking system. As opposed to purely local banks that operate only in one state, integrated banks held a geographically diversified portfolio of mortgages. Since the aggregate U.S. housing market was considered safe at the time, this portfolio allowed them to tap the global demand for safe assets by refinancing themselves at low rates and by providing the international capital market with private-label safe assets in the form of mortgage-backed securities while increasing leverage at the same time. Consistent with this interpretation, we find that aggregate capital inflows into the U.S. lead integrated banks to increase their lending and leverage and to lower interest rates whereas there is virtually no impact on local banks.

Our results provide an empirical perspective on a recent literature that has argued that a global demand for safe assets can actually lead to an increase in the prices of risky assets (Caballero and Krishnamurthy (2009)). Our finding suggests that the run-up in U.S. housing valuations occurred because regionally diversified financial intermediaries were perceived as safer than local banks. This allowed them to increase leverage and to invest into local mortgages, thus driving up housing markets. Hence, *intra*-national banking liberalization within the United States had a long shadow in that it effectively increased the ability of the U.S. financial system to produce assets that were perceived as safe by global investor when a huge demand for such assets arose more than a decade later, after the Asian financial crisis and with the emergence of China on the world economic stage.

References

Adrian, Tobias, and Hyun Song Shin. 2010. "The changing nature of financial intermediation and the financial crisis of 2007-09." *Annual Review of Economics*, , (2).

Aizenman, Joshua, and Yothin Jinjarak. 2009. "Current account patterns and national real estate markets." *Journal of Urban Economics*, 66(2): 75–89.

Alfaro, Laura, Sebnem Kalemli-Ozcan, and Vadym Volosovych. 2014. "Sovereigns, Upstream Capital Flows and Global Imbalances." *Journal of European Economic Association*, 12(5): 1240–1284.

Bernanke, Ben S. 2005. "The global saving glut and the U.S. current account deficit." Board of Governors of the Federal Reserve System (U.S.) Speech 77.

Borio, Claudio, and Haibin Zhu. 2012. "Capital regulation, risk-taking and monetary policy: A missing link in the transmission mechanism?" *Journal of Financial Stability*, 8(4): 236–251.

Borio, Claudio, and Piti Disyatat. 2011. "Global imbalances and the financial crisis: Link or no link?" Bank for International Settlements BIS Working Papers 346.

Caballero, Ricardo J., and Arvind Krishnamurthy. 2009. "Global Imbalances and Financial Fragility." *American Economic Review*, 99(2): 584–88.

Caballero, Ricardo J., Emmanuel Farhi, and Pierre-Olivier Gourinchas. 2008. "An Equilibrium Model of Global Imbalances and Low Interest Rates." *American Economic Review*, 98(1): 358 – 393.

Davis, Morris A., and Jonathan Heathcote. 2007. "The price and quantity of residential land in the United States." *Journal of Monetary Economics*, 54(8): 2595–2620.

Favara, Giovanni, and Jean Imbs. 2015. "Credit Supply and the Price of Housing." *American Economic Review*, 105(3): 958–92.

Favilukis, Jack, David Kohn, Sydney C. Ludvigson, and Stijn Van Nieuwerburgh. 2012. "International Capital Flows and House Prices: Theory and Evidence." In *Housing and the Financial Crisis*. *NBER Chapters*, 235–299. National Bureau of Economic Research, Inc.

Ferrero, Andrea. 2015. "House Price Booms, Current Account Deficits, and Low Interest Rates." *Journal of Money, Credit and Banking*, 47(S1): 261–293.

Gourinchas, Pierre-Olivier, and Hélène Rey. 2007. "International Financial Adjustment." *Journal of Political Economy*, 115(4): 665–703.

Jayaratne, Jith, and Philip E. Strahan. 1996. "The Finance-Growth Nexus: Evidence from Bank Branch Deregulation." *Quarterly Journal of Economics*, 111 (3): 639–70.

Jorda, Oscar. 2005. "Estimation and Inference of Impulse Responses by Local Projections." *American Economic Review*, 95(1): 161–182.

Jorda, Oscar, Moritz Schularick, and Alan M. Taylor. 2015. "Betting the house." *Journal of International Economics*, 96(S1): S2–S18.

Justiniano, Alejandro, Giorgio E. Primiceri, and Andrea Tambalotti. 2013. "The Effects of the Saving and Banking Glut on the U.S. Economy." In *NBER International Seminar on Macroeconomics 2013. NBER Chapters*, 52–67. National Bureau of Economic Research, Inc.

Kroszner, Randall S., and Philip E. Strahan. 1999. "What Drives Deregulation? Economics and Politics of the Relaxation of Bank Branching Restrictions." *Quarterly Journal of Economics*, 114 (4): 1437–67.

Landier, Augustin, David Sraer, and David Thesmar. 2013. "Banking Integration and House Price Comovement." C.E.P.R. Discussion Papers CEPR Discussion Papers 9754.

Mian, Atif, and Amir Sufi. 2009. "The Consequences of Mortgage Credit Expansion: Evidence from the 2007 Mortgage Default Crisis." *Quarterly Journal of Economics*, 124(4): 1449–1496.

Morgan, Donald P., Bertrand Rime, and Philip E. Strahan. 2004. "Bank Integration and State Business Cycles." *Quarterly Journal of Economics*, 119 (4): 1555–85.

Obstfeld, Maurice, and Kenneth Rogoff. 2009. "Global imbalances and the financial crisis: products of common causes." *Federal Reserve Bank of San Francisco Proceedings*, , (Oct): 131–172.

Rice, Tara, and Philip E. Strahan. 2010. "Does Credit Competition Affect Small-Firm Finance?" *Journal of Finance*, 65(3): 861–889.

Shin, Hyun Song. 2010. "Risk and Liquidity." Chapter Chapter 2: Value-at-Risk Capital. Oxford University Press.

Shin, Hyun Song. 2012. "Global Banking Glut and Loan Risk Premium." *IMF Economic Review*, 60(2): 155–192.

Taylor, John B. 2007. "Housing and monetary policy." *Proceedings - Economic Policy Symposium - Jackson Hole*, 463–476.

Table 1: House Prices, Financial Openness and Capital Inflows — baseline results

Panel A: dependent variable is change in logarithmic house price—income ratio, Δhpy_t^k

	I	II	III	IV	V
$\text{OPEN}^k \times \text{CAPFLOW}_t$	0.12	0.12	0.07	0.07	0.07
	(3.63)	(3.58)	(2.84)	(3.07)	(3.06)
Δhpy_{t-1}			0.38	0.38	0.38
			(5.75)	(5.74)	(5.75)
hpy_{t-1}				-0.01	
				(-2.25)	
$hpy_{1990}^k \times \text{CAPFLOW}_t$					0.08
					(0.19)
$\Delta pop_{t,k}$		0.96	0.94	0.94	0.94
		(11.80)	(12.69)	(12.78)	(12.65)
R^2	0.53	0.57	0.64	0.64	0.64

Panel B: dependent variable is change in logarithmic house price—rent ratio, Δhpr_t^k

	I	II	III	IV	V
$\text{OPEN}^k \times \text{CAPFLOW}_t$	0.26	0.26	0.25	0.17	0.25
	(2.62)	(2.60)	(2.52)	(1.97)	(2.25)
Δhpr_{t-1}^k			0.03	0.01	0.03
			(1.27)	(0.15)	(1.27)
hpr_{t-1}^k				0.05	
				(1.05)	
$hpr_{1990}^k \times \text{CAPFLOW}_t$					-0.05
					(-0.08)
$\Delta pop_{t,k}$		0.26	0.25	0.34	0.25
		(1.06)	(1.03)	(1.54)	(1.04)
R^2	0.82	0.82	0.82	0.83	0.82

The Table shows the results from the panel regression

$$\Delta \text{HV}_t^k = \alpha \times \text{OPEN}^k \times \text{CAPFLOW}_t + \text{CONTROLS} + \tau_t + \delta_k + \epsilon_{k,t},$$

where $\text{OPEN}^k = 1995 - \mathit{Year\,of\,Interstate\,Banking\,Deregulation}$ and CAPFLOW are capital inflows, measured here as the negative current account deficit over GDP $\left(\text{CAPFLOW}_t = -\frac{CA}{GDP}_t\right)$. House valuations, ΔHV_t^k, are measured by the growth rate in house price-income ratio, Δhpy_t^k, or house price-rent ratio, Δhpr_t^k. Δhpy_{t-1}^k and Δhpr_{t-1}^k denote lags of house valuation variables. hpy_{t-1}^k and hpr_{t-1}^k denote lagged levels of house price-income and house price-rent ratios and hpy_{1990}^k and hpr_{1990}^k are their corresponding initial levels (as of year 1990). $\Delta pop_{t,k}$ denotes growth rate of state k's population. Data are quarterly for the sample period is 1991-2012. Sample includes 47 US States (Alaska, Hawaii, Delaware as well as District of Columbia are left out). OLS estimates, all regressions include time- and state fixed effects. Standard errors are clustered by state and year, t-statistics appear in parentheses.

Table 2: House Prices, Financial Openness and Capital Inflows — alternative measures of capital inflows

Panel A: dependent variable is change in logarithmic house price—income ratio, Δhpy_t^k,

	I net foreign holdings of US assets			II net foreign holdings of US securities			III Gourinchas-Rey *nxa*		
$\text{OPEN}^k \times \text{CAPFLOW}_t$	0.01	0.01	0.01	0.03	0.02	0.02	0.007	0.004	0.004
	(2.31)	(2.53)	(2.60)	(1.62)	(1.86)	(2.11)	(3.47)	(2.74)	(2.59)
$\Delta hpy_{t-1,k}^k$		0.39	0.39		0.39	0.39		0.31	0.31
		(5.98)	(5.97)		(5.99)	(5.99)		(4.43)	(4.42)
$hpy_{1990}^k \times \text{CAPFLOW}_t$			0.01			0.07			0.04
			(0.14)			(0.26)			(1.90)
$\Delta pop_{t,k}$	0.96	0.94	0.94	0.96	0.95	0.94	0.90	0.91	0.91
	(11.58)	(12.57)	(12.58)	(11.63)	(12.61)	(12.62)	(7.95)	(8.55)	(8.53)
R^2	0.57	0.64	0.64	0.57	0.64	0.64	0.57	0.62	0.61

Panel B: dependent variable is change in logarithmic house price—rent ratio, Δhpr_t^k

	I			II			III		
$\text{OPEN}^k \times \text{CAPFLOW}_t$	0.07	0.06	0.07	0.15	0.14	0.16	0.007	0.006	0.007
	(2.21)	(2.15)	(1.97)	(1.98)	(1.94)	(1.75)	(2.17)	(2.12)	(2.23)
Δhpr_{t-1}^k		0.02	0.02		0.03	0.03		0.08	0.08
		(1.10)	(1.03)		(1.25)	(1.19)		(2.19)	(2.19)
$hpr_{1990}^k \times \text{CAPFLOW}_t$			-0.10			-0.53			0.03
			(-0.51)			(-0.83)			(1.33)
$\Delta pop_{t,k}$	0.25	0.25	0.24	0.27	0.26	0.26	0.28	0.26	0.26
	(1.05)	(1.02)	(1.01)	(1.08)	(1.05)	(1.05)	(0.89)	(0.83)	(0.83)
R^2	0.82	0.82	0.82	0.82	0.82	0.82	0.91	0.91	0.91

The Table shows the results from the panel regression

$$\Delta \text{HV}_t^k = \alpha \times \text{OPEN}^k \times \text{CAPFLOW}_t + \text{CONTROLS} + \tau_t + \delta_k + \epsilon_{k,t},$$

where $\text{OPEN}^k = 1995 - \textit{Year of Interstate Banking Deregulation}$. CAPFLOW_t is represented by alternative measures of capital inflows, which vary from column I to III. In column I CAPFLOW_t is defined as net foreign holdings of total assets, in column II as net foreign holdings of total securities, in column III as cyclical external imbalances (nxa_t) as constructed by Gourinchas and Rey (2007). nxa_t is available only till the fourth quarter of 2003. House valuations, ΔHV_t^k, are measured by the growth rate in house price-income ratio, Δhpy_t^k, or house price-rent ratio, Δhpr_t^k. Δhpy_{t-1}^k and Δhpr_{t-1}^k denote lags of house valuation variables and hpy_{1990}^k and hpr_{1990}^k are their corresponding initial levels (as of year 1990). $\Delta pop_{t,k}$ denotes growth rate of state k's population. Data are quarterly, sample period is 1991-2012, sample includes 47 US States (Alaska, Hawaii, Delaware and District of Columbia are left out). All regressions are estimated by OLS and include time- and state- fixed effects. The t-statistics in parentheses are based on standard errors clustered by state and time.

Table 3: Gross vs. net capital inflows and state-level house prices

	Dependent variable is change in logarithmic house price—income ratio, Δhpy_t^k										
	I	II		III		IV		V		VI	
	Measure of $BANKFLOW$ is										
	total banking claims	net banking holdings		gross banking holdings		changes in claims		changes in net banking holdings		changes in gross banking holdings	
OPEN^k × CAPFLOW$_t$			0.07		0.10		0.06		0.07		0.06
			(2.89)		(2.90)		(2.52)		(2.89)		(2.34)
OPEN^k × $BANKFLOW_t$	0.06	0.33	-0.05	0.03	-0.09	1.18	0.71	0.03	-0.05	0.75	0.47
	(0.96)	(1.66)	(-0.05)	(0.80)	(-1.55)	(1.81)	(0.97)	(0.03)	(-0.05)	(2.45)	(1.37)
CONTROLS	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes
R^2	0.64	0.64	0.64	0.64	0.64	0.64	0.64	0.64	0.64	0.64	0.64

The Table shows the results from the panel regression

$$\Delta \text{HV}_t^k = \alpha \times \text{OPEN}^k \times \text{CAPFLOW}_t + \alpha_{BG} \times \text{OPEN}^k \times BANKFLOW_t + \text{CONTROLS} + \tau_t + \delta_k + \epsilon_{k,t},$$

where OPEN$^k = 1995 - \textit{Year of Interstate Banking Deregulation}$ and CAPFLOW are capital inflows, measured here as the negative current account deficit over GDP $\left(\text{CAPFLOW}_t = -\frac{CA}{GDP_t}\right)$. The various measures of banking flows, $BANKGLUT_t$ are defined in the column headings. The coefficient α_{BG} is multiplied by 100. Sample period is 1991-2012, quarterly data. The sample includes 47 US States (Alaska, Hawaii, Delaware and District of Columbia are left out). CONTROLS include population growth Δpop_t and a lag of left hand-side variable. All regressions include time and state effects, t-statistics in parentheses are based on standard errors that are two-way clustered.

Table 4: Housing valuations and general credit conditions

Panel A: dependent variable is change in logarithmic house price—income ratio, Δhpy_t^k

	I		II		III		IV		V	
	measure of credit conditions (CC_t)									
	short rate		Taylor residual		long rate		loan officer survey		corporate spread	
$\text{OPEN}^k \times CC_t$	-0.01	-0.01	-0.009	-0.004	-0.02	-0.01	-0.001	-0.001	-0.05	-0.03
	(-1.97)	(-1.64)	(-2.13)	(-1.31)	(-2.11)	(-2.13)	(-1.29)	(-1.19)	(-1.36)	(-1.17)
CONTROLS	no	yes	no	yes	no	yes	no	yes	no	yes
R^2	0.52	0.64	0.52	0.64	0.52	0.64	0.52	0.64	0.52	0.64

Panel B: dependent variable is change in logarithmic house price—rent ratio, Δhpr_t^k

	I		II		III		IV		V	
$\text{OPEN}^k \times CC_t$	-0.03	-0.02	-0.03	-0.03	0.003	0.002	-0.005	-0.005	-0.26	-0.25
	(-1.56)	(-1.53)	(-2.00)	(-1.95)	(0.12)	(0.10)	(-1.92)	(-1.87)	(-1.97)	(-1.92)
CONTROLS	no	yes	no	yes	no	yes	no	yes	no	yes
R^2	0.82	0.82	0.82	0.82	0.81	0.81	0.82	0.82	0.82	0.82

The Table shows the results from the panel regression

$$\Delta \text{HV}_t^k = \alpha_{MP} \times \text{OPEN}^k \times CC_t + \text{CONTROLS} + \tau_t + \delta_k + \epsilon_{k,t},$$

where $\text{OPEN}^k = 1995 - \textit{Year of Interstate Banking Deregulation}$. Alternative measures of general credit conditions, CC_t are represented as follows: in column I as short-term real interest rate, in column II as the residual from a Taylor rule, in column III as real annual interest rate on the 10-year Treasury bond (here the data is only available from 1992 to 2012), in column IV as the Senior Loan Officer Opinion Survey on Bank Lending Practices and in columns V as financial risk measured as the corporate bond (Baa-Aaa) yield spread. Sample is 1991-2012, 47 US States (Alaska, Hawaii, Delaware and District of Columbia are left out). CONTROLS include population growth, Δpop_t, and a lag of left hand-side variable. OLS estimates, all regressions include time- and state- fixed effects. t-statistics in parentheses, standard errors are two-way clustered.

Table 5: Capital inflows and credit supply conditions — horse race

Panel A: dependent variable is change in logarithmic house price—income ratio, Δhpy_t^k

	I		II		III		IV		V		VI	
$\text{OPEN}^k \times \text{CAPFLOW}_t$	0.12	0.06	0.11	0.07	0.13	0.05	0.13	0.07	0.13	0.07	0.12	0.05
	(3.25)	(2.58)	(3.04)	(2.55)	(2.91)	(1.91)	(3.56)	(2.89)	(3.76)	(3.00)	(2.69)	(1.99)
$\text{OPEN}^k \times short\ rate_t$	-0.00	-0.00									-0.02	-0.01
	(-0.56)	(-0.45)									(-0.71)	(-0.48)
$\text{OPEN}^k \times Taylor\ residual_t$			-0.00	-0.00							0.02	0.01
			(-0.68)	(-0.23)							(1.20)	(1.02)
$\text{OPEN}^k \times long\ rate_t$					-0.00	-0.01					-0.02	-0.02
					(-0.25)	(-1.18)					(-2.14)	(-2.41)
$\text{OPEN}^k \times senior\ officer\ servey_t$							-0.00	-0.00			-0.00	-0.00
							(-1.59)	(-1.42)			(-1.80)	(-1.20)
$\text{OPEN}^k \times corporate\ spread_t$									-0.07	-0.04	-0.09	-0.08
									(-2.08)	(-1.64)	(-3.26)	(-2.90)
CONTROLS	no	yes	no	yes	no	yes	no	yes	no	yes	no	yes
R^2	0.53	0.64	0.53	0.64	0.53	0.64	0.53	0.64	0.53	0.64	0.53	0.64

Panel B: dependent variable is change in logarithmic house price—rent ratio, Δhpr_t^k

	I		II		III		IV		V		VI	
$\text{OPEN}^k \times \text{CAPFLOW}_t$	0.24	0.24	0.22	0.21	0.36	0.34	0.28	0.28	0.31	0.30	0.35	0.34
	(2.07)	(1.99)	(2.00)	(1.93)	(2.53)	(2.43)	(2.69)	(2.60)	(2.82)	(2.72)	(2.78)	(2.67)
$\text{OPEN}^k \times short\ rate_t$	-0.01	-0.01									-0.01	-0.01
	(-0.42)	(-0.43)									(-0.18)	(-0.19)
$\text{OPEN}^k \times Taylor\ residual_t$			-0.01	-0.01							0.01	0.01
			(-1.06)	(-1.03)							(0.21)	(0.22)
$\text{OPEN}^k \times long\ rate_t$					0.04	0.04					-0.02	-0.02
					(1.53)	(1.50)					(-0.63)	(-0.62)
$\text{OPEN}^k \times loan\ officer\ survey_t$							-0.01	-0.01			0.00	0.00
							(-2.10)	(-2.05)			(0.18)	(0.22)
$\text{OPEN}^k \times default\ spread_t$									-0.31	-0.30	-0.38	-0.38
									(-2.33)	(-2.28)	(-2.23)	(-2.20)
CONTROLS	no	yes	no	yes	no	yes	no	yes	no	yes	no	yes
R^2	0.82	0.82	0.82	0.82	0.81	0.81	0.82	0.82	0.82	0.82	0.81	0.82

The Table shows the results from the panel regression

$$\Delta \text{HV}_t^k = \alpha \times \text{OPEN}^k \times \text{CAPFLOW}_t + \alpha_{MP} \times \text{OPEN}^k \times CC_t + \text{CONTROLS} + \tau_t + \delta_k + \epsilon_{k,t},$$

where $\text{OPEN}^k = 1995 - Year\ of\ Interstate\ Banking\ Deregulation$ and CAPFLOW are capital inflows, measured here as the negative current account deficit over GDP $\left(\text{CAPFLOW}_t = -\frac{CA}{GDP}_t\right)$. Alternative measures of general credit conditions are represented as follows: in column I as the short-term real interest rate, in column II as the deviation of the short-term rate from the rate implied by a Taylor rule, in column III as real annual interest rate on the 10-year Treasury bond (here the data is only available from 1992 to 2012), in column IV as the Senior Loan Officer Opinion Survey on Bank Lending Practices and in column V as corporate bond yield spread. CONTROLS include population growth Δpop_t and a lag of left hand-side variable. Data are quarterly, for the period 1991-2012 and the sample includes 47 US States (Alaska, Hawaii, Delaware and District of Columbia are left out). All regressions are estimated by OLS and include time- and state- fixed effects. t-statistics in parentheses based on standard errors clustered by time and state.

Table 6: Different housing supply elasticities (county-level results)

	I	II	III
$\text{OPEN}^{k(c)} \times \text{CAPFLOW}_t$	0.21	0.45	0.20
	(2.019	(2.52)	(1.92)
$\text{OPEN}^{k(c)} \times \text{CAPFLOW}_t \times elasticity_t^c$		-0.12	-0.05
		(-2.54)	(-1.96)
$\text{CAPFLOW}_t \times elasticity_t^c$		0.48	0.14
		(1.23)	(0.62)
Full set of county controls	No	No	Yes

NOTES: County level regressions of the form

$$\Delta \text{HV}_t^k = \alpha \times \text{OPEN}^{k(c)} \times \text{CAPFLOW}_t + ELASTICITY + \text{CONTROLS} + \tau_t + \delta_c + \epsilon_t^c$$

where $ELASTICITY$ stands for the interaction terms $elasticity^c \times \text{OPEN}^{k(c)} \times \text{CAPFLOW}_t$ and $elasticity^c \times \text{CAPFLOW}_t$ and where c denotes the county and $k(c)$ its state. $elasticity^c$ is a county-level housing supply elasticity of county c in state k. Controls are the lagged endogenous variable, current and lagged values of income, population growth, the county-level Herfindahl index. Sample comprises urban counties in the US for the period 1994 to 2005. Standard errors clustered at state level. County-level data are from Favara and Imbs (2015).

Table 7: *de facto* Financial Openness and Capital Inflows

	Dependent variable is change in logarithmic house price—income ratio, Δhpy_t^k							
	I interstate asset ratio		II interstate mortgage ratio		III $\frac{1}{HHI}$		IV number of states	
$\text{OPEN}^k_{defacto} \times \text{CAPFLOW}_t$	0.73	0.50	0.85	0.59	0.59	0.45	3.29	1.76
	(1.32)	(1.56)	(1.40)	(1.70)	(1.34)	(1.89)	(2.78)	(2.17)
CONTROLS	no	yes	no	yes	no	yes	no	yes
R^2	0.52	0.64	0.52	0.64	0.52	0.64	0.52	0.64

The Table shows the results from the panel regression

$$\Delta \text{HV}_t^k = \alpha \times \text{OPEN}^k_{defacto} + Controls + \tau_t + \delta_k + \epsilon_{k,t},$$

where $\text{OPEN}^k_{defacto}$ is defined in the column headings: the interstate asset ratio proposed by Morgan, Rime and Strahan (2004); the interstate mortgage ratio is the 1980-1995 average of the share of mortgages issued by integrated banks for each state; $\frac{1}{HHI}$ is the Herfindahl index of a BHC's asset holdings across states; number of states indicate the number of states in which the BHC to which an integrated bank belongs is active. Capital inflows CAPFLOW_t are measured as current account deficit over GDP $\left(\text{CAPFLOW}_t = -\frac{CA}{GDP}_t\right)$. Data are quarterly. Data on house valuations are logged. Separate time- and state fixed effect as dummies. Sample period is 1991-2012. 47 US States (Alaska, Hawaii, Delaware and District of Columbia are left out). OLS estimates, t-statistics in parentheses, standard errors are two-way clustered.

Table 8: Transmission Mechanism

Z_t^k	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	XIII
	lending growth			mortgage rates		deposit rates		interest rate spread		deposits growth		market liabilities growth	
	total	integrated	local	integrated	local	integrated	local	integrated	local	integrated	local	integrated	local
$\text{OPEN}^k \times \text{CAPFLOW}_t$	0.39	1.90	-0.19	-0.11	-0.03	-0.07	-0.07	-0.30	0.07	1.70	0.11	4.09	2.24
	(2.44)	(2.28)	(-0.34)	(-1.64)	(-0.36)	(-2.53)	(-3.29)	(-1.95)	(1.38)	(2.38)	(0.28)	(2.06)	(0.25)
R^2	0.08	0.05	0.07	0.98	0.95	0.91	0.95	0.95	0.92	0.09	0.06	0.03	0.02

For both local and integrated banks, the Table shows the results from the panel regression

$$Z_t^k = \alpha \times \text{OPEN}^k \times \text{CAPFLOW}_t + \tau_t + \delta_k + \epsilon_{k,t}.$$

The dependent variable Z_t^k is defined in the heading of the respective columns: column I-III lending growth of all, integrated and local banks, columns IV-V mortgage rates, columns VI and VII deposit rates , columns VIII and IX the spread between mortgage rates and deposit rates. Sample period is 1990-1999, quarterly data. Alaska, Hawaii, Delaware and District of Columbia are generally left out. Additionally following states are left out for interest rate regressions: Alabama, Arizona, Idaho, Indiana, Kansas, Michigan, Missouri, Montana, New Jersey, New Mexico, Ohio, Rhode Island, Tennessee. All data but interest rates are logged. All regressions are estimated by OLS and include time and state fixed effects, t-statistics in parentheses, standard errors are clustered by time and state.

Table 9: Financial Openness, Capital Inflows and Interstate Branching

	state-level regressions		county-level regressions	
dep. variable	Δhpy	Δhpr	Δhp	
$\text{OPEN}^k \times \text{CAPFLOW}_t$	0.10	0.23	0.22	0.22
	(3.09)	(2.40)	(2.03)	(2.07)
$\text{OPEN}^k \times \text{CAPFLOW}_t \times elasticity$				-0.05
				(-1.98)
$\text{CAPFLOW}_t \times elasticity$				0.13
				(0.59)
IB_t^k	0.00	0.01	-0.001	-0.002
	(2.07)	(1.45)	(-0.62)	(-1.66)
R^2	0.82	0.53	0.25	0.48

Memorandum items:

In the regression $\overline{IB_k} = \alpha_0 + \alpha_1 open^k + \epsilon_k$ $\alpha_1 = 0.06$ (4.12), $R^2 = 0.74$

In the regression $IB_t^k = \alpha_0 + \alpha_1 \text{OPEN}^k \times \text{CAPFLOW}_t + \epsilon_t^k$ $\alpha_1 = 4.70$ (4.08), $R^2 = 0.89$

Results of the baseline regression with interstate branching as additional regressor. The index of interstate branching deregulation (IB_t^k) ranges from 0 (no integration) to 1 (full integration). $\overline{IB_k} = \frac{1}{T}\sum_{t=1}^{T} IB_t^k$ is an average of Sample period is 1991-2012, quarterly data. The sample includes 47 US States (Alaska, Hawaii, Delaware and District of Columbia are left out). All regressions include time and state effects, t-statistics in parentheses, standard errors are clustered by time and state / state-pair.

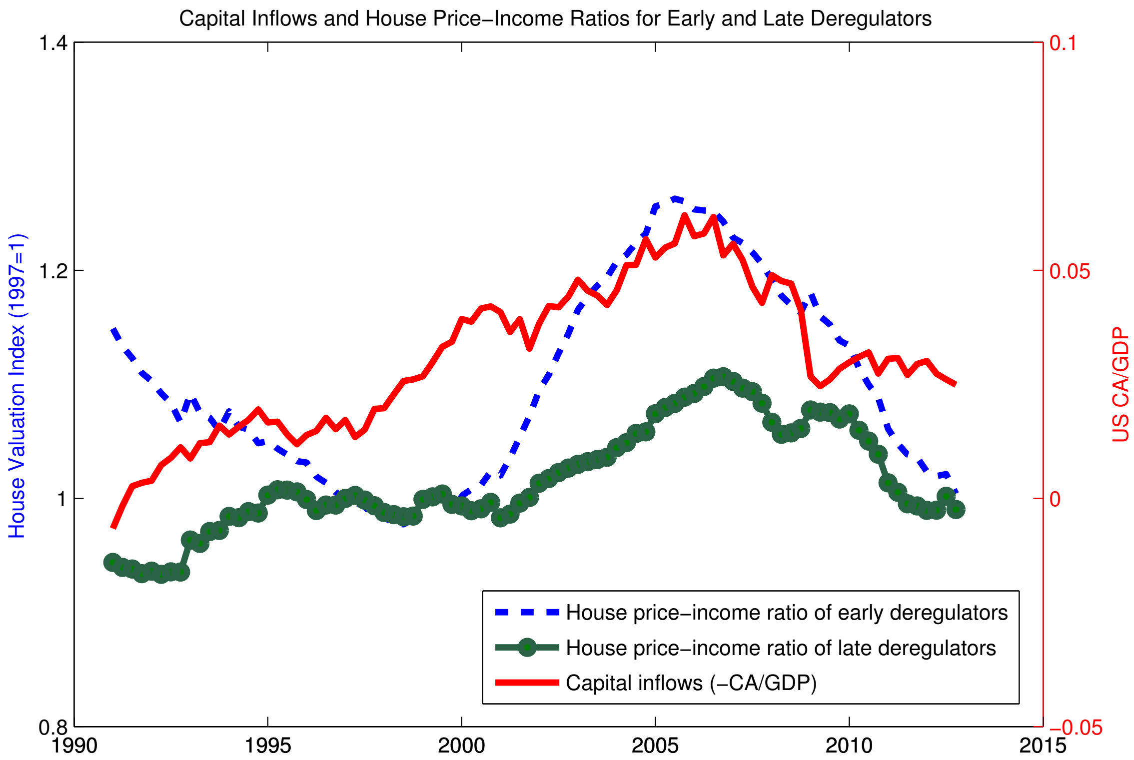
Table 10: Aggregate capital inflows and securitization — county-level evidence

Dependent variable is number of loans sold by bank type at county level

	all banks	local banks	out-of-state banks	
			w/o local branches	with local branches
$\text{OPEN}^{k(c)} \times \text{CAPFLOW}_t$	0.83	0.16	0.96	-15.4
	(1.61)	(0.14)	(1.08)	(-2.77)
$\text{OPEN}^{k(c)} \times \text{CAPFLOW}_t \times elasticity_t^c$	-0.31	-0.45	-0.29	-23.6
	(-2.67)	(-1.42)	(1.70)	(-1.92)
$\text{CAPFLOW}_t \times elasticity_t^c$	2.80	4.48	2.59	2.76
	(2.77)	(1.57)	(1.64)	(1.89)
Full set of county controls	Yes	Yes	Yes	Yes

$elasticity_t^c$ is a county-level housing supply elasticity of county c in state k. Controls include lagged end. variable, current and lagged values of income, population growth, the county-level Herfindahl index and the lagged interstate branching indicator. All regressions contain time and county-level fixed effects. Standard errors are clustered at the state level.

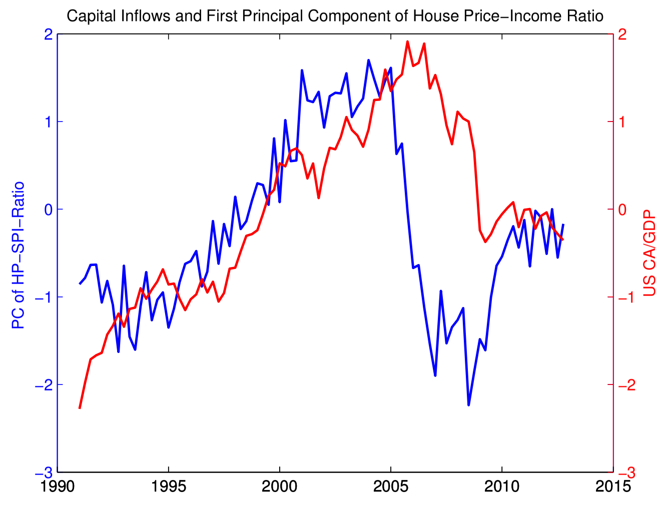
Figure 1: Capital Inflows and House Valuations, 1991-2012



NOTES: The figure plot US current account to GDP ratio (red solid line) against average house price-income ratios for states that deregulated their interstate banking before 1985 (blue dashed line) and states that deregulated after 1987 (green circle-dashed line).

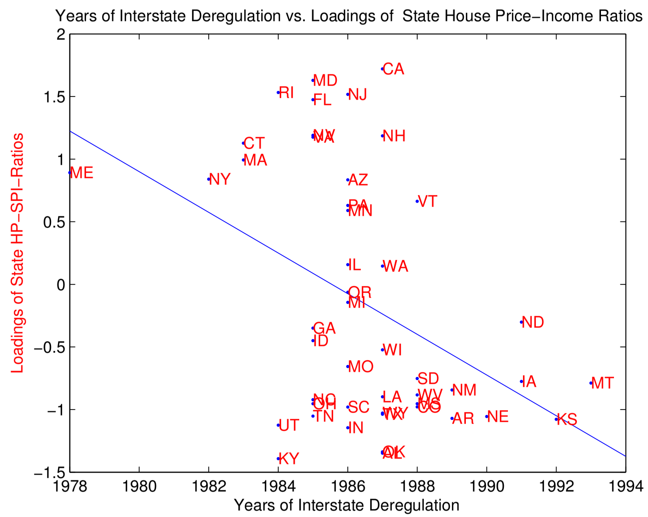
Figure 2: First Principal Component Analysis of State House Valuations

Panel A



NOTES: The figure plots US current account to GDP ratio (red line) against first principal component extracted from the time series of state level ratios of housing prices to personal income (blue line). Both variables are normalized to standard deviation of unity.

Panel B

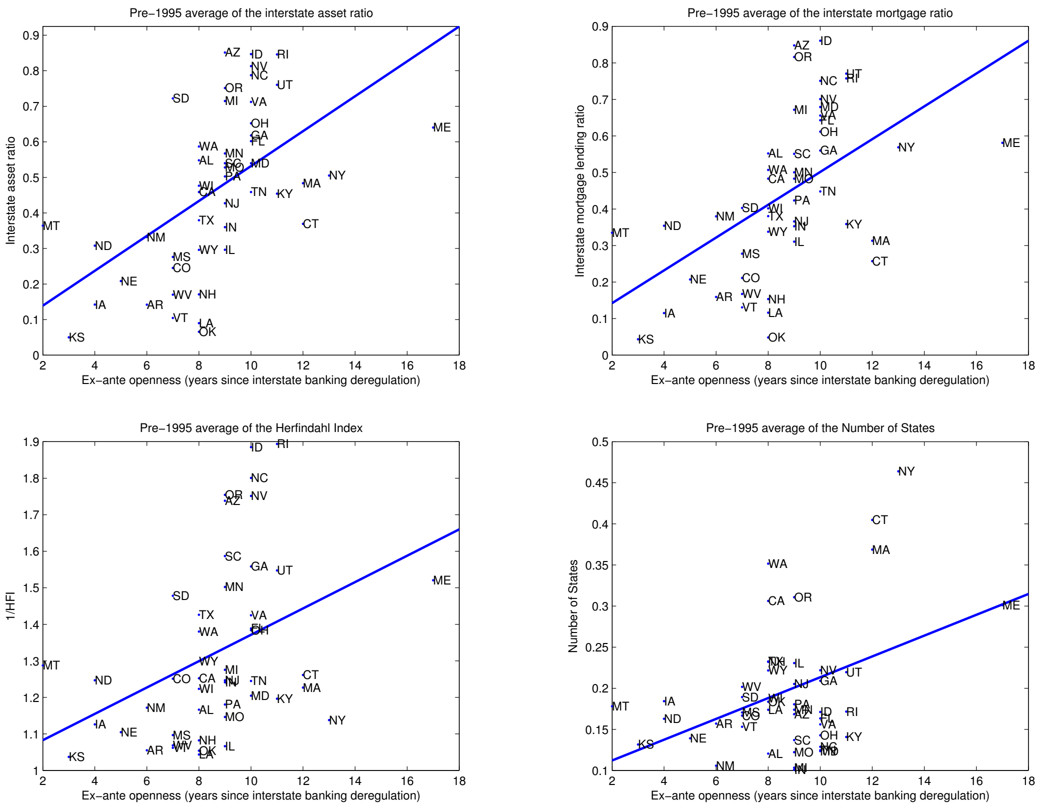


NOTES: The figure plots the years of interstate banking deregulation against loadings of the first principal components of the state level house pricing to personal income ratios. The cross-sectional regression of the form

$$DeregulationYear^k = b \times LoadPC^k + constant + \epsilon^k$$

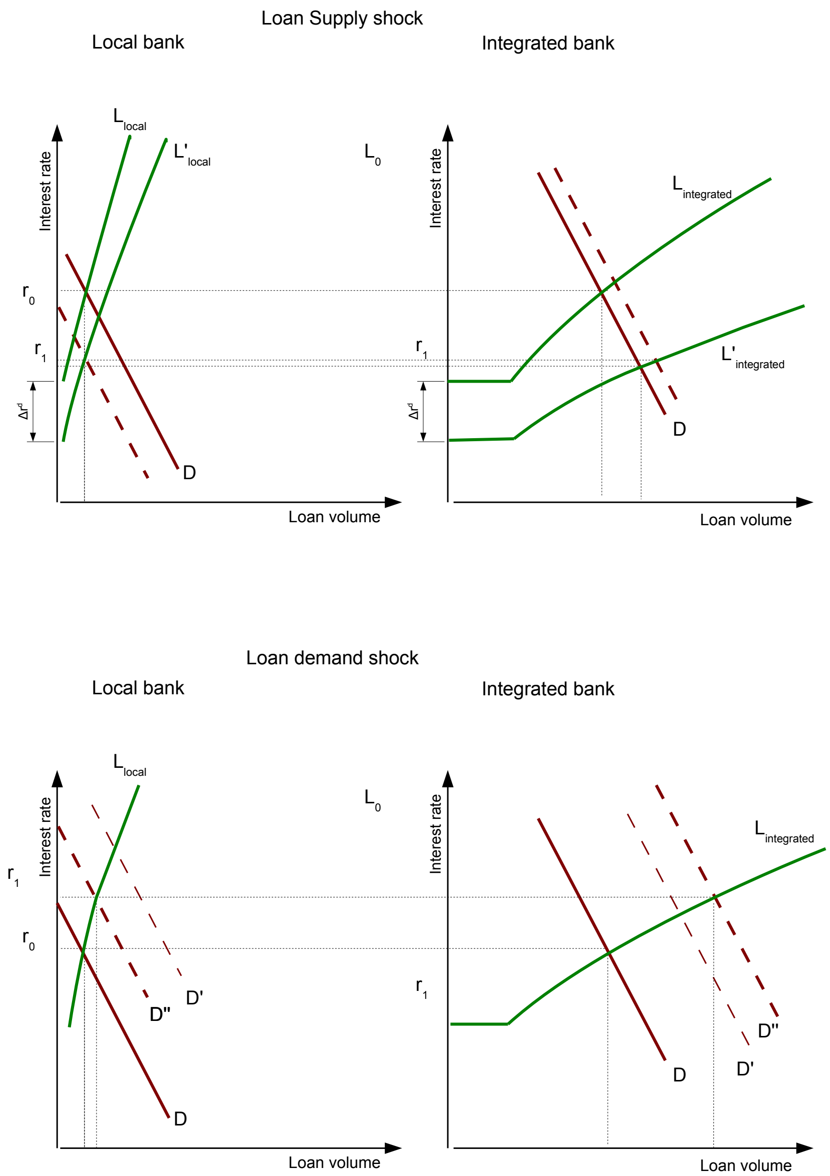
yields a coefficient estimate of $b = -1.09$, a t-statistics of 3.11.

Figure 3: *Ex-ante* and *de facto* Measures of Openness



NOTES: The figures plot our baseline openness measure —the number of years passed since interstate banking deregulation — against various de facto measures of openness: the 1986-1995 average of the interstate asset ratio, the share of mortgages in a state issued by integrated banks, the inverse of the Herfindahl Index, $1/HFI^k$, and the average number of states in which banks in a state are operating. Cross-sectional regressions of four *de facto* measures on the baselines measure, $\text{OPEN}^k_{defacto} = \beta years^k + constant + \epsilon^k$, yield the following coefficient estimates (t-statistics) and R^2 : *interstate asset ratio:* 0.05 (4.43) R^2=0.30 ; *interstate mortgage ratio:* 0.04 (4.11) R^2=0.27 , *inverse of Herfindahl:* 0.04 (2.85) R^2=0.15 ; *Average number of states in which a states banks are operating:* 0.01 (3.03) R^2=0.17 .

Figure 4: A stylized model of state-level bank lending

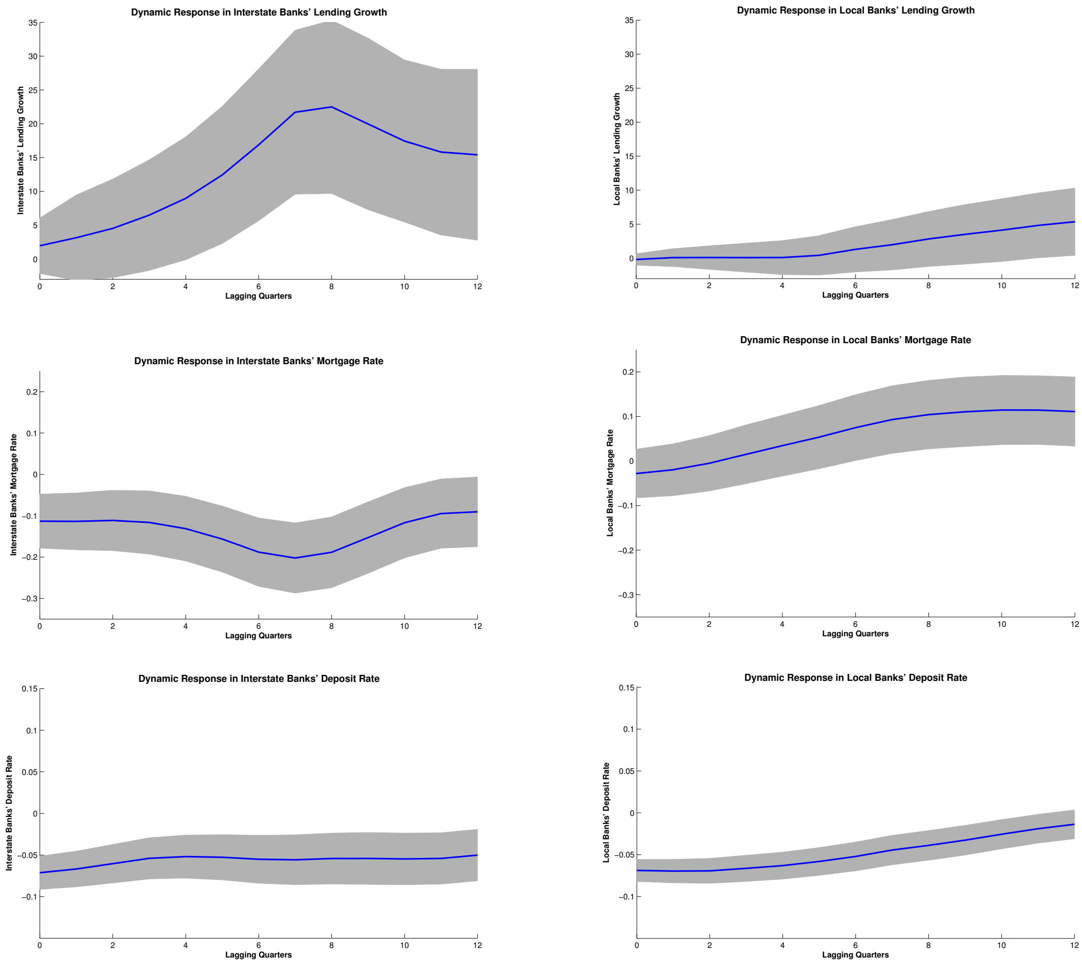


NOTES: The figure illustrates how local banks (on the left) and integrated banks (on the right) react to a positive loan supply shock (savings glut/ refinancing shock) (upper panel) and a loan demand shock (lower panel). In both panels, the supply curve of integrated bank is flatter (and more curved) than that of the local bank because due to its geographical diversification it can take on more leverage for any given level (and increase) of the interest rate.

A loan supply shock — represented here by a drop in the refinancing cost Δr — shifts down banks' loan supply curve and tilts it to the right. Lending increases and lending rates decline and the effect is particularly strong for the integrated bank, leading it to lower its lending rates and to increase its lending more than the local bank. The term spread of lending over refinancing rates will decrease in particular for the integrated bank. Over time, some local bank customers will migrate to the integrated bank which charges lower rates until both banks charge the same mortgage rate again (the move from the solid to the dashed demand curve).

A positive loan demand shock (shift from D to D') increases lending rates of both integrated and local banks. Again, the increase in lending is larger for the integrated bank, but this time refinancing rates stay constant for both banks and term spreads rise. Since the initial increase in rates is higher for the local bank, some of its customers move away towards the integrated bank, equalizing rates between banks over time (demand curve D'').

Figure 5: Dynamic Responses in Lending Growth and Interest Rate



NOTES: The figure plots dynamic responses of lending (panel above), interest rate (panel in the middle) and deposit rate (panel below) to the movements in US current account as a function of state's openness for two types of banks: integrated bank (on the left) and local bank (on the right). These dynamic responses are represented by a regression coefficient α_h of a regression of the form

$$x^i_{t+h} = \alpha_h \text{OPEN}^i \times \text{CAPFLOW} + \delta^i + \tau_t + \varepsilon^i_t$$

where x^i_{t+h} is the h-period ahead interest/deposit rate in state i or the cumulated lending growth in this state between period t and $t+h$.

Appendix A-C: for online publication only

Appendix A: Data

Our empirical analysis uses a panel of variables for the 47 contiguous U.S. states excluding Delaware for the period 1991-2012. We give a detailed description of the data and the methodology used to construct the variables used in the analysis in a separate Data appendix. Growth rates of variables are calculated as the first differences of the natural log of level values.

Housing valuations, HV_t^k, are our main dependent variable. We consider two measures: the first is the logarithm of the ratio of house prices to personal income, the house price—income ratio that we abbreviate with hpy_t^k. The second is the logarithm of the ratio of house prices to rents. We abbreviate this second measure with the acronym hpr_t^k. We construct these measures from the house price, income and rent data described next.

*House price*s. We use quarterly data on land and property values provided by the U.S., Lincoln Institute of Land Policy. The data are based on the adjusted Federal funding housing agency (FHFA) indexes estimated for 50 U.S. states and the District of Columbia of the prices and quantities of residential housing and its two components, land and structures. Calculated using the method by Davis and Heathcote (2007), these data are uniquely suited for our analysis since they are corrected for interstate differences in the quality of residential land and housing and are thus comparable across states.

State personal income is quarterly personal income by state provided by the Bureau of Economic Analysis (BEA).

Rental income is also obtained from the state-level national income and product account (NIPA) tables published by the BEA. Rental income of persons is the net income of persons from the rental of property. It consists of the net income from the rental of tenant-occupied housing by persons, the imputed net income from the housing services of owner-occupied housing, and the royalty income of persons from patents, copyrights, and rights to natural resources. It does not include the net income from rental of tenant-occupied housing by corporations (which is included in corporate profits) or by partnerships and sole proprietors (which is included in proprietors' income). Like other measures of income in the NIPAs, rental income of persons measures income from current production and excludes capital gains or losses resulting from changes in the prices of existing assets. Both measures of income are nominal in per capita terms, we generally omit the term "per capita" for the sake of brevity.

State-level financial openness. Our main measure, OPEN^k, indicates how many years had passed by 1995 since interstate banking deregulation took place, i.e.

$$\text{OPEN}^k = 1995 - Year\, of\, Interstate\, Banking\, Deregulation$$

Deregulation dates are from Kroszner and Strahan (1999). For comparison, we also compute several *de facto* measures of banking market integration based on data from the Call reports that we describe them in more detail below.

Interstate Branching (IB_t^k). The index is constructed using information provided in the Table 1 of Rice and Strahan (2010) on the effective date of interstate branching regulation changes, and each of the following four provisions: the minimum age of the institution for acquisition, allowance of de novo interstate branching, allowance of interstate branching by acquisition of a single branch or portions of an institution, and statewide deposit cap on branch acquisitions. The index is set to zero for states that impose all four restrictions to out-of state-entry. Abolishment of each of the restriction adds one quarter to the index. The index ranges from 0 (no integration) to 1 (full integration).

Capital Inflows (CAPFLOW_t). Our first and principal measure is the (negative) U.S. current account deficit over nominal GDP at current market prices ($-\frac{CA}{GDP}_t$). The current account balance is from the BEA, U.S. International Transactions Accounts Data, quarterly and seasonally adjusted. GDP data is from the BEA, National Economic Accounts, quarterly and seasonally adjusted at annual rates. The second measure is net foreign holdings of total assets defined as foreign-owned assets in the United States minus U.S.-owned assets abroad. The third measure, net foreign holdings of total securities is defined as foreign-owned U.S. government securities plus U.S. Treasury securities plus U.S. securities other than Treasury securities minus U.S.-owned foreign securities. The last two measures of capital inflows are quarterly and provided by the BEA, U.S. International Transactions Accounts Data. They are also expressed relative to nominal GDP at current prices. As an additional measure of cyclical external imbalances we use the negative of nxa_t-residual constructed by Gourinchas and Rey (2007) that essentially denotes a ratio of net exports over net foreign assets, thus taking account of the impact of valuation changes on the U.S. external balance. The nxa_t data is available only till the fourth quarter of 2003 and is kindly provided by Pierre-Olivier Gourinchas on his personal web page.

Indicators of monetary policy and credit availability. The short-term real interest rate, is constructed as U.S. (effective) Federal Funds minus U.S.-wide inflation. Data on Federal Funds are from the Board of Governors of the Federal Reserve System, Historical Data. The data is monthly and to compute quarterly data we average it over 3 months. U.S. inflation is computed using quarterly data on Personal Consumption Expenditures from the BEA . Our measure of monetary policy looseness is constructed as the deviation of the monetary policy rate from the interest rate implied by a Taylor rule where the monetary policy rate is the U.S. (effective) Federal Funds rate from the Board of Governors of the Federal Reserve System. The Taylor rule we use is: $0.02 + 1.5\,(\pi - 0.02) + 0.5\times$output gap, where π is U.S.-wide inflation and the output gap is measured by detrending an index for real GDP (constructed using the cumulation of official quarterly real GDP growth rates) with the HP-filter. Real long-term interest rates are measured as the 10-year constant maturity Treasury bond rate minus expectations of the average annual rate of CPI inflation over the next 10 years from the Survey of Professional Forecasters (only available from 1992), in percent per annum. Finally, we use a measure of credit standards from the Senior Loan Officer Opinion Survey on Bank Lending Practices that gives the net percentage of banks that reported tighter credit conditions. A positive value for this variable therefore indicates a tightening of credit conditions.

Financial Distress is measured as Corporate Bond Yield Spread between AAA- and BAA-rated corporate bonds.

Mortgage Lending. Bank lending and interest rate on mortgage lending are computed using data from the Call Reports. The data are available for the period 1986-1999 on the quarterly basis. For each commercial bank the data provides us with information on identification number (rssd 9001), total loans secured by real estate (rcfd1410), state of location (rssd9200), the BHC with which it is affiliated – if one exists– (rssd9348), and interest and fee income on loans secured by real estate. Banks are divided into two groups depending if they are owned by a BHC that operates in several states –interstate or integrated banks– or belong to a in-state local bank –local banks. Real estate loans and interest and fee income for these two groups are then aggregated, each quarter, at the state level.

Appendix B: the baseline regression in a reduced-form model of banks' credit supply

In this appendix, we provide a theoretical foundation for our baseline regression

$$\Delta \text{HV}_t^k = \alpha \text{OPEN}^k \times \text{CAPFLOW}_t + \tau_t + \delta^k + \varepsilon_t^k$$

and also derive a general form of the *de facto* openness measure that is consistent with a wide class of theoretical models. We follow Landier, Sraer and Thesmar (2013) and assume that lending supply in state drives local house prices growth with an elasticity of α, so that

$$\Delta \text{HV}_t^k = \alpha \frac{\Delta L_t^k}{L_{t-1}^k} + \nu_t^k$$

where

$$L_t^k = \sum_{n=1}^{N} L_{n,t}^k$$

is state-level lending and $L_{n,t}^k$ is the lending of bank n in state k. We assume that the growth rate of lending supply of bank n is given by

$$\frac{\Delta L_{n,t}^k}{L_{n,t-1}^k} = \gamma_t + \lambda_{n,t-1} \text{CAPFLOW}_t + \eta_{n,t}^k$$

where γ_t captures aggregate factors and η_{kt}^n is a bank and/or state-specific shock which is assumed to be uncorrelated with aggregate factors and capital inflows but may correlate with other banks' lending shocks as well as with the local house price shocks ν_t^k. The (potentially time-varying) parameter $\lambda_{n,t-1} \in \left[\ 0,\quad 1\ \right]$ captures the extent to which bank n is diversified across states.

The key feature of this reduced-form specification is that the lending of more geographically diversified banks is more sensitive to variation in the aggregate capital inflows into the U.S., CAPFLOW_t. This general reduced-form of the lending supply function is consistent in particular with the more articulated theoretical model that we describe in the next appendix and in which banks' lending supply is determined by a value-at-risk (VaR) constraint. In this model, more diversified banks will increase lending more in response to a given capital inflow, which is exactly what the reduced-form here is saying.

Based on this general setup, we can now write the house price change in state k as:

$$\Delta \text{HV}_t^k \quad = \quad \alpha \frac{\Delta L_t^k}{L_{t-1}^k} + \varepsilon_t^k = \alpha \sum_{n=1}^{N} \frac{\Delta L_{n,t}^k}{L_{n,t-1}^k} \omega_{n,t-1}^k + \nu_t^k$$

where $\omega_{n,t-1}^k = \frac{L_{n,t-1}^k}{L_{k_{t-1}}}$ is the lending share of bank n in state k. Plugging in for $\frac{\Delta L_{n,t}^k}{L_{n,t-1}^k}$ from the bank lending supply equation, we get

$$\Delta \text{HV}_t^k \quad = \quad \alpha \left(\sum_{n=1}^{N} \left(\lambda_{n,t-1} \text{CAPFLOW}_t + \eta_{n,t}^k + \gamma_t \right) \omega_{n,t-1}^k \right) + \nu_t^k$$

With this representation, it is now natural to define the financial openness of state k as the (asset-share) weighted average of the geographical diversification of banks:

$$\text{OPEN}_{t-1}^k = \sum_{n=1}^{N} \lambda_{n,t-1} \omega_{n,t-1}^k$$

so that

$$\Delta \text{HV}_t^k = \tau_t + \alpha \text{OPEN}_{t-1}^k \times \text{CAPFLOW}_t + \varepsilon_t^k$$

where $\tau_t = \alpha \times \gamma_t$ and $\varepsilon_t^k = \alpha \left(\sum_{n=1}^{N} \eta_{n,t}^k \omega_{n,t-1}^k \right) + \nu_t^k$. In this setting, OPEN_{t-1}^k will be correlated with ε_t^k via the bank market shares $\omega_{n,t-1}^k$. To account for this source of endogeneity and for the possibility that capital inflows impact on banks diversification decisions , we use *ex ante* (pre-sample) averages of OPEN_{t-1}^k in all our estimations.

It is interesting to relate the above equation to the findings of Landier, Sraer and Thesmar (2013), who emphasize the role of granularity in the bank-size distribution for the synchronization of house prices across states. In our setup, conditional on CAPFLOW_t, lending and house prices are perfectly correlated across states. Still, capital inflows differ in their impact on house prices across states if bank-size distributions are very different between states. This is because, unlike in Landier, Sraer and Thesmar (2013), the common factor CAPFLOW_t differs in its impact on banks, depending on the banks degree of diversification. Our openness measure OPEN_t^k therefore captures two dimensions of granularity: the within-bank dimension that determines the banks' geographical diversification, $\lambda_{n,t}$, and the within-state dimension of the bank size distribution, reflected in banks' local market shares, $\omega_{n,t-1}^k$.

Appendix C: A Value-at-risk model of bank lending and global imbalances.

We use a variant of the model by Shin (2010) to describe the optimal leverage choice of individual banks. In a second step, we then consider equilibrium in a market for deposits in which there are two types of banks: integrated banks which are geographically diversified and local banks which are not. The maintained assumption in the model is that bank deposits are safe (due to deposit insurance or due to bailout expectations or because banks insolvency risk is sufficiently small). As in Caballero and Krishnamurthy (2009), the global demand for U.S. safe assets is exogenous and amounts to the 'deposit' supply to the U.S. financial system. Global imbalances are modelled as an exogenous increase in this deposit supply.

Start from the balance sheet identity of the typical bank

$$A_t = E_t + D_t$$

where E_t denotes equity, D_t bank debt (deposits and wholesale debt) and A_t total bank assets (which we assume are just mortgage loans) at time t. The bank pays the safe refinancing (deposit) rate r_t^d and it generates a (risky) return r_{t+1}^a with standard deviation σ on its assets. Then the bank's equity in the next period is

$$\begin{aligned} E_{t+1} &= A_t(1 + r_{t+1}^a) - \left(1 + r_t^d\right) D_t \\ &= A_t(1 + r_{t+1}^a) - \left(1 + r_t^d\right) (A_t - E_t) \\ &= \left(r_{t+1}^a - r_t^d\right) A_t + (1 + r_t^d)E_t \end{aligned}$$

The bank becomes insolvent whenever $E_{t+1} < 0$ which will happen whenever the return r_{t+1}^a falls below the critical level r_t^{min}

$$r_{t+1}^a < r_t^d - \frac{(1 + r^d)E_t}{A_t} \equiv r_t^{min}$$

The regulator requires the bank to maintain a constant default probability of $1 - \alpha$, so that $r_t^{min} \leq r_{t+1}^a$ with probability α. Assuming a normal i.i.d. probability distribution for r_{t+1}^a with mean $\boldsymbol{E}\left(r_{t+1}^a\right)$and standard deviation σ, we can write this value-at-risk (VaR) constraint as

$$\boldsymbol{E}\left(r_t^{min}\right) = \boldsymbol{E}\left(r_{t+1}^a\right) - \phi\sigma \leq r_{t+1}^a \text{ with probability } \alpha$$

where ϕ is the (constant) distance to default expressed as a multiple of the standard deviation of r^a (Shin (2010)).

The bank is assumed to be risk-neutral and thus maximizes expected profit. It is then easy to see that the banks' problem would be unbounded if it was not for the VaR constraint. Hence, the VaR constraint holds with equality and the banks' optimal leverage is

$$\text{LVG}_t \equiv \frac{A_t}{E_t} = \frac{(1 + r_t^d)}{\phi\sigma - \boldsymbol{E}\left(r_{t+1}^a - r^d\right)}$$

which is equation (2) above. This equation implies that banks will seek to implement a constant leverage over time – given the expected return and risk of their portfolio and given their refinancing rates.

As in Shin (2010) we assume that banks stabilize leverage through adjustments in debt and not via issuing or buying back equity. Adrian and Shin (2010) that this assumption is in line with the actual behavior of U.S. banks. Negative return shocks lead banks to reduce leverage by lowering debt given equity. Positive return shocks induce them to take on more debt.

Let us now think of σ as a bank (-type) specific parameter that reflects the bank's degree of geographical diversification. Consider two (types of) banks, one, called I, that is geographically diversified (integrated) and one local bank, L, that is working only in one state. Then, $\sigma^L > \sigma^I$ and the integrated bank will have higher leverage. Also, for a given decline in the deposit rate r^d, the leverage of the integrated bank increases by more than that of the local bank:

$$\frac{\partial \text{LVG}}{\partial r^d} = \frac{(\phi\sigma_n - \mu) - (1 + r^d)}{(\phi\sigma_n - \mu)^2} = \frac{\phi\sigma_n - \boldsymbol{E}\left(r^a_{t+1}\right) - 1}{(\phi\sigma_n - \mu)^2} = \frac{1}{(\phi\sigma_n - \mu)} - \frac{1}{(\phi\sigma_n - \mu)^2} < 0$$

where $\mu = \boldsymbol{E}\left(r^a_{t+1} - r^d\right)$ denotes the 'term spread' or excess return on risky assets. This expression decreases (increases in absolute value) as σ_n decreases.[16]

Equilibrium in the U.S. money market and global imbalances In what follows, we think of the U.S. banking system as being composed of banks of the I and the L type. Then equilibrium in the money market implies

$$D^{US}_t = \frac{E^I_t(1 + r^d)}{\phi\sigma^I - \boldsymbol{E}\left(r^a_{t+1} - r^d_t\right)} + \frac{E^L_t(1 + r^d)}{\phi\sigma^L - \boldsymbol{E}\left(r^a_{t+1} - r^d_t\right)} - \left(E^I_t + E^L_t\right)$$

where D^{US} is the supply of deposits that, for our purposes here, we take as exogenous. We can rewrite this condition as

$$\frac{D^{US}_t}{\left(E^I_t + E^L_t\right)} = \frac{(1 + r^d_t)\lambda_t}{\phi\sigma^I - \boldsymbol{E}\left(r^a_{t+1} - r^d\right)} + \frac{(1 + r^d_t)(1 - \lambda_t)}{\phi\sigma^L - \boldsymbol{E}\left(r^a_{t+1} - r^d\right)} - 1 = L^I_t\lambda_t + L^L_t(1 - \lambda_t) - 1$$

where

$$\lambda_t = \frac{E^I_t}{E^I_t + E^L_t}$$

can be interpreted as the degree of regional integration of the U.S. financial system (defined as the share of all equity owned by regionally integrated banks). Now consider an exogenous shock ΔD^{US}_t to deposit supply – the emergence of global imbalances. With constant total U.S. banking equity $E^{US} = E^I_t + E^L_t$ and constant regional diversification λ we get:

$$\frac{\Delta D^{US}_t}{E^I_t + E^L_t} = \left(\frac{\partial \text{LVG}^I}{\partial r^d}\lambda_t + \frac{\partial \text{LVG}^L}{\partial r^d}(1 - \lambda_t)\right)\Delta r^d_t$$

Here, we can think of $\frac{\Delta D^{US}_t}{E^I_t + E^L_t}$ as the theoretical counterpart of our capital inflow measures, CAPFLOW_t. Hence, the increase in capital inflows translates into an offsetting decline in interest rates. As we have seen, a given interest rate decline will affect leverage — and thus lending — more for I-banks than for L-banks. Hence,at the level of individual states, we will also see that lending increases more strongly in integrated states than in segmented states with only local banks.

Endogenous geographical diversification Once we allow banks to react to the savings glut by also changing their geographical diversification, the market clearing condition becomes:

$$\frac{\Delta D^{US}_t}{E^I_t + E^L_t} = \left(\frac{\partial \text{LVG}^I}{\partial r^d}\lambda_t + \frac{\partial \text{LVG}^L}{\partial r^d}(1 - \lambda_t)\right)\Delta r^d + \left[\left(\text{LVG}^I - \text{LVG}^L\right) + \left(\frac{\partial \text{LVG}^I}{\partial \sigma^I} \times \frac{\partial \sigma^I}{\partial \lambda} - \frac{\partial \text{LVG}^L}{\partial \sigma^L} \times \frac{\partial \sigma^I}{\partial \lambda}\right)\right]\Delta\lambda_t$$

[16] Note that the term is negative as long as $\phi\sigma_n - \boldsymbol{E}\left(r^a_{t+1}\right) - 1 < 0$, which will always be the case, since otherwise, there would be a positive probability of the expected gross minimum return $1 + E\left(r^{min}\right) = 1 + \boldsymbol{E}\left(r^a_{t+1}\right) - \phi\sigma_n$ being negative, which is rule out by the bank's limited liability.

Here, the first part of the second term, $\text{LVG}^I - \text{LVG}^L$, captures how an increase in λ increases the ability of the U.S. financial system to absorb additional deposits as local banks become I-banks, *given* each bank type's respective level of geographical diversification ($\sigma^I$and σ^L respectively). The second part of the term captures, how an increase in λ may also change the geographical diversification of banks' portfolios. Clearly, it makes sense to assume that regional diversification lowers notional portfolio risk, so that $\partial\sigma/\partial\lambda$¡0. Note also that

$$\frac{\partial \text{LVG}}{\partial \sigma_n} = \frac{-\phi}{\left[\phi\sigma_n - \boldsymbol{E}\left(r^a_{t+1} - r^d_t\right)\right]^2} < 0$$

and that

$$\frac{\partial \text{LVG}}{\partial \sigma_n \partial r^d} = \frac{\phi}{\left[\phi\sigma_n - \boldsymbol{E}\left(r^a_{t+1} - r^d\right)\right]^3} > 0$$

Hence, as refinancing rates r^d fall after the savings glut, the sensitivity of leverage to changes in the volatility of the portfolio increases. Thus, for any given marginal cost of lowering σ_n (which in the above comes about by increasing λ), banks will now have a stronger incentive to increase their geographical diversification, making diversification a endogenous reaction to the savings glut.