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## Holes in the Dike: The Global Savings Glut, U.S. House Prices and the Long Shadow of Banking Deregulation

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# Holes in the Dike: The Global Savings Glut, U.S. House Prices and the Long Shadow of Banking Deregulation

## Abstract

We explore empirically how capital inflows into the US and financial deregulation within the United States interacted in driving the run-up (and subsequent decline) in US housing prices over the period 1990-2012. To obtain an ex ante measure of financial liberalization, we focus on the history of interstate-banking deregulation during the 1980s, i.e. prior to the large net capital inflows into the US from China and other emerging economies. Our results suggest a long shadow of deregulation: in states that opened their banking markets to out-of-state banks earlier, house prices were more sensitive to capital inflows. We provide evidence that global imbalances were a major positive funding shock for US wide banks: different from local banks, these banks held a geographically diversified portfolio of mortgages which allowed them to tap the global demand for safe assets by issuing private-label safe assets backed by the country-wide US housing market. This, in turn, allowed them to expand mortgage lending and lower interest rates, driving up housing prices.

JEL-Code: G100, G210, G280, F200, F320, F400.

Keywords: house prices, savings glut, global imbalances, credit constraints, state banking deregulation.

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# 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 between US federal states in the degree of openness to international capital: 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 that started to reach the US from emerging market economies in the second half of the 1990s. Over the decade between 1995 and 2005 the US was running a current account deficit of 3.5 percent of GDP on average. Our estimates imply that these capital inflows increased house prices by almost 30 percent more 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 US economy—as a major threat to global economic stability (see the review in Obstfeld and Rogoff (2009)). As early as 2005, Federal Reserve Chairman Ben Bernanke argued that a global glut of savings flowing into the US 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 US 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 (2012); Favilukis et al. (2012); Aizenman and Jinjark (2009)).

To the best of our knowledge, ours is the first empirical paper to exploit the *interaction* between financial liberalization at the state level and aggregate US capital inflows to identify the

channels through which global imbalances could have impacted housing prices. The intuition underlying our analysis is simple: when US federal states deregulated during the 1980s, thus giving large US banks access to their local banking markets, 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 therefore 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 US 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 argue that this savings glut was a funding shock to the banking sector that benefited in particular integrated banks: their geographical diversification effectively made the balance sheets of integrated banks attractive to international investors hungry for safe 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 builds on the interaction of *ex ante* state-level characteristics with US-wide *aggregate* inflows roughly a decade later. Importantly, we therefore do not have to make use of state-level capital inflows which could clearly be plagued by endogeneity (and on which good data do not exist in any case). By contrast, aggregate inflows into the US are arguably exogenous with respect to developments in house prices in most individual states. Since it still may be the case that developments in some bigger states impact aggregate US inflows, we also conduct much of our analysis at the state-pair level, where it would seem even less plausible that state-pair specific developments have a big feedback on aggregate inflows. Our findings therefore, allow the interpretation that US capital inflows were causal for house price developments.

The period of the “savings glut”, starting in the late 1990s, was also a period of major changes in the regulatory environment for banks. This liberalization could at least in part have been an endogenous reaction to the easy availability of capital from outside the US. Our empirical identification therefore makes use of an *ex ante* measure of financial openness in assessing

the impact of capital inflows on asset valuations. As our primary measure of openness we use the number of years that had passed since a state liberalized its interstate banking regime until 1995, the year from which we date the onset of the big wave of global imbalances (Obstfeld and Rogoff (2009)). We believe it is plausible that the wave of cheap capital in hunt for safe assets that hit the US 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. This makes our main financial openness measure clearly pre-determined and facilitates the causal interpretation of our results. By contrast, liberalizations in state banking markets that took place from the second half of the 1990s onwards could well have taken place under the impression that global capital markets were easy to tap. For example, Rice and Strahan (2010) show that states with a stronger presence of integrated banks were earlier and more determined to fully liberalize their inter-state bank branching regimes from the mid-1990s onwards. To the extent that global imbalances were a positive funding shock primarily to integrated banks—as we document—one may expect the incentive for integrated banks to lobby for a quick and full liberalization of state-level banking markets to have been strengthened. We provide evidence to this effect; weaker dikes were more easily washed away by the global savings glut.

Clearly, 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 get at this issue, we first show that states that opened up their banking market earlier had indeed a stronger presence of relatively big banks operating in several states when huge capital inflows started during the 1990s. We then put forward a stylized model of state-level bank lending in which integrated banks have a more interest-elastic loan supply than purely local banks that operate only in one state. The reason for this is that integrated banks hold a geographically diversified portfolio of mortgages. This has two immediate implications: first, geographic diversification means that integrated banks require a lower risk premium than local banks for a given increase in local lending since they diversify away their exposure to idiosyncratic shocks in the local property market. The geographical diversification of integrated banks' portfolios, secondly, translates into a funding advantage relative to local banks. The fact that the US-

wide housing market—in spite of some regional declines—had never declined in aggregate in the seventy years before 2007 hugely contributed to the general perception of private-label mortgage-backed securities (MBS) as safe assets. Since integrated banks' geographically diversified mortgage portfolio mainly reflects risks in the aggregate US housing market, we argue that they could tap this global demand for safe assets more easily than local banks— either by borrowing at lower rates than local banks or by issuing MBS at more favorable conditions.

Consistent with this simple model, we find that fluctuations in US-wide capital inflows were transmitted to state housing markets primarily through their impact on the lending decisions of integrated banks. Different from local banks, integrated banks also decreased the rates they charged on mortgages in response to aggregate capital inflows, and in fact also their spreads over refinancing rates. This suggests that aggregate capital inflows into the US reflected a positive liquidity supply shock to the geographically diversified part of the country's banking sector.

Our results also shed some light on the question whether house price increases in the US were due to a world-wide increase in the supply of savings or due to excessively lax monetary policy. Using measures of monetary policy tightness and general measures of credit availability, we find results that are in analogy to the ones we have reported for capital inflows: looser monetary policy and lower interest rates all have a stronger bearing on house prices in states that liberalized earlier. This lends support to the risk-taking channel as a key driver of house price dynamics in the United States (see Borio and Zhu (2008) for the notion of the risk taking channel and and Jorda, Schularick and Taylor (2014) for long-run historical evidence). However, in all our specifications, capital flows drive out real interest rates and other indicators of monetary policy tightness. Our results therefore suggest that increased risk taking by integrated banks was possible only because these banks could tap into a global demand for private-label safe assets.

A growing literature has documented the misincentives that nationwide deregulation as well as the emergence of securitization in the mortgage market may have provided to banks and other mortgage originators and our results are in principle consistent with these findings (see e.g. Mian and Sufi (2009); Loutskina and Strahan (2009)). However, our results do not

suggest *a priori* that the states that liberalized their banking markets earlier generally saw the worst excesses in lending and the biggest house price increases.<sup>1</sup> For example, Favilukis et al. (2012) argue that the increase in housing valuations could be linked to a declining risk premium for housing. Our theoretical framework captures a variant of this idea: their geographically concentrated portfolio makes local banks less willing to lend while better diversification of the integrated banks contributes to increased local lending supply. Our results, *per se*, therefore, do not suggest that lending was excessive.

Our analysis also relates closely to the recent work by Imbs and Favara (2015) and by Landier, Sraer and Thesmar (2013). Imbs and Favara (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 is complementary to theirs in that it emphasizes the role that better diversification of the asset side of integrated banks' balance sheet played in facilitating these banks' ability to tap the global demand for safe assets that was reflected in aggregate capital inflows into the US.

Landier, Sraer and Thesmar (2013) show that granularity in the size distribution of banks in local markets and the fact that big banks operate in several states was a major driver in increasing the comovement of housing markets in the years after the liberalization of state-level banking markets. We add to this by showing that global imbalances were a major 'common factor' in the lending decisions of integrated (big) banks and thus contributed significantly to the synchronization of house price developments between states during the late 1990s and 2000s.

Borio and Disyatat (2011) and Shin (2012) have pointed at the importance of a banking glut as a key factor in the genesis and international transmission of the crisis. European banks heavily borrowed short-term in dollars through their US subsidiaries while buying long-term US mortgage-backed securities. Adrian and Shin (2010) show that this banking glut was reflected in huge gross international banking positions and allowed US financial institutions to increase their intermediation capacity but had a relatively modest effect on net positions only.

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<sup>1</sup>For example, *a priori* it could also be the least developed banking markets, where local banks have to invest any excess funds locally, for example by ploughing them into the housing market.

We emphasize that our findings are fully consistent with this pattern. We argue that the positive funding shock of the savings glut allowed integrated banks to increase leverage in a way that was unavailable to local banks, thus contributing to the growth in gross international banking positions.

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 US housing market. Our findings, therefore, suggest that the intra-national liberalization of US banking markets during the 1980s cast a long shadow: it helped lay the foundation for the ability of the US 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.

Finally, our findings also have implications for current policy discussions about 'better' banking integration in Europe. Hale and Obstfeld (2014) find that the lending boom in the EMU periphery countries was financed mainly by big banks located in the core countries that, in turn, refinanced themselves in international capital markets. By contrast, there was little growth in direct lending from non-European banks to the European periphery. Our findings here suggest a similar pattern for the US: geographically diversified US banks—rather than international banks directly—played a key role in channeling international capital to the housing markets of peripheral US states.

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. Sec-



tion 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 US 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.<sup>2</sup>

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,<sup>3</sup> interstate banking in the US 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 allow-

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<sup>2</sup>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.

<sup>3</sup>Only nineteen existing multi-state BHCs (Savage (1993)) were grandfathered as the Douglas Amendment was enacted.

ing 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 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 US 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 states started to increase from the mid-1990s, together with rising capital inflows into the US. 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 US 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 US 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 and Data

#### 3.1 Empirical Framework

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

$$\Delta housevaluation_t^k = \alpha \times open^k \times CAPFLOW_t + Controls + \tau_t + \delta_k + \epsilon_{k,t} \quad (1)$$

The dependent variable is a measure of housing valuation in state  $k$  at time  $t$ . 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 discuss the choice of these variables in detail below. We also include a range of control variables and time ( $\tau_t$ ) and state fixed effects ( $\delta_k$ ).

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 US. 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 US 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.<sup>4</sup>

We note, secondly, our use of aggregate capital inflows as a driver of housing valuations. To the extent that aggregate inflows into the US are big relative to state-level inflows (for which we have no official data), 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 good data on those existed).

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 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 Stra-

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<sup>4</sup>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.

han (2010), states with a stronger presence of nationwide banks were more likely to liberalize their bank branching regimes during the 1990s. The incentive to lobby for a liberalization of a state's branching regime would seem very strong for nationwide banks in particular during a period when capital from outside the state is cheaply available due to a global savings glut. This suggest that any concurrent changes in regulation could possibly be endogenous.

### 3.2 Data

We use a panel of variables for the 47 contiguous U.S. states excluding Delaware for the period 1991-2012. Below, we describe the main sources of data and the methodology used to construct the variables used in the analysis. Growth rates of variables are calculated as the first differences of the natural log of level values.

*Housing valuations* 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 prices.* 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.

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

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) US 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  $nxa_t$ -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 US 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 US (effective) Federal Funds minus US-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. US 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 US (effective) Federal Funds rate from the Board of Governors of the Federal Reserve System. The Taylor rule we use is:  $0.02 + 1.5 (\pi - 0.02) + 0.5 \times \text{output gap}$ , where  $\pi$  is US-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 (rssid 9001), total loans secured by real estate (rcfd1410), state of location (rssid9200), the BHC with which it is affiliated – if one exists– (rssid9348), 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.

## 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) US 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 US. 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. 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.<sup>5</sup>

None of this affects our basic results: though including past valuations reduces the estimate

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<sup>5</sup>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.



of our coefficient of interest by around a half,  $\alpha$  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 higher annual increase than in Montana.<sup>6</sup> For a hypothetical pair of states of which one was liberalizing in 1980 and one in 1990, the 1995-2005 average US 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.<sup>7</sup>

**Alternative measures of capital inflows** Table 2 presents results for alternative measures of capital inflows. The current account could misrepresent actual inflows into the US 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 US 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 US capital inflows over the late 1990s and early 2000s was motivated by global demand for US safe assets. As a second alternative measure of capital inflows, we therefore focus on the change in foreigners' net holdings of *safe* US securities, defined here as changes in the holdings of US government bonds and mortgage-backed securities issued by government sponsored enterprises such as Freddie Mac and Fannie Mae.

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<sup>6</sup>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  $CAPFLOW_t \times open$  are directly interpretable as the annualized impact of capital inflows on the left hand side variable.

<sup>7</sup>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.

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 US trade balance and US foreign assets that again allows to control for the impact of valuation changes on the US 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 US. Before 2008, US affiliates (subsidiaries and branches) of foreign banks borrowed heavily in the US money market. At the same time, the foreign parents of these affiliates built considerable long-term positions in the US 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 US financial sector by effectively enhancing the intermediation capacity of the US financial system. When short-term dollar financing dried up in 2008, the balance sheets of international banks operating in the US 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 US 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 US assets as well as the banks' net and the gross positions vis-à-vis the US. In our empirical specifications, we consider all three measures in both levels and in changes. All measures are normalized with US 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. We draw the following conclusion from this result: while an increase in global gross banking positions—effectively an increase in economy-wide leverage—seems to matter for the transmission, net inflows rather than the development of gross positions appear as the ultimate driver of house price developments in the US. 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 a precondition to allow integrated banks to increase leverage and expand mortgage lending.

**Capital inflows or lax monetary policy?** A leading competitor to the view that capital inflows into the US were the driver of US 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 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:

$$\Delta housevaluation_t^k = \alpha_{CC} \times open^k \times CC_t + Controls + \tau_t + \delta_k + \epsilon_{k,t},$$

where  $CC_t$  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 broader measures of credit supply, 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

$$\Delta housevaluation_t^k = \alpha \times open^k \times CAPFLOW_t + \alpha_{CC} \times open^k \times CC_t + Controls + \tau_t + \delta_k + \epsilon_{k,t},$$

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 (in the  $\Delta hpy_t^k$  regression) the long-term bond rate are not. These findings suggest that capital inflows into the US seem to be more strongly and consistently linked to house price valuations than most broad measures of domestic credit availability or monetary policy.

## 4.2 State-pair regressions

In this section, we demonstrate that all our key results also hold up in regressions in which state-pairs (instead of individual states) are the unit of observation. Specifically, we run regressions of the form

$$\Delta valuation_{t+1}^i - \Delta valuation_{t+1}^j = \alpha(open_t^i - open_t^j) \times CAPFLOW_t + \mu_{ij} + \tau_t + \epsilon_{t+1}^{ij}$$

The literature on state-level banking deregulations has recently started to use state-pair regressions more widely (see e.g. Goetz and Gozzi (2014), Michalski and Ors (2012) ) since they allow to increase the power of the statistical analysis by expanding the space of cross-sectional dimension of the data set (in our case to  $47 \times 46/2 = 1081$  state-pairs) and by enabling us to control for state-pair specific factors. In addition, by allowing us to cluster standard errors at

the state-pair level, the state-pair approach can take account of very general forms of spatial correlation in a way that the state-level analysis cannot easily achieve. Finally, in the context of our analysis state-pair regressions seem especially attractive since the assumption that aggregate capital inflows into the US are exogenous appears even more plausible at the level of individual state-pairs than at that of entire states.

Table 6 presents results for the state-pair version of our baseline regression, Table 7 presents the results for alternative capital flow measures. Our previous results remain virtually unchanged. In most cases, the regression coefficients are virtually identical to the corresponding regressions based on individual states instead of state-pairs. The levels of significance of the estimated coefficients do not generally change either. This suggests that the more general forms of cross-sectional dependence and spatial correlation for which the state-pair analysis controls did not affect our previous state-level results. In what follows, we will often report both state-level and state-pair results. As will become apparent, the results are generally not sensitive to the choice of specification.

### 4.3 Alternative measures of financial openness

#### Relation to *de facto* measures

We check the robustness of our results using a range of different *de facto* measures of state-level openness. In the appendix we present a stylized model of bank lending in which we formalize our conjecture that more geographically diversified banks are more strongly exposed to fluctuations in aggregate capital inflows because they are perceived as safer. This model implies that state-level openness used in our baseline regressions should be of the following general form:

$$open^k = \frac{1}{T} \sum_{t=1}^T \left( \sum_{n=1}^N \lambda_t^n \omega_{kt-1}^n \right)$$

where the parameter  $\lambda_t^n \in [0, 1]$  captures the extent to which bank  $n$  is diversified across states and  $\omega_{kt-1}^n$  is the share of bank  $n$  in total bank lending in state  $k$  at time  $t - 1$ .  $N$  and  $T$  denote the number of banks and the length of the sample period respectively.

To construct  $\lambda_t^n$  and  $\omega_{kt-1}^n$ , 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,  $open^k$  is just 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.<sup>8</sup> 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  $\lambda_i^n$  between zero and one, we divide this number with the number of states in our sample. Our fourth measure of  $\lambda_i^n$  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 8, we also perform versions of our baseline regressions based on the *de facto* measures themselves, both at the state and the state-pair level. 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 in the appendix.

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<sup>8</sup>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.

### ***Ex ante* deregulation measures and state-level branching deregulation**

Our *ex ante* measure of financial openness used in our results above exploits the state-level variation in the time elapsed since a state's liberalization and the onset of the savings glut in the second half of the 1990s. It is important to realize that the interstate liberalization during the 1980s allowed bank holding companies from other states to acquire local banks, but that these acquired banks had to remain separate legal entities. However, concurrent with the huge capital inflows hitting the US from the second half of the 1990s onwards, the US banking sector saw a second major wave of state-level financial liberalization: the gradual dismantling of remaining interstate bank-branching restrictions.<sup>9</sup> Imbs and Favara (2015) show that the liberalization of the branching regime also had a big impact on the growth rate of mortgage loans and, on housing prices. Here, we examine to which extent our results are affected by this second wave of interstate liberalizations.

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). Our results, are presented in Table 9. Regressions of our two housing valuation measures on the  $IB$  indicator alone yield significant and positive coefficients. This replicates the flavor of the results by Imbs and Favara (2015). We then add capital inflows interacted with our *ex ante* measure of openness. Our coefficient of interest remains significant and in the order or magnitude of our previous estimates, as does the coefficient on  $IB_t^k$ .

The fact that both variables are significant suggest that they affect housing valuations through different channels. Indeed, Imbs and Favara (2015) emphasize that interstate branching deregulation improved the diversification of integrated banks' deposit base, thus leading integrated banks to lend more. By contrast, our analysis emphasizes how banks with a more geographically diversified asset side of their balance sheets benefited more from the global demand for safety, providing an additional and distinct motive for these banks to increase lending.

Rice and Strahan (2010) have argued that states with a strong presence of big, nationwide

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<sup>9</sup>While the Riegle-Neale 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.

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 in states where they had a big market share. In addition, we would expect this lobbying effort to become the stronger, the easier it became for these integrated banks to tap financing opportunities in international markets as global imbalances widened. At the bottom of Table 9 we report two regressions that shed some light on these two conjectures. 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 support to the first conjecture, in line with Rice and Strahan (2010). 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. Again the coefficient is positive and highly significant, in line with the second conjecture that the global savings glut may have increased political pressure in open states to liberalize the branching regime. These results illustrate that it is important to use *ex ante* measures of financial integration to identify the causal effect of global capital inflows on house prices—as we have done throughout the paper.

## 5 Transmission mechanism

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 capture the main intuition behind our analysis using a stylized 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 lower the risk premia they charge and to expand their lending whereas local banks mainly tend to increase their margins. We provide evidence for the theoretical mechanism highlighted in this model.

The upper panel of Figure 4 captures the intuition. The graph on the right shows the shock



to the loan supply of the integrated bank. The drop in refinancing cost (marked as the reduction in the vertical intercept of the loan supply function by  $\Delta r$ ) shifts the loan supply function rightwards, leading to higher lending and lower interest rates. The graph on the left shows the case of the local bank. For the same drop in refinancing cost,  $\Delta r$ , the net effect on the lending supplied and the interest rate charged by the local bank is very small in comparison to the integrated bank, reflecting local banks' reluctance to leverage up (because of their non-diversified exposure to the local property market).<sup>10</sup> The take-away from the model is twofold. First, if the savings glut was indeed a general liquidity supply shock that affects integrated banks asymmetrically, we should see higher loan growth in more integrated states and this higher loan growth should be driven primarily by integrated banks. Also, for the integrated banks we should see a pronounced decline in lending rates whereas local banks' lending rates should remain largely unchanged.<sup>11</sup> The lower panel of Figure 4 contrasts these predictions with the case of a demand shock. As was the case with the supply shock, the positive demand shock should predominantly be associated with an increase in lending by integrated banks. However, interest rates should increase and on impact they should increase more for the local banks (due to their lower supply elasticity), as indicated by the shift from the thick, solid original demand curve to the thin, dashed demand curve. As customers start to move away from local banks due to their higher interest rate, we will see a small and gradual increase in the interest rate charged by the integrated banks and a decline in the interest rate charged by the local bank.

The simple model therefore allows us to test whether the savings glut reflects demand or supply factors: if loan demand was responsible for our findings, we should see interest rates increases predominantly by local banks and lending increases predominantly by integrated banks. If supply factors dominate, we should see an increase in lending of integrated banks accompanied with a strong decline in interest rates charged by these banks. As we will see, it

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<sup>10</sup>Note that the differential effect on local and integrated banks would be reinforced, if, in addition, we assume that the reduction in refinancing cost is bigger for the integrated banks, which we believe is plausible. Even though local banks can also sell mortgages to government sponsored enterprises such as Fannie Mae and Freddie Mac or other institutions, they will not be able to 'produce' a country-wide diversified portfolio of mortgages by themselves. For example, most likely this would imply that they face haircuts in selling these loans that the integrated banks do not have to accept, suggesting that integrated banks can produce the private-label safe asset at lower cost.

<sup>11</sup>Clearly, 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).

is the latter pattern that we observe in the data.

To test these hypotheses empirically, we compile aggregates of state-level mortgage lending from the quarterly Call Reports for the period 1984-1999.<sup>12</sup> 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 through the moving average of lending over the same period.

Table 10 provides empirical evidence on the theoretical mechanism. It first shows results for both the state-level and the state-pair versions of 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. Importantly, the mortgage lending rates of integrated banks decline with capital inflows, suggesting that capital inflows into the US 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 basic assumption of the model, deposit rates drop more in more open states and they do so 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. We interpret this finding as evidence that geographically 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

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<sup>12</sup>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).

into the global demand for safe assets.<sup>13</sup>

In the last two sets of columns of Table 10, we also examine how the liability side of banks balance sheets reacts to fluctuations in the current account, depending on state openness. 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.<sup>14</sup> This pattern is consistent with our conjectured mechanism: the global demand for safe assets should mainly increase 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 the supply of 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

$$x_{t+k}^{ij} = \alpha_k(Open_t^i - Open_t^j) \times CA_t + \mu_{ij} + \tau_t + \varepsilon_{t+1}^{ij}$$

on state pairs where  $x_{t+k}^{ij}$  is the  $k$ -period ahead interest rate difference between states  $i$  and  $j$  or the cumulated lending growth difference between these states between period  $t$  and  $t + k$ . By collecting the coefficients  $\alpha_k$  obtained from these regressions for different forecasting horizons  $k$ , we can obtain a dynamic responses of interest rates and lending.

Our findings confirm the intuition from our model and our earlier conclusion that capital inflows largely impacted house prices through their impact on 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. By contrast—in keeping with the theory above—both local and integrated banks experience very similar and persistent declines in deposit rates.

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<sup>13</sup>This decline in the the spread on the risky investment in housing in response to an increase in demand for safe assets is consistent with models such as that of Caballero and Krishnamurthy (2009).

<sup>14</sup>We construct wholesale funding as total liabilities less equity and deposits.

## 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 reflection of a global demand for safe assets — as a savings glut. We argue that this global demand for US safe assets constituted a funding shock that benefited in particular integrated banks. As opposed to purely local banks that operate only in one state, integrated banks held a geographically diversified portfolio of mortgages. Since the aggregate US 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 US lead integrated banks to increase their lending 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. Our finding suggests that the run-up in US 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.

Our findings suggest that *intra*-national banking liberalization within the United States had a long shadow in that it effectively increased the ability of the US 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 the emergence of China on the world economic stage (Caballero and Krishnamurthy (2009)).

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## Appendix: the baseline regression in a model simple model of banks' credit supply

In this appendix, we provide a theoretical foundation of the pairwise version of our baseline regression

$$\Delta housevaluation_t^i - \Delta housevaluation_t^j = \alpha \left( open^i - open^j \right) \times CAPFLOW_t + \dots$$

We follow Landier, Sraer and Thesmar (2013) and assume that lending supply in state drives local house prices growth with an elasticity of  $\mu$ , so that

$$\frac{\Delta P_{kt}}{P_{kt-1}} = \mu \frac{\Delta L_{kt}}{L_{kt-1}} + \varepsilon_{st}$$

where  $\frac{\Delta P_{kt}}{P_{kt-1}}$  measures the growth in housing valuations in state  $k$  and

$$L_{kt} = \sum_{n=1}^N L_{kt}^n$$

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

$$\frac{\Delta L_{kt}^n}{L_{kt-1}^n} = a_t + \lambda_n X_t + (1 - \lambda_n) \eta_{kt}^n$$

where  $X_t$  is a country-funding shock to integrated banks (reflecting the global demand for safe assets),  $a_t$  captures other aggregate factors and  $\eta_{kt}^n$  is a bank and/or state-specific shock which is assumed to be uncorrelated with aggregate factors but may correlate with other banks' lending shocks as well as with the local house price shocks. The (potentially time-varying) parameter  $\lambda_t^n \in [0, 1]$  captures the extent to which bank  $n$  is diversified across states. A couple of remarks are in order about the specification of the banks's lending supply function.

- The more geographically diversified banks are, the more correlated will their lending growth be across states, reflecting the operation of internal capital markets.
- The global funding supply shock (reflecting foreign demand for safe assets),  $X_t$ , loads more strongly on more diversified banks. This captures the idea that more diversified banks were perceived as safer and could therefore benefit more from this demand for safe assets. Diversified banks, therefore have a higher elasticity of lending supply with respect to  $X_t$  than less diversified banks. This assumption is key for our identification: what distinguishes the global demand for safe assets / aggregate funding supply shock from other aggregate factors is that it affects different banks differently, depending on the bank's geographical diversification. Conversely, other aggregate shocks, captured by  $a_t$ , affect all banks equally.

Based on these assumptions, we can now calculate the difference between house prices in two states  $i$  and  $j$ :

$$\frac{\Delta P_{it}}{P_{it-1}} - \frac{\Delta P_{jt}}{P_{jt-1}} = \mu \left( \frac{\Delta L_{it}}{L_{it-1}} - \frac{\Delta L_{jt}}{L_{jt-1}} \right) + \varepsilon_{it} - \varepsilon_{jt} = \mu \left( \sum_{n=1}^N \left( \frac{\Delta L_{it}^n}{L_{it-1}^n} \omega_{it-1}^n - \frac{\Delta L_{jt}^n}{L_{jt-1}^n} \omega_{jt-1}^n \right) \right) + \varepsilon_{it} - \varepsilon_{jt}$$

Plugging in for  $\frac{\Delta L_{it}^n}{L_{it-1}^n}$  from the bank-lending supply equation, we get

$$\frac{\Delta P_{it}}{P_{it-1}} - \frac{\Delta P_{jt}}{P_{jt-1}} = \mu \left( \sum_{n=1}^N (a_t + \lambda_t X_t + (1 - \lambda_t^n) \eta_{kt}^n) (\omega_{it-1}^n - \omega_{jt-1}^n) \right) + \varepsilon_{it} - \varepsilon_{jt}$$

The theoretical regression coefficient of idiosyncratic house price growth and aggregate capital inflows  $X_t$  is

$$\frac{cov_{t-1} \left( \frac{\Delta P_{it}}{P_{it-1}} - \frac{\Delta P_{jt}}{P_{jt-1}}, X_t \right)}{var_{t-1} (X_t)} = \mu \sum_{n=1}^N \lambda_t^n (\omega_{it-1}^n - \omega_{jt-1}^n)$$

It is now natural to define the financial openness of states  $s$  as the average of banks' geographical diversification weighted with banks' asset share in the state:

$$open_t^k = \sum_{n=1}^N \lambda_t^n \omega_{kt-1}^n$$

so that

$$\frac{cov_{t-1} \left( \frac{\Delta P_{it}}{P_{it-1}} - \frac{\Delta P_{jt}}{P_{jt-1}}, X_t \right)}{var_{t-1} (X_t)} = \mu (open_t^i - open_t^j)$$

Hence, the correlation between price growth and  $X_t$  varies across states as a function of states' financial openness and it may also vary over time as individual states become relatively more or less open over time.

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  $X_t$ , lending and house prices are perfectly correlated across states. Still, shocks to  $X_t$  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  $X_t$  differs in its impact on banks, depending on the banks degree of diversification. Our openness measure  $open_t^k$  therefore captures two potential dimensions of granularity: the within-bank dimension that determines the banks' geographical diversification,  $\lambda_t^n$ , and the within-state dimension of the bank size distribution, reflected in banks' local market shares,  $\omega_{kt}^n$ .

We can think of the baseline panel regression as being based on a time-average of relative openness so that with  $open^k = \frac{1}{T} \sum_{t=1}^T open_t^k$  we get for the state-pair  $ij$

$$\frac{1}{T} \sum_{t=1}^T \left( \frac{cov_{t-1} \left( \frac{\Delta P_{it}}{P_{it-1}} - \frac{\Delta P_{jt}}{P_{jt-1}}, X_t \right)}{var_{t-1} (X_t)} \right) = \mu (open_i - open_j)$$

and the coefficient  $\alpha$  in our baseline regression identifies the elasticity  $\mu$  of house prices with respect to lending growth.

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

Panel A: dependent variable is change in logarithmic house price—income ratio, $\Delta hpy_t^k$					
	I	II	III	IV	V
$open^k \times CAPFLOW_t$	0.12 (3.63)	0.12 (3.58)	0.07 (2.84)	0.07 (3.07)	0.07 (3.06)
$\Delta hpy_{t-1}$			0.38 (5.75)	0.38 (5.74)	0.38 (5.75)
$hpy_{t-1}$				-0.01 (-2.25)	
$hpy_{1990}^k \times CAPFLOW_t$					0.08 (0.19)
$\Delta pop_{t,k}$		0.96 (11.80)	0.94 (12.69)	0.94 (12.78)	0.94 (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, $\Delta hpr_t^k$					
	I	II	III	IV	V
$open^k \times CAPFLOW_t$	0.26 (2.62)	0.26 (2.60)	0.25 (2.52)	0.17 (1.97)	0.25 (2.25)
$\Delta hpr_{t-1}^k$			0.03 (1.27)	0.01 (0.15)	0.03 (1.27)
$hpr_{t-1}^k$				0.05 (1.05)	
$hpr_{1990}^k \times CAPFLOW_t$					-0.05 (-0.08)
$\Delta pop_{t,k}$		0.26 (1.06)	0.25 (1.03)	0.34 (1.54)	0.25 (1.04)
$R^2$	0.82	0.82	0.82	0.83	0.82

The Table shows the results from the panel regression

$$\Delta housevaluation_t^k = \alpha \times open^k \times CAPFLOW_t + Controls + \tau_t + \delta_k + \epsilon_{k,t},$$

where  $open^k = 1995 - Year\ of\ Interstate\ Banking\ Deregulation$  and  $CAPFLOW_t$  are capital inflows, measured here as the negative current account deficit over GDP ( $CAPFLOW_t = -\frac{CA}{GDP_t}$ ). House valuations are measured by the growth rate in house price-income ratio,  $\Delta hpy_t^k$ , or house price-rent ratio,  $\Delta hpr_t^k$ .  $\Delta hpy_{t-1}^k$  and  $\Delta hpr_{t-1}^k$  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, $\Delta hpy_t^k$ ,									
	I net foreign holdings of US assets			II net foreign holdings of US securities			III Gourinchas-Rey $nx_a$		
$open^k \times CAPFLOW_t$	0.01 (2.31)	0.01 (2.53)	0.01 (2.60)	0.03 (1.62)	0.02 (1.86)	0.02 (2.11)	-0.01 (-3.47)	-0.00 (-2.74)	-0.00 (-2.59)
$\Delta hpy_{t-1,k}^k$		0.39 (5.98)	0.39 (5.97)		0.39 (5.99)	0.39 (5.99)		0.31 (4.43)	0.31 (4.42)
$hpy_{1990}^k \times CAPFLOW_t$			0.01 (0.14)			0.07 (0.26)			0.04 (1.90)
$\Delta pop_{t,k}$	0.96 (11.58)	0.94 (12.57)	0.94 (12.58)	0.96 (11.63)	0.95 (12.61)	0.94 (12.62)	0.90 (7.95)	0.91 (8.55)	0.91 (8.53)
$R^2$	0.57	0.64	0.64	0.57	0.64	0.64	0.58	0.63	0.57
Panel B: dependent variable is change in logarithmic house price—rent ratio, $\Delta hpr_t^k$									
	I			II			III		
$open^k \times CAPFLOW_t$	0.07 (2.21)	0.06 (2.15)	0.07 (1.97)	0.15 (1.98)	0.14 (1.94)	0.16 (1.75)	-0.01 (-2.17)	-0.01 (-2.12)	-0.01 (-2.23)
$\Delta hpr_{t-1}^k$		0.02 (1.10)	0.02 (1.03)		0.03 (1.25)	0.03 (1.19)		0.08 (2.19)	0.08 (2.19)
$hpr_{1990}^k \times CAPFLOW_t$			-0.10 (-0.51)			-0.53 (-0.83)			0.03 (1.33)
$\Delta pop_{t,k}$	0.25 (1.05)	0.25 (1.02)	0.24 (1.01)	0.27 (1.08)	0.26 (1.05)	0.26 (1.05)	0.28 (0.89)	0.26 (0.83)	0.26 (0.83)
$R^2$	0.82	0.82	0.82	0.82	0.82	0.82	0.92	0.92	0.92

The Table shows the results from the panel regression  $\Delta housevaluation_t^k = \alpha \times open^k \times CAPFLOW_t + Controls + \tau_t + \delta_k + \epsilon_{k,t}$ .  $open^k = Year1995 - Year of Interstate Banking Deregulation$ .  $CAPFLOW_t$  is represented by alternative measures of capital inflows, which vary from column I to III. In columns 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 ( $nx_a$ ) as constructed by Gourinchas and Rey (2007).  $nx_a$  is available only till the fourth quarter of 2003. 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, $\Delta hpy_t^k$					
	I	II	III	IV	V	VI
	total banking claims	net banking holdings	gross banking holdings	Measure of $BANKFLOW$ is changes in claims	changes in net banking holdings	changes in gross banking holdings
$open^k \times CAPFLOW_t$		0.07 (2.89)	0.10 (2.90)	0.06 (2.52)	0.07 (2.89)	0.06 (2.34)
$open^k \times BANKFLOW_t$	0.06 (0.96)	0.33 (1.66)	-0.09 (-1.55)	1.18 (1.81)	0.03 (0.03)	0.75 (2.45)
Controls	yes	yes	yes	yes	yes	yes
$R^2$	0.64	0.64	0.64	0.64	0.64	0.64

The Table shows the results from the panel regression  $\Delta housevaluation_t^k = \alpha \times open^k \times CAPFLOW_t + \alpha_{BG} \times open^k \times BANKFLOW_t + Controls + \tau_t + \delta_k + \epsilon_{k,t}$ ,  $open^k = Years^{sinceInterD} = 1995 - Year\ of\ Interstate\ Banking\ Deregulation$ . Capital inflows  $CAPFLOW_t$  are measured as current account deficit over GDP ( $CAPFLOW_t = -\frac{CA}{GDP_t}$ ). The various measures of banking flows,  $BANKGLUT_t$  are defined at in the column headings. The coefficient  $\alpha_{BG}$  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  $\Delta pop_t$  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 5: Capital inflows and credit supply conditions — horse race

Panel A: dependent variable is change in logarithmic house price—income ratio, $\Delta hpy_t^k$												
	I		II		III		IV		V		VI	
$open^k \times CAPFLOW_t$	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)
$open^k \times short\ rate_t$	-0.00	-0.00									-0.02	-0.01
	(-0.56)	(-0.45)									(-0.71)	(-0.48)
$open^k \times Taylor\ residual_t$			-0.00	-0.00							0.02	0.01
			(-0.68)	(-0.23)							(1.20)	(1.02)
$open^k \times long\ rate_t$					-0.00	-0.01					-0.02	-0.02
					(-0.25)	(-1.18)					(-2.14)	(-2.41)
$open^k \times senior\ officer\ survey_t$							-0.00	-0.00			-0.00	-0.00
							(-1.59)	(-1.42)			(-1.80)	(-1.20)
$open^k \times corporate\ spread_t$									-0.07	-0.04	-0.09	-0.08
									(-2.08)	(-1.64)	(-3.26)	(-2.90)
<i>Controls</i>	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, $\Delta hpr_t^k$												
	I		II		III		IV		V		VI	
$open^k \times CAPFLOW_t$	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)
$open^k \times short\ rate_t$	-0.01	-0.01									-0.01	-0.01
	(-0.42)	(-0.43)									(-0.18)	(-0.19)
$open^k \times Taylor\ residual_t$			-0.01	-0.01							0.01	0.01
			(-1.06)	(-1.03)							(0.21)	(0.22)
$open^k \times long\ rate_t$					0.04	0.04					-0.02	-0.02
					(1.53)	(1.50)					(-0.63)	(-0.62)
$open^k \times loan\ officer\ survey_t$							-0.01	-0.01			0.00	0.00
							(-2.10)	(-2.05)			(0.18)	(0.22)
$open^k \times default\ spread_t$									-0.31	-0.30	-0.38	-0.38
									(-2.33)	(-2.28)	(-2.23)	(-2.20)
<i>Controls</i>	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  $\Delta housevaluation_t^k = \alpha \times open^k \times CAPFLOW_t + \alpha_{MP} \times open^k \times CC_t + Controls + \tau_t + \delta_k + \epsilon_{k,t}$ .  $open^k = 1995 - Year\ of\ Interstate\ Banking\ Deregulation$ . Capital inflows,  $CAPFLOW_t$ , are measured as current account deficit over GDP ( $CAPFLOW_t = -\frac{CA}{GDP_t}$ ). 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  $\Delta pop_t$  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: House Prices, Financial Openness and Capital Inflows — state-pair results

Panel A: dependent variable is change in logarithmic house price—income ratio, $\Delta hpy_t^k$					
	I	II	III	IV	V
$open^k \times CAPFLOW_t$	0.12 (4.14)	0.12 (4.21)	0.07 (2.90)	0.07 (3.21)	0.07 (3.18)
$\Delta hpy_{t-1}^k$			0.38 (10.07)	0.38 (10.07)	0.38 (10.07)
$hpy_{t-1}^k$				-0.01 (-2.09)	
$hpy_{1990}^k \times CAPFLOW_t$					0.08 (0.23)
$\Delta pop_{t,k}$		0.95 (11.31)	0.94 (11.86)	0.93 (11.73)	0.94 (11.84)
$R^2$	0.07	0.16	0.30	0.30	0.30
Panel B: dependent variable is change in logarithmic house price—rent ratio, $\Delta hpr_t^k$					
	I	II	III	IV	V
$open^k \times CAPFLOW_t$	0.26 (2.89)	0.26 (2.88)	0.25 (2.77)	0.17 (2.05)	0.25 (2.31)
$\Delta hpr_{t-1}^k$			0.03 (1.39)	0.01 (0.12)	0.03 (1.39)
$hpr_{t,k-1}$				0.05 (0.85)	
$hpr_{1990}^k \times CAPFLOW_t$					-0.05 (-0.05)
$\Delta pop_{t,k}$		0.25 (0.76)	0.24 (0.74)	0.33 (1.25)	0.24 (0.75)
$R^2$	0.02	0.02	0.02	0.04	0.02

The Table shows the results from the panel regression  $\Delta housevaluation_t^k - \Delta housevaluation_t^i = \alpha \times (open^k - open^i) \times CAPFLOW_t + Controls + \tau_t + \delta_{k,i} + \epsilon_{k,i,t}$  for state-pairs  $k, i$ .  $open^k = Years^{sinceInterD} = 1995 - Year\ of\ Interstate\ Banking\ Deregulation$  Capital inflows  $CAPFLOW_t$  are measured as current account deficit over GDP ( $CAPFLOW_t = -\frac{CA}{GDP_t}$ ). Data are quarterly for the period 1991-2012 and 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 are based on standard errors clustered by time and state pair.



Table 7: State-pair results for alternative capital inflow measures

Dependent variable is change in logarithmic house price—income ratio, $\Delta hpy_t^k$			
	I	II	III
	net foreign holdings of US assets	net foreign holdings of US safe assets	gross banking holdings
$(open^k - open^i) \times CAPFLOW_t$	0.02 (2.79) no	0.03 (1.81) no	0.00 (0.49) no
Controls	yes	yes	yes
$R^2$	0.30	0.29	0.29

The Table shows the results from the state-pair panel regression

$$\Delta hpy_t^k - \Delta hpy_t^i = \alpha \times (open^k - open^i) \times CAPFLOW_t + Controls + \tau_t + \delta_{k,i} + \epsilon_{k,i,t}$$

where  $CAPFLOW_t$  is represented by different measure of capital inflows as indicated in the column headings: net foreign holdings of US assets (column I), net foreign holding of US safe assets (government bonds and securities issued by government-sponsored enterprises), and gross banking holdings (column III). Data are quarterly, 1991-2012 for 47 US States (Alaska, Hawaii, Delaware and District of Columbia are left out). Controls include population growth  $\Delta pop_t$  and a lag of left hand-side variable. All regressions estimated by OLS including time and state-pair fixed effects, t-statistics in parentheses, standard errors are clustered by time and state-pair.

Table 8: *de facto* Financial Openness and Capital Inflows

	Panel A: dependent variable is change in logarithmic house price—income ratio, $\Delta \ln p y_t^k$			
	I	II	III	IV
	interstate asset ratio	interstate lending ratio	$\frac{1}{HHI}$	number of states
$open_{defacto}^k \times CAPFLOW_t$	0.73 (1.32)	0.59 (1.70)	0.45 (1.89)	3.29 (2.78)
Controls	no	yes	yes	no
$R^2$	0.52	0.64	0.64	0.64
	Panel B: State-pair Results			
	I	II	III	IV
	interstate asset ratio	interstate lending ratio	$\frac{1}{HHI}$	number of states
$(open_{defacto}^k - open_{defacto}^i) \times CAPFLOW_t$	0.73 (1.81)	0.59 (2.09)	0.45 (2.01)	3.29 (3.39)
Controls	no	yes	yes	no
$R^2$	0.06	0.30	0.29	0.30

The Table shows the results from the panel regression  $\Delta \ln housevaluation_t^k = \alpha \times open_{defacto}^k \times CAPFLOW_t + Controls + \tau_i + \delta_k + \epsilon_{k,t}$ , the *InterstateLendRatio*<sup>k</sup> is defined as the 1980-1995 average of the share of mortgages issued by integrated banks for each state. Capital inflows *CAPFLOW*<sub>t</sub> are measured as current account deficit over GDP ( $CAPFLOW_t = -\frac{CA}{GDP_t}$ ). As additional control the regression in column IV is augmented by the baseline measure of openness  $open_t^k = Years^{sinceInterD} = 1995 - Year\ of\ Interstate\ Banking\ Deregulation$ . 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 9: Financial Openness, Capital Inflows and Interstate Branching

Panel A: Baseline Results				
	Dependent variable is house valuation based on ...			
	... house price—income ratio $\Delta hpy_t^k$		... house price—rent ratio $\Delta hpr_t^k$	
$IB_t^i$	0.01 (2.66)	0.00 (2.07)	0.01 (2.05)	0.01 (1.45)
$open^k \times CAPFLOW_t$		0.10 (3.09)		0.23 (2.40)
$R^2$	0.52	0.53	0.82	0.82
Panel B: State-pair Results				
$(IB_t^k - IB_t^i)$	0.01 (4.64)	0.00 (3.70)	0.01 (2.57)	0.01 (1.95)
$(open^k - open^i) \times CAPFLOW_t$		0.10 (3.47)		0.23 (2.72)
$R^2$	0.07	0.08	0.02	0.02
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 $IB_t^k = \alpha_0 + \alpha_1 open^k \times CAPFLOW_t + \epsilon_k$ $\alpha_1 = 4.70$ (4.08), $R^2 = 0.89$				

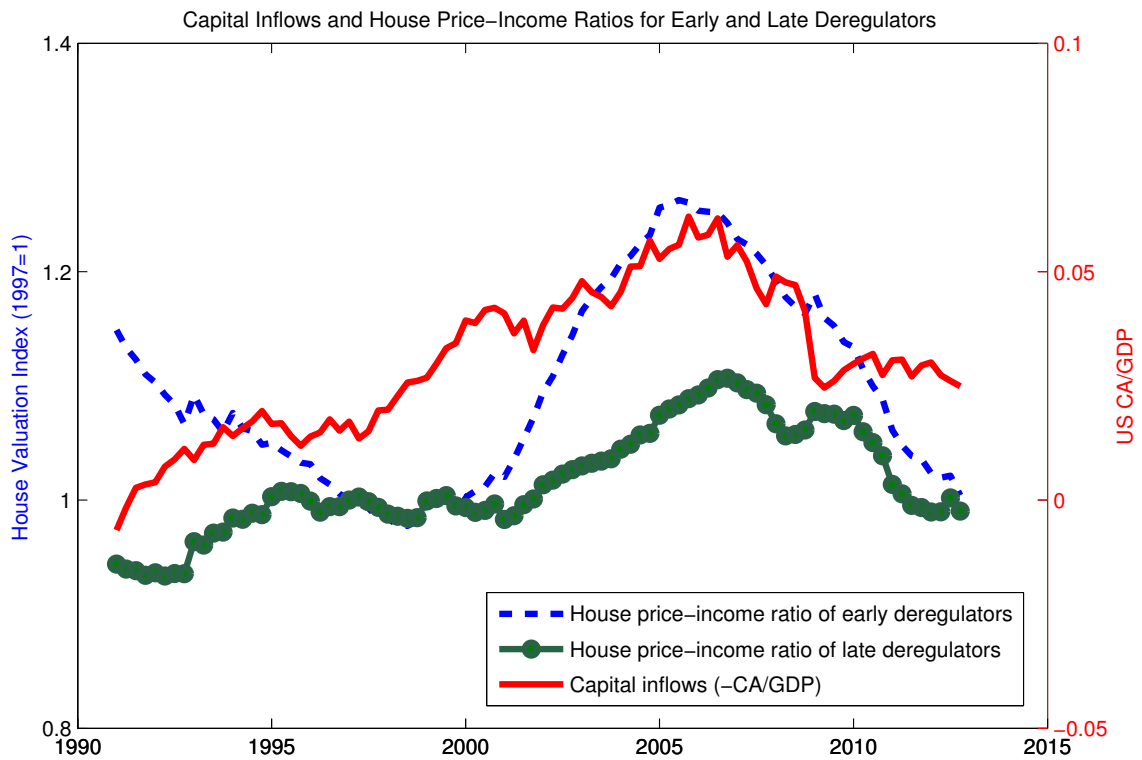
Results of the baseline regression with interstate branching as additional regressor. The index of interstate branching deregulation ( $IB_t^k$ ) ranges from 0 (no integration) to 1 (full integration).  $\overline{IB}_k = \frac{1}{T} \sum_{t=1}^T IB_t^k$  is an average of Sample period is 1991-2012,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

Table 10: Transmission Mechanism

$Z_t^k$	Panel A: Baseline Results																									
	I		II		III		IV		V		VI		VII		VIII		IX		X		XI		XII		XIII	
	total	integrated	lending growth	integrated	local	mortgage rates	integrated	local	mortgage rates	integrated	local	deposit rates	integrated	local	deposit rates	integrated	local	interest rate spread	integrated	local	deposits growth	integrated	local	market liabilities growth	integrated	local
$open^k \times CAPFLOW_t$	0.39 (2.44)	1.90 (2.28)	-0.19 (-0.34)	-0.11 (-1.64)	-0.03 (-0.36)	-0.07 (-2.53)	-0.07 (-3.29)	-0.30 (-1.95)	0.07 (1.38)	1.70 (2.38)	0.09 (0.28)	4.09 (2.06)	2.24 (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													
$(open^k - open^l) \times CAPFLOW_t$	0.38 (2.36)	1.91 (2.74)	-0.20 (-0.32)	-0.11 (-3.44)	-0.02 (-0.78)	-0.07 (-7.86)	-0.07 (-8.66)	-0.30 (-7.57)	0.07 (3.62)	1.70 (3.18)	0.11 (0.28)	4.09 (0.44)	2.24 (0.86)													
$R^2$	0.04	0.02	0.05	0.55	0.85	0.59	0.66	0.53	0.84	0.04	0.03	0.03	0.01													

For both local and integrated banks, the Table shows the results from the panel regression  $Z_t^k = \alpha \times open^k \times CAPFLOW_t + \tau_t + \delta_k + \epsilon_{k,t}$  in Panel A and  $Z_t^k - Z_t^l = \alpha \times (open^k - open^l) \times CAPFLOW_t + \tau_t + \delta_{ik} + \epsilon_{ik,t}$  in Panel B respectively. 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 Mexico, 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 / state-pair fixed effects, t-statistics in parentheses, standard errors are clustered by time and state / state-pair.

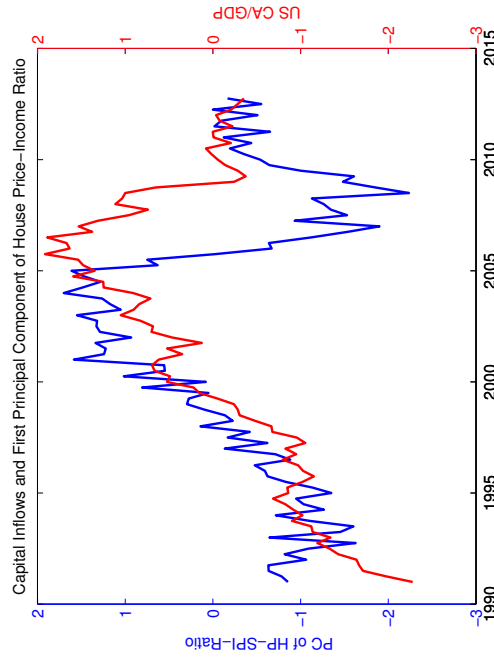
Figure 1: Capital Inflows and House Valuations, 1991-2012



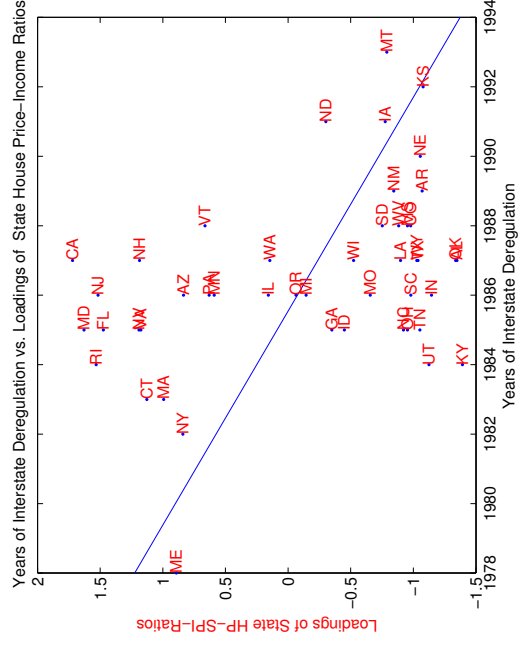
NOTES: The figure plot US current account to GDP ratio (red solid line) against average house price-income ratios for states that deregulated their interstate banking before 1985 (blue dashed line) and states that deregulated after 1987 (blue dot-dashed line).

Figure 2: First Principal Component Analysis of State House Valuations

Panel A



Panel B



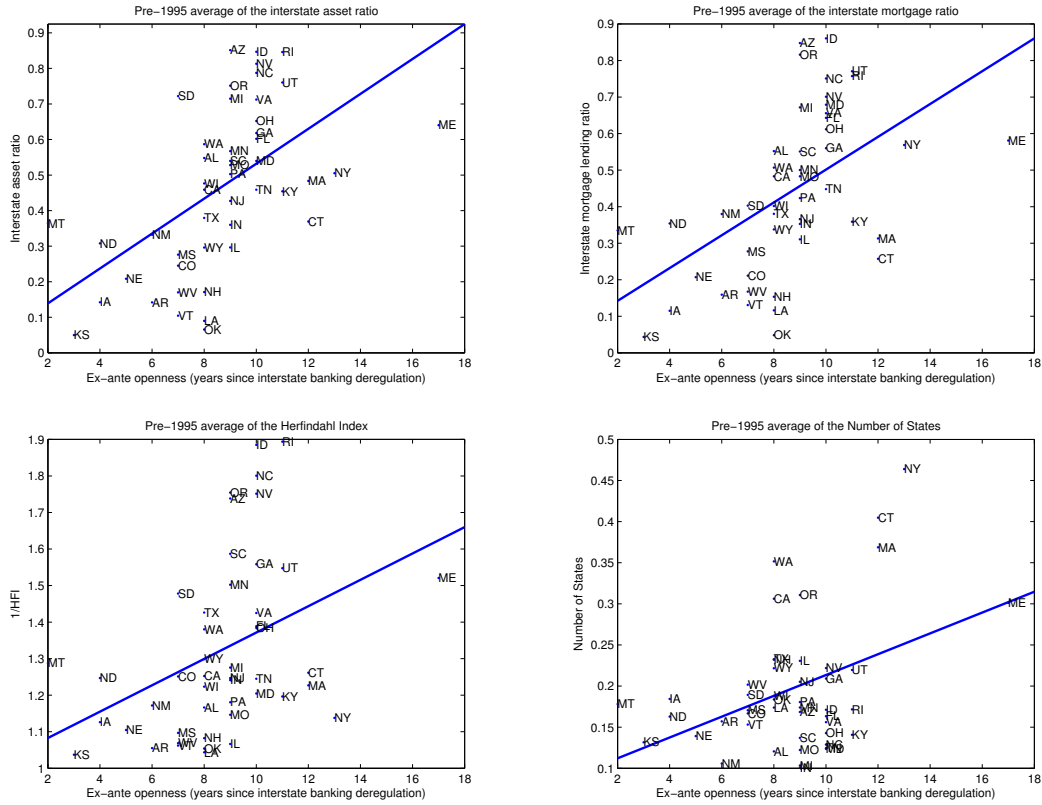
NOTES: The figure plots US current account to GDP ratio (red line) against first principal component extracted from the time series of state level ratios of housing prices to personal income (blue line). Both variables are normalized to standard deviation of unity.

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

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

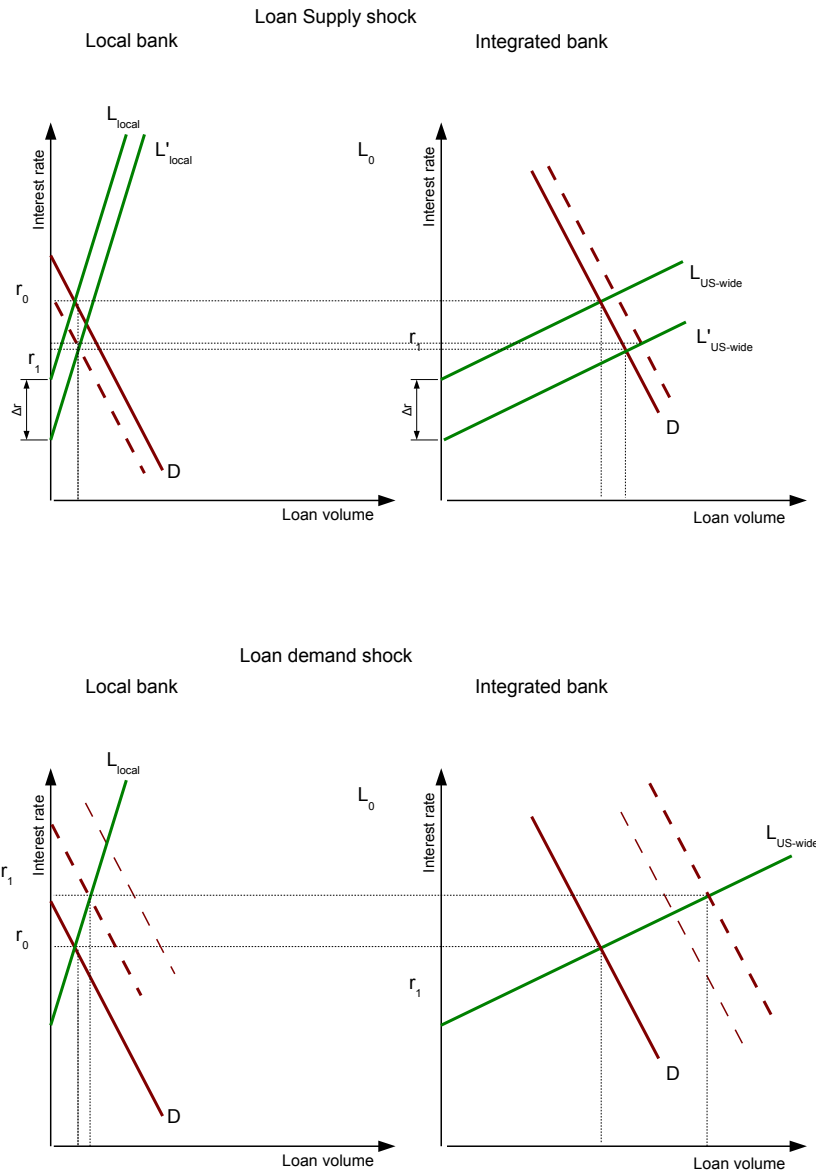
yields a coefficient estimate of  $b = -1.09$ , a t-statistics of 3.11.

Figure 3: *Ex-ante* and *defacto* 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 baseline measure,  $open_{defacto}^k = \beta years^k + constant + \epsilon^k$ , 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)  $R^2=0.17$  .

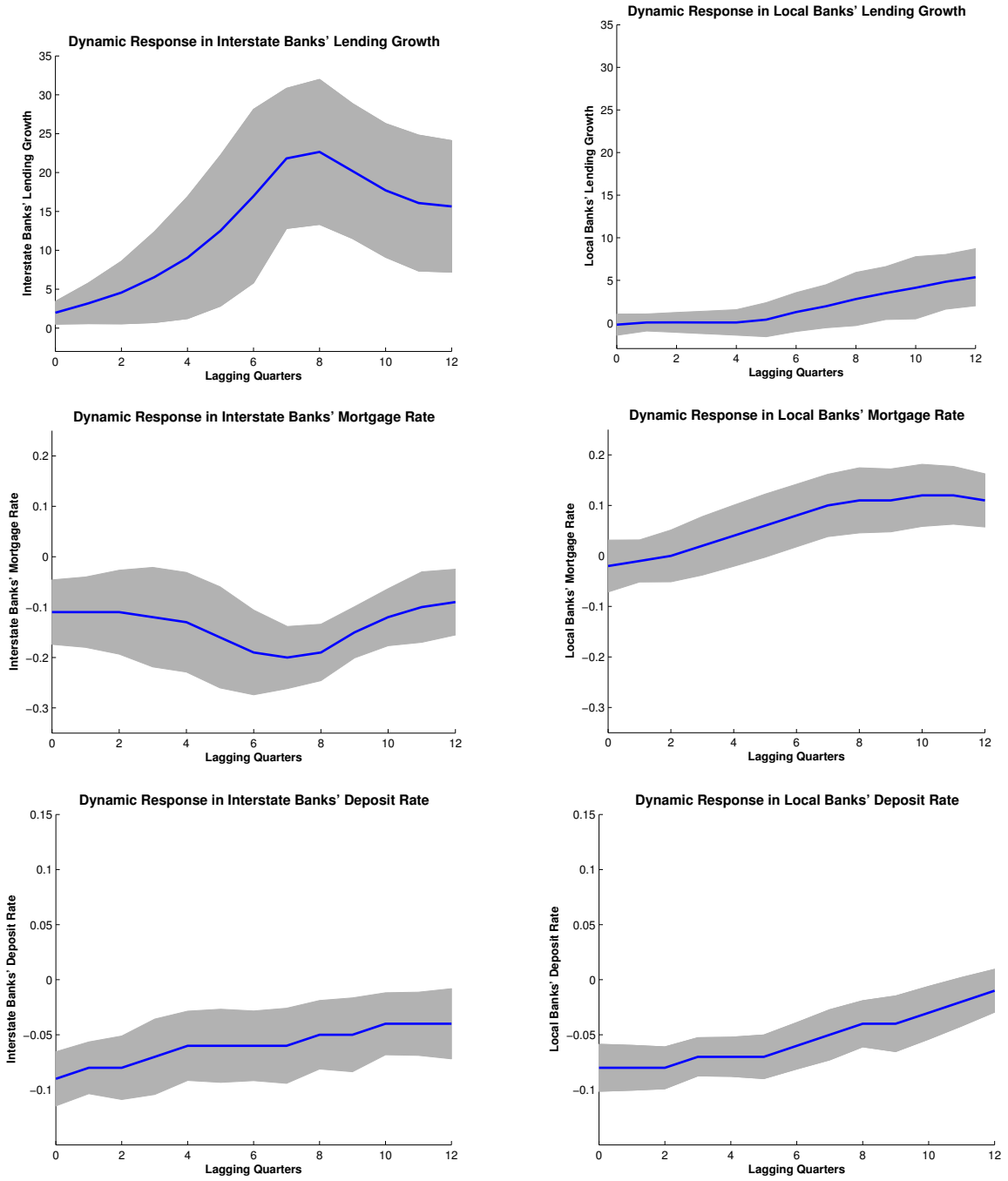
Figure 4: A stylized model of state-level bank lending



NOTES: The figure illustrates the case of loan supply (above) and demand (below) shock that hits local bank (on the left) and integrated bank (on the right). The supply curve of integrated bank is flatter than the one faced by the local bank because integrated bank has a higher elasticity of loan supply with respect to interest rate. A loan supply shock – represented by a drop in refinancing cost  $\Delta r$  – increases lending and lowers interest rate of the integrated bank. The effect on lending and interest rate of local bank is very small or even negligible. A positive demand shock increases lending and interest rate of both integrated and local banks (thin dashed demand curve). Interest rate increase is much higher for the local bank (due to the lower supply elasticity) which forces local banks' customers to move away towards integrated banks. This in turn increases gradually interest rate of the integrated bank and decreases interest rate of the local bank.



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  $\alpha_k$  of a regression of the form

$$x_{t+k}^{ij} = \alpha_k(\text{open}^i - \text{open}^j) \times CA_t + \mu_{ij} + \tau_t + \varepsilon_t^{ij}$$

on state pairs where  $x_{t+k}^{ij}$  is the  $k$ -period ahead interest/deposit rate difference between state  $i$  and  $j$  or the cumulated lending growth between these states between period  $t$  and  $t+k$ .