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Household Debt and House Prices-at-risk: A Tale of Two Countries

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Abstract

To identify and quantify downside risks to housing markets, we apply the house price-at-risk methodology to a sample of 37 cities across the United States and Canada using quarterly data from 1983 to 2018. This paper finds that downside risks to housing markets in the United States have seemingly fallen over the past decade, while having increased in Canada. Supply-side drivers, valuation, household debt, and financial conditions jointly play a key role in forecasting house price risks. In addition, capital flows are found to be significantly associated with future downside risks to major housing markets, but the net effect depends on the type of flows and varies across cities and forecast horizons. Using micro-level data, we identify households vulnerable to potential housing shocks and assess the riskiness of household debt.

JEL Classification Numbers: G1; G12; E37; R31

Keywords: Housing; Household Indebtedness; United States; Canada; Quantile Regressions

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I. INTRODUCTION

House prices play a major role in assessing financial stability and monitoring systemic risk. A sharp deterioration of housing markets can have severe adverse effects on household balance sheets, business confidence, and on banks' ability to lend. These effects can spill over across borders due to increasingly synchronized housing cycles. The collapse of the U.S. housing market in 2008 sent the global economy into a lasting period of financial turbulence, leading to the largest crisis since the Great Depression. Examining current economic conditions can help identify risks associated with house prices and the underlying drivers of these tail risks.

There is a wide literature examining the relationship between housing markets and household wealth, as well as its impact on the business cycle. A decrease in house prices coincides with a decrease in household's perceived wealth and, in turn, is followed by a decline in consumption (Campbell and Cocco, 2005; Mian and Sufi, 2016). Moreover, high household debt hinders the ability of households to combat exogenous shocks such as a sudden increase in interest rates or a loss in income, which would ultimately be reflected in a decline in private consumption during an economic downturn. Thus, it is necessary to identify the main drivers and tail risks to house prices in order to prepare for potential vulnerabilities to household wealth.

Numerous academic studies have found that house price valuation is linked to a variety of macroeconomic and structural factors. House prices are found to be highly correlated with supply factors and real interest rates (Agnello and Schuknecht, 2011; Grimes and Aitken, 2010). Furthermore, macroprudential and monetary policy measures are important drivers of house prices through various transmission channels such as credit availability, housing demand, and balance sheet effects. Rental yields, capital flows, household income and leverage each have an additional influence on housing valuation (Capozza et al., 2002; Duca, Muellbauer and Murphy, 2011).

Along with influencing house price valuations, household debt has significant economy-wide implications. Housing markets in highly leveraged areas appear to be more vulnerable to income shocks (Lamont and Stein, 1999). Excessive levels of household debt also negatively impact future GDP growth in the medium and long term, primarily due to debt overhang effects (Mian, Sufi, and Verner, 2017). Residential real estate makes up a notable portion of household wealth, which in turn makes household wealth vulnerable to the volatility of house prices. A sharp and unexpected decrease in house prices impacts household's ability to borrow and consume through wealth and collateral effects. In addition to lower output growth, household debt is associated with an increase in unemployment and a greater probability of banking crises (Mian, Sufi, Verner, 2017; Jorda, Schularick, and Taylor, 2016).

To further deepen our understanding, we take a closer look at house prices in major metropolitan areas and overall household indebtedness in the U.S. and Canada. The main questions addressed in this paper are: (1) How do previously identified drivers help measure downside risks to future house price growth? (2) How do downside house price risks vary across countries and cities? (3) What is the role of indicators such as overvaluation, financial conditions, and capital inflows on house price risks? (4) What role does household indebtedness play in influencing house price risks? (5) How did household debt in the U.S. and Canada evolve over time and which types of households are more vulnerable to shocks?

We dissect these questions by analyzing future downside risks to housing markets across a wide range of cities in the U.S. and Canada building on the methodology developed by Adrian, Boyarchenko and Giannone (2019) and Deghi et al. (2020). The sample includes quarterly data from 37 cities in Canada and the U.S. between 1983 to 2018.[2] In the first stage, quantile regressions are estimated for each city to model the nonlinear relationship between various city- and country-level indicators and housing market vulnerabilities. This allows us to capture the contribution of specific variables at different parts of the forecast distribution. In the second stage, a skewed-t distribution is fit using the predicted values for each quantile obtained in the first stage. The left tail of the fitted distribution, or the lower fifth percentile is considered the house prices-at-risk for any given city.

Housing markets vary substantially across cities, as highlighted and corroborated in several studies. At the aggregate level, housing valuation in the U.S. has remained relatively stable around the long-term average since 2013, while in Canada it was about 30 percent overvalued as of 2018Q3 (Figure 1.1, 1.2). While country-level analysis gives an adequate overview of the overall state of the housing markets in a particular economy, it is unable to capture the vast idiosyncrasies of each individual housing market within that economy.

A key contribution of this paper lies in the granularity of the city-level house prices-at-risk analysis. To pinpoint any disparities between city-level house price risks, we estimate each city univariately. This enables us to measure the distinct sensitives of each city's housing market to different drivers of risk, allowing us to identify the effects of certain risk factors which may be obscured at the aggregate level. To truly grasp the level of house prices-at-risk, it is imperative to consider endogenous factors that vary at the city-level to account for fundamental differences between housing markets.

A second contribution of this paper is the micro-level analysis of household debt in the U.S. and Canada. Household survey data is used to gauge the level of debt held by financially weak households. This further strengthens the analysis of housing market risks because in addition to quantifying the factors associated with inflated house price risks, a micro-level evaluation provides insights into potential amplification effects should house prices fall. This could be particularly relevant for policymakers considering that a sharp decline in house prices is likely to be more disruptive if the level of debt held by financially fragile households is elevated.

Our main findings are threefold. First, downside risks to house prices in the U.S. appear to have declined over the past decade, while having increased in Canada. Compared to historical levels, the U.S. is significantly better off than prior and during the GFC, while Canada is approaching GFC-level risks, indicative of increasing vulnerabilities. These findings are supported by both the economy-wide and city-level analyses. Second, house price risks and their determinants vary depending on the horizon. In the short term, tighter financial conditions are detrimental to house price risks, while the effect is dampened in the long term. Similarly, household leverage is associated with ameliorating short-term house price risks, while exacerbating them in the long

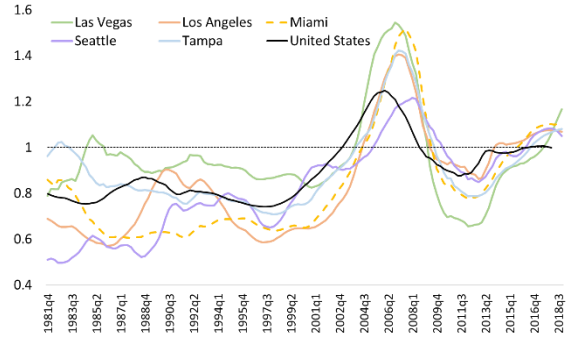
[2] For a complete list of cities see Table 1.

term.[3] Capital flows are also significantly associated with future downside risks to key residential housing markets, though the net effect varies by city depending on the types of flows and the horizon.[4] Interestingly, the sensitivity of housing market's future downside risks to capital flows is found to be correlated with city's foreign openness (i.e. the immigration population). Furthermore, city-specific valuation and supply factors are found to be influential determinants of downside risks to housing markets. Finally, given the influence of household debt on house price risks, we examine household balance sheets in the U.S. and Canada using survey data. On the one hand, the overall share of U.S. household debt-to-GDP has decreased in recent years along with a contraction in risky debt, suggesting a lesser degree of over-indebtedness. On the other hand, Canadian households have become more leveraged, coinciding with an increase in the share of risky debt thereby indicating increased vulnerabilities of the household sector.

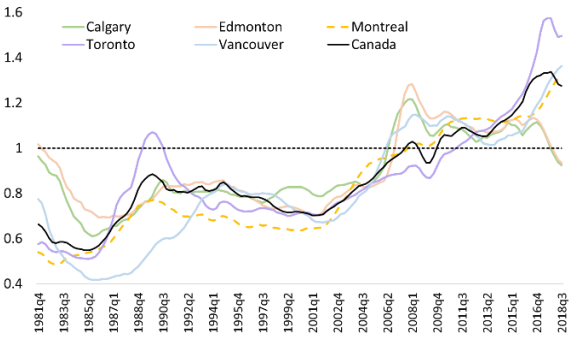
[3] Throughout this paper, short- and long-term refers to 4 and 12 quarters ahead, respectively.
[4] In the context of this paper, the term "capital flows" refers to capital inflows. Further details are available in the subsequent data section.

Figure 1. Overview of Macroeconomic Conditions in the United States and Canada

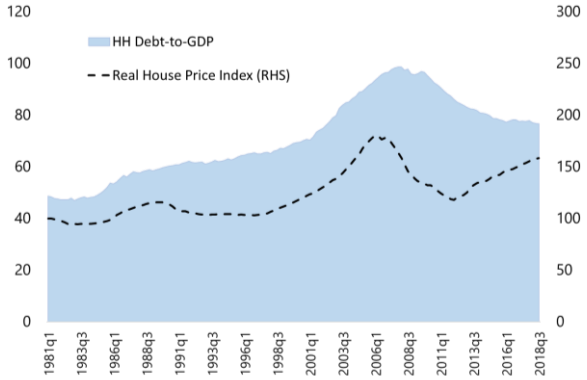
1. House Price-to-Income Ratio in the US
(Standardized to long-term average)



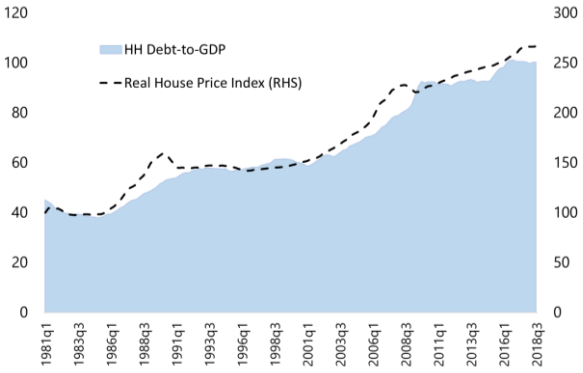
2. House Price-to-Income Ratio in Canada
(Standardized to long-term average)



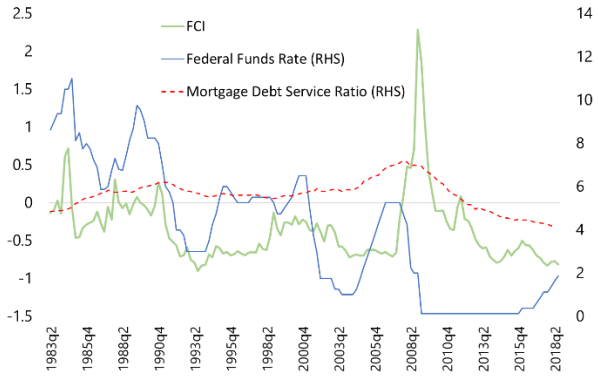
3. Household Debt-to-GDP Ratio and House Prices in the US



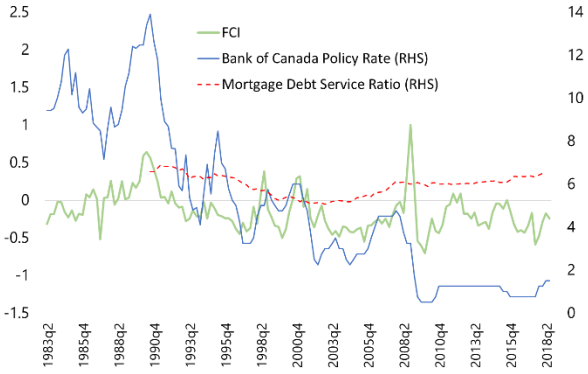
4. Household Debt-to-GDP Ratio and House Prices in Canada



5. Financial Conditions and Mortgage Debt Service in the US



6. Financial Conditions and Mortgage Debt Service in Canada



Source: BIS; Statistics Canada; Bank of Canada; FRED; IMF staff calculations.

Note: In panels 1 and 2, house price-to-income ratios are standardized by the average house price-to-income ratio over 2000q1 to 2018q3.

II. CONCEPTUAL FRAMEWORK

The extensive literature regarding housing markets is supported by theoretical foundations which underpin the effects on house prices of various factors such as financial conditions, household balance sheets, housing supply, capital flows, speculation, and various demographic elements.

A. Financial Conditions

Financial conditions have a complex transmission mechanism to housing market fluctuations through multiple channels. There is extensive empirical literature associating financial conditions with economic growth.[5] For instance, an increase in excess bond premia of corporates could lead to a contraction in credit supply, adversely impacting the macroeconomy (Gilchrist and Zakrajšek, 2012). Empirical work by Philippon (2009) highlights the ability of corporate bond credit spreads to predict economic activity such as fixed investment. More generally, Adrian, Boyarchenko, and Giannone (2019) analyze the impact of financial conditions on the distribution of GDP growth and find that downside risks to GDP growth increase as financial conditions tighten, specifically in the short-term horizon.[6] The impact of financial conditions on economic growth has significant implications for the macroeconomy. An economy-wide downturn would indicate a decline in employment and a subsequent decrease in household income. Various studies find correlation between household income and house price fluctuations (Capozza et al., 2002). In particular, Ortalo-Magne and Rady (2005) find household income to be a powerful driver of the housing market, asserting that income strongly influences younger households' ability to afford the down payment on a starter home and in turn, impacts house prices. Furthermore, financial conditions also transmit to house prices through the leverage channel, given the impact of household debt on house prices which will be further explored in this paper.

B. Household Debt

There is an abundance of empirical research studying the implications of household debt. More specifically, several studies document the influence of household debt on consumption, net wealth and GDP growth (Graham, 2018; Caceres, 2019).[7] Mian, Sufi, and Verner (2017) provide evidence of the impact of household debt on future GDP growth using a sample of 30 countries, partially attributing this impact to the influence of debt overhang on household consumption. This finding is later confirmed by Alter, Feng, and Valckx (2018) using a larger sample of 80 countries. Further testing the impact of debt on consumption and wealth, Mian, Rao and Sufi (2013) find that an economy wide shock has a more severe impact on areas with highly leveraged, poorer households due to the heterogeneity in household's marginal propensity to consume across income groups. Furthermore, excessive household debt may weaken the

[5] Laurent (1988) finds that the spread between long-term government bond rates and the federal funds policy rate is accurately able to forecast future changes in real income. Campbell et al. (2001) find that the elevated stock return volatility can predict output contraction in the short term.

[6] Relatedly, Adrian et al. (2018) measure the term structure of Growth at Risk and find that the impact of financial conditions on GDP growth varies contingent on the horizon. Looser financial conditions increase GDP growth in the short term while negatively impacting GDP growth in the long term.

[7] Real estate wealth is found to be closely linked to consumption (Annex Figure 1).

effectiveness of monetary policy in mitigating the side-effects of economic downturns (Sufi, 2015). Households that are highly indebted are unable to change their spending habits in response to an adjustment in monetary policy. However, some studies find that, though household consumption responsiveness to monetary policy shifts has diminished since the GFC, highly indebted households are more sensitive to monetary policy shocks than households with less debt (Gelos et al., 2019). The transmission of household debt to house price fluctuations is synonymous to the influence of financial conditions on house prices.[8] An increase in the level of household debt negatively impacts subsequent GDP growth which in turn impacts employment and income, as previously stated. Through these channels, household debt influences housing markets.

Following the GFC, there has been a renewed interest in the riskiness of household debt. There have been various theories put forth to understand exactly how the housing market boom and bust in the years leading up to the GFC became so devastating. Jones, Midrigan, and Philippon (2018) evaluate the role of credit constraints during the GFC by imposing liquidity constraints to restrict households' wealth and find that credit limitations were more influential at the state-level than the country-level. A common theory linking household debt to the onset of the GFC is the subprime view, claiming that low lending standards led to an increase in the level of credit provided to poor quality borrowers through distortions in underwriting (Parlour and Plantin, 2008; Dang et al., 2010). However, Bhutta (2015) challenges this view, finding that housing market capital inflows from real estate investors experienced significantly more growth than inflows from first-time homebuyers with low credit scores, indicating that debt from subprime borrowers may not have had that large of a contribution to the GFC as previously thought. Furthermore, many studies link the severity of the GFC to speculation rather than subprime lending, finding that house price fluctuations are correlated with backwards-looking expectations of home buyers because market participants may view homes in booming markets as investments (Case and Shiller 1988, 1989; Shiller, 1990; Capozza and Seguin, 1996).

C. Capital Flows

The intense boom-bust cycle in house prices over the last two decades coinciding with dramatic fluctuations in capital inflows has led to many theories about the relationship between foreign demand and house prices, though the relationship, whether it is causal or distinct has been the subject of much debate among economists. The Global Savings Glut hypothesis attributes global imbalances such as high savings rates in emerging markets mixed with the U.S. current account deficit to the increased level of capital inflows into the U.S. beginning in 2003, which in turn, lowered U.S. long-term interest rates below expectations, contributing to the overvaluation of asset pricing including housing markets (Bernanke, 2005; Mendoza, Quadrini, and Rios-Rull, 2007; Sa and Wieladek, 2015). Various empirical studies have corroborated this hypothesis, claiming that the excess savings in emerging market economies made the safety and quality of U.S. assets more attractive to investors, lowering interest rates and driving up house prices (Himmelberg, Mater, and Sinai, 2005; Caballero, Fahri, and Gourinchas, 2008). Similarly, Badarinza and Ramadorai (2018) use historical housing transactions to show that foreign demand

[8] In a cross-country study, IMF (2019a) finds that credit booms are strongly related to negative house price corrections in both advanced and emerging economies.

has played an important role in housing valuation in London over the past few decades, perhaps reflecting the predilection for safe assets. Recent studies from Li, Shen, and Zhang (2019) and Ari, Puy, and Shi (forthcoming) both find that foreign investment purchases of real estate increase local house prices significantly. This in turn distorts equilibrium prices, affecting affordability and potentially leading to overvaluation. Adam, Kuang, and Marcet (2011) use an asset pricing model to directly link low interest rates, driven in part by capital inflows, to housing booms. Sa, Towbin and Wieladek (2014) assert that shocks to capital inflows are associated with house price fluctuations, particularly in economies with developed mortgage credit markets. Contrasting this view, Favilukis et al. (2012) use a general equilibrium model on a dataset of credit standards, capital flows, and U.S. interest rates from 1994 to 2010 to argue that international capital flows had a minimal role in driving house prices in the U.S., and instead attribute housing market fluctuations to financial market liberalization.

D. Other Key Indicators

Other studies point to the role of housing supply and housing valuation as being important indicators of housing market conditions (Capozza et al., 2002; Turk, 2015). Gattini and Hieber (2010) use housing supply measures to forecast housing market developments in the Euro Area, finding that housing supply measures including residential investment and real interest rates are correlated with house price swings. Various studies use overvaluation metrics to understand the house price cycle and gauge how risky a housing market may be (Dokko et al., 2014; Fernandez Kranz and Hon, 2006). Housing overvaluation is a good indicator of housing market risk as it may signal how a potential housing bust may morph into systemic risk, as seen during the GFC. Valuation also serves as a proxy for demand, given that the demand for housing is a function of both house prices and household income. Additionally, demographics are found to influence long-term dynamics of house prices (Girouard et al., 2006; Lin et al., 2018).[9]

III. Stylized Facts

Historically, household debt and house prices have moved in tandem, although the relationship has weakened in the U.S. over the past few years (Figure 1.3, 1.4). In the U.S., household debt has remained generally stable following the GFC, while house prices have steadily recovered since the great housing bust. In contrast, for the past few decades the real house price index in Canada has been continuously increasing along with household debt relative to GDP. However, the household debt-to-GDP ratio leveled off over 2016 to 2018, indicating that household indebtedness may have peaked. Household debt in Canada was about 98 percent of GDP at end-2018, compared to 80 percent of GDP in the U.S. (Figure 1.3, 1.4).[10] Mortgage debt makes up about 65 percent of total household debt in Canada compared to about 70 percent of total debt in the U.S. as of 2019 (Annex Figure 1.3, 1.4). Other types of consumer debt such as home equity loans could be directly linked to the housing market as well. In fact, home equity loans in

[9] Demographic factors, including urbanization and population growth are both found to be positively associated with house prices. These demographic factors influence housing demand, thereby influencing house prices.

[10] High house prices in major Canadian cities like Toronto and Vancouver have contributed to the record high household debt levels, as households acquire more debt to afford housing (IMF, 2019c). In estimating the downside risks to house prices, we account for many other relevant factors such as household debt, housing investment, capital flows, and financial conditions.

Canada stood at $173 billion in 2018Q4, about 10 percent of household debt.[11] As households borrow against their home value, they become increasingly vulnerable to unexpected shifts in house prices.

Country-level valuation in the U.S., proxied by the house price-to-income ratio, has remained stable since 2013. Cities that were particularly overvalued before the GFC like Miami, Las Vegas, Los Angeles and Tampa seemed to be more prone to large declines during the bust (Figure 1.1). In 2018, U.S. house prices appear to be less overvalued, relative to the long-term average. In contrast, the long-term trend in Canada's house prices points to about 30 percent overvaluation. However, the aggregate house price-to-income ratio has declined in 2017-2018, though this trend varies across Canadian cities. Major Canadian cities are found to be significantly overvalued compared to the long-term average. In 2018, Toronto appeared to be about one and a half times overvalued relative to the long-term average, while house prices in Vancouver were about 40 percent overvalued (Figure 1.2). While some Canadian housing market fluctuations can be explained by household income and mortgage rate dynamics, the evolution of the housing markets in Hamilton, Toronto and Vancouver are found to have risen beyond values supported by economic fundamentals (Andrle and Plasil, 2019).

At the same time, overall financial conditions (proxied by the FCI) have remained loose for the past decade, allowing a buildup of debt and potential vulnerabilities. In the U.S., the Federal Reserve has deployed a substantial package of unconventional monetary policies in the aftermath of the GFC. Short-term interest rates were brought close to zero in 2008 and kept low for a protracted period, along with a series of large-scale asset purchases including treasuries and mortgage-backed securities (Figure 1.5). The Fed started tapering quantitative easing and normalizing monetary policy in 2014, scaling back its bond-buying program. At its peak, the balance sheet of the Federal Reserve reached $4.5 trillion.

Similarly, the Bank of Canada has swiftly lowered interest rates in 2008-09 and kept them close to the zero-lower bound, before tightening them in 2017-18 (Figure 1.6). Contrasting the Fed, the Bank of Canada abstained from deploying unconventional policy tools. Instead, the Bank focused on maintaining an efficient inflation-targeting regime throughout the crisis and managing spillover effects from U.S. monetary policy. Additionally, in 2008 Canadian authorities began refining their macroprudential policy stance through six rounds of tightening mortgage insurance rules to address household over-indebtedness and house price imbalances. These include policies targeting lending standards such as loan-to-value limitations, credit score requirements and amortization limits.[12] In addition, demand-side measures such as property-related taxes were enacted to target housing affordability issues. For instance, buyer stamp

[11] Bank of Canada (2017) highlights the market trends and potential vulnerabilities in HELOCs (i.e., Home Equity Line of Credit), which are typically used for housing renovation, travelling, or repaying other types of debt such as credit cards. See also Al-Mqbali et al. (2019).

[12] Krznar and Morsink (2014) find mixed evidence supporting the effectiveness of the first three rounds of macroprudential policy tools in Canada. While mortgage credit growth was curbed, high household debt and elevated house prices remained. Similarly, Kuncl (2016) finds that, in some episodes, a macroprudential policy tightening is followed by a temporary increase in the growth rate of mortgage credit, while in the long run the growth rate declines. At the same time, the effects on first-time buyers' housing demand from tightening loan-to-value limits are found to be more powerful than those from debt-service ratio (see Allen et al., 2017).

duties, speculation and vacancy taxes were implemented by the provincial governments in British Columbia and Ontario in 2016-18.

As monetary and macroprudential policy tightens, mortgage financing becomes more expensive which could exacerbate household vulnerabilities, considering the sensitivity of household debt service to interest rates (Figure 1.5, 1.6). In Canada, most mortgages have a contractual maturity of five years, which suggests that the renewed interest rate on mortgages could be higher, stretching household balance sheets and increasing the already high level of indebtedness and debt service.[13] Total household debt in both the United States and Canada is primarily made up of mortgage debt, further signifying possible vulnerabilities as interest rates increase (Annex Figure 1).

IV. Data and Empirical Analysis

A. Data

U.S. house price indices are from the S&P/Case & Shiller Home Price Indices and the U.S. Federal Housing Finance Agency, while Canada house price indices are from Statistics Canada.[14] We obtain real house prices by adjusting the nominal house prices by the regional- and provincial-level CPI series for the U.S. and Canada, respectively. For the U.S. we use the National Financial Conditions Index from the Federal Reserve Bank of Chicago, which incorporates money market, credit supply, and shadow bank indicators into a financial conditions index. In Canada, a price-based financial conditions index is calculated based on IMF (2017) methodology. In addition to capturing monetary policy movements, financial condition indices adequately reflect macroprudential policy stances, given the transmission of lending standards and capital requirements to interest rates.[15]

In the U.S. housing valuation is the real house price over state-level real income, standardized by the long-term average.[16] In Canada housing valuation is derived by taking the ratio of the nominal house prices sourced from Real Property Solutions and Canadian Real Estate Association to nominal provincial level income and then standardized to the long-term average and smoothed by taking the moving sum of the previous four quarters. In the U.S. supply is proxied by housing starts, while in Canada the supply proxy is residential investment scaled by provincial GDP.[17] For both the U.S. and Canada, the capital inflows are from the IMF's BPM6

[13] IMF (2019b) suggests that household's debt service in Canada will increase by 0.4 percentage points to 15.3 percent of disposable income over the following year.
[14] The aggregate U.S. house price index is the S&P CoreLogic Case-Shiller Home Price Index, while the city-level indices are from the Federal Housing Finance Agency. City-level U.S. house prices encompass all transactions, while house price data for Canada refer to prices of new homes.
[15] Alam et al. (2019) use a comprehensive macroprudential policy database to gauge the effectiveness of macroprudential policy in combating systemic risks and confirm that loan-targeting instruments have a significant impact on household credit but weaker effects on house price movements.
[16] Rent indices were considered, however they were not available at the city-level for all cities during our sample period. Additionally, we compared our series to the OECD price-to-income series to ensure accuracy, though the house price-to-income series for the U.S. and Canada may not be directly comparable.
[17] City-level housing starts were not available for Canadian cities during the sample period.

dataset and represent net changes in liabilities, scaled by GDP.[18] To annualize and adjust for seasonality, we take the ratio of the average moving sum of the previous four quarters. Oil is the quarter-on-quarter change in the West Texas Intermediate crude oil price index. Household debt is the first difference in household debt-to-GDP from the BIS. More information about the variables, transformations, and sources is available in Table 2.[19]

The household sector debt analysis for the U.S. is based on representative household data from the Survey of Consumer Finances (SCF), and the analysis for Canada is based on representative household data from the Survey of Financial Security (SFS). Further details about the two datasets are available in Annex Table 7.

B. Empirical Approach

The city-level HaR analysis follows a two-stage approach as proposed by Adrian, Boyarchenko and Giannone (2019). In the first stage, a quantile regression model is estimated for each city. Specifically, for each city a quantile regression is run with future residential real house price growth as the dependent variable:

$$\Delta CityHP^{q}_{c,i,t+h} = \beta X_{c,i,t} + \delta Z_{c,t} + \gamma Oil_t + \phi FCI_{c,t} + \varepsilon_{c,i,t} \qquad (1)$$

where h is the forecast horizon (e.g., 4 quarters-, 12 quarters- ahead), q is the quantile (q=0.1, 0.25, 0.5, 0.75 and 0.9), and ε encompasses the error terms. City-level indicators are represented by $X_{c,i,t}$, which include an autoregressive term, house price-to-income ratio and a supply-side indicator, proxied by residential investment for Canada and housing starts in the United States. Endogeneity concerns are less relevant to this study given that the main purpose of this methodology is to forecast downside risks to house prices. The country-level variables represented by $Z_{c,t}$ include household debt, foreign direct investment, and other capital flows. OIL is the WTI oil price index. FCI is a country-specific financial conditions index.

In the second stage, a skewed-t distribution is fitted for each city house price series at each point in time. The distribution uses the predicted values for each quantile obtained in the first stage. In general, house prices-at-risk refer to the lower fifth percentile of the city-specific distribution for a given horizon using the fitted t-student parameters. The skewed-t distribution is derived by minimizing the distance between the quantiles estimated in the first stage and the skewed-t distribution quantiles:

$$\text{loc}^*, \text{scale}^*, \text{skew}^* = argmin \left[\sum_q tskew.quantile(q, loc, df^*, scale, skew) - Q\left[y^q_{t+h}\right]^2\right] \qquad (2)$$

[18] The IMF BPM6 dataset records transactions between residents and nonresidents that involve financial assets and liabilities.

[19] Additionally, summary statistics at the city- and country-level are available in Tables 3 and 4.

Where *tskew.quantile(q, loc, df, scale, skew)* represents the quantile *q* of the skewed-t distribution with the parameters (location, degrees of freedom, scale, skewness). A fitted t-skew CDF and PDF are derived from here, producing the 5 percent house prices-at-risk estimates.

V. EMPIRICAL FINDINGS

A. Through the Cycle

Across both U.S. and Canadian cities, downside risks to house prices have changed substantially over time, with U.S. housing markets generally being riskier.[20] The magnitude and volatility of the U.S. short-term housing market downside risks suggests that U.S. house prices are more susceptible to abrupt booms and busts than in Canada, which is especially evident during the GFC (Figures 2.1, 2.2). It appears that long-term housing market risks in Canada are much more severe than short-term housing market risks, while in the U.S. long- and short-term risks are generally consistent. (Figures 2.5 and 2.6).

Over the past two decades short-term downside risks to the U.S. housing market have seemed to improve, standing at about -1 percent (annualized) at end-2018Q3. In real terms, there is a 5 percent likelihood that house prices will experience a 1-percentage point decline over the following four quarters. Nevertheless, this magnitude varies across cities, with Los Angeles and San Francisco both facing a 4-percentage point decline within the following four quarters. Similarly, there is considerable dispersion in downside risks to house prices across Canadian cities, which is reflected in the volatility of the lower bound (tenth percentile of the cross-sectional distribution). Downside risks to the housing market in Canada have deteriorated over the past two decades, surpassing levels seen around the GFC. At the country level, over the 4-quarter horizon, the 5 percent house price-at-risk is about -3 percent at end-2018Q3 in Canada. City-level analysis shows that Toronto is facing a -10.8 percent tail risk, while Vancouver is facing a -6.5 percent tail risk at end-2018Q3 (Figure 2.3, 2.4).

A closer look at the house price cycle over time sheds some light on the current state of the housing markets in both the U.S. and Canada. The overall U.S. house price risks have improved immensely since the GFC, suggesting stability in the U.S. housing market. Comparing 2007 to 2018, downside risks to house prices decreased homogenously across cities in the U.S. (Figure 2.3). Alternatively, house price risks in Canada are high by historical standards, nearing levels seen around the GFC and deteriorating further as of recent quarters (Annex Figure 2). From 2007 to 2018, cities like Toronto, Quebec, and Hamilton have experienced mounting risks to house prices. While the impact of the GFC was not as detrimental in Canada as it was in the U.S., it is important to note that house prices in the U.S. rose rapidly and then fell substantially, and have not since reached concerning levels, while prices in Canada have continued to rise following a minimal decline in the wake of the GFC.

[20] In this section, short-term downside risks are defined as the 5 percent value-at-risk for a one-year ahead horizon. Long-term downside risks refer to the 5 percent value-at-risk for a three-year ahead horizon.

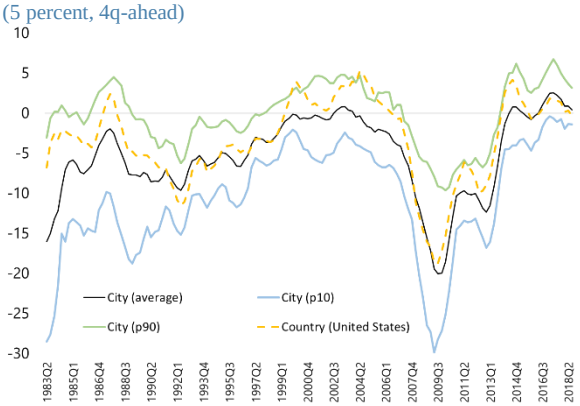
The house price-to-income ratio provides valuable insights into the state of the housing markets in both the U.S. and Canada. Major U.S. cities like Chicago, Phoenix and Atlanta, which had particularly high overvaluation in 2007 also appeared to be more susceptible to downside risks to their housing markets, with their 5 percent house price-at-risk ranging between -10 and -25 percent right before the GFC. This contrasts notably to 2018 when each city's house price overvaluation decreased along with their riskiness (Figure 2.3). Though house price risks seemed to have improved since 2007, some metro areas remain significantly overvalued, including San Francisco, which as of 2018 had a house price to income ratio more than double the long-term average, at around 220 percent.

The housing markets in cities like Hamilton and Toronto seem to have gotten riskier since 2007 with the 5 percent house price-at-risk standing at -6.5 and -10.8 percent respectively, which appear to have coincided with an increase in house price valuation. Imbalances in house price valuation seemed to have worsened since 2007 in Canadian metro areas (Figure 2.4). Toronto appears to be among the most severely overvalued, with a house price-to-income ratio of 150 percent as of 2018. Additionally, house price valuations in Toronto, Vancouver and Hamilton have surpassed sustainable levels based on the borrowing capacity of households as well as the net present value of rental income (Andrle and Plasil, 2019).

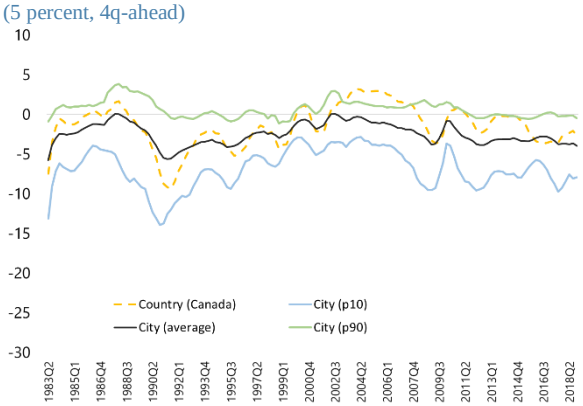
Identifying the individual factors that contribute to house price risks is vital in order to combat these risks. A closer examination of the drivers of house price risk and how these drivers differ across cities is in the following subsection.

Figure 2. City-Level House Prices-at-risk: The Tails of Two Countries

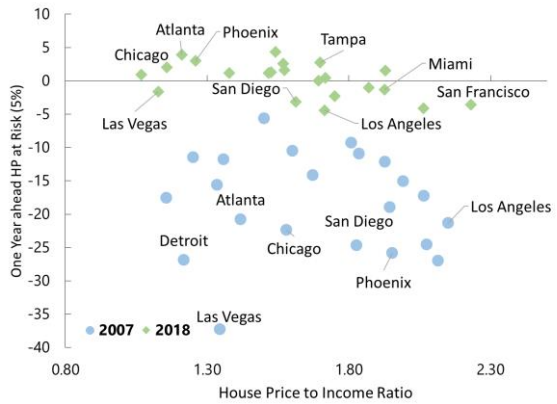
1. Downside Risks across American cities
(5 percent, 4q-ahead)



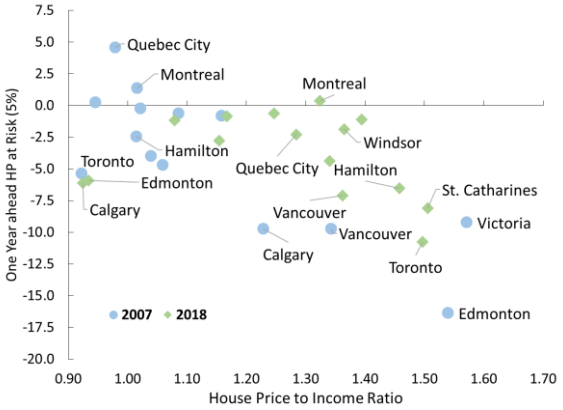
2. Downside Risks across Canadian cities
(5 percent, 4q-ahead)



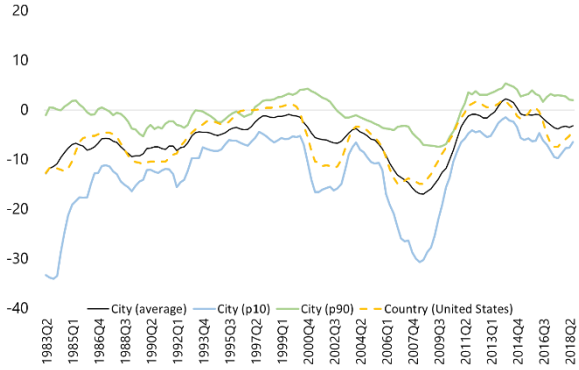
3. Downside Risks and Valuations across American cities



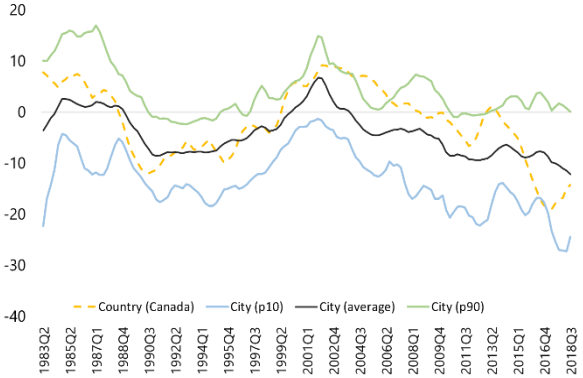
4. Downside Risks and Valuations across Canadian cities



5. Downside Risks across American cities
(5 percent, 12q-ahead)



6. Downside Risks across Canadian cities
(5 percent, 12q-ahead)



Source: CREA; Statistics Canada; Haver; IMF staff calculations.

Note: In panels 1, 2, 5, and 6 the green line refers to the 90th percentile of the cross-sectional city distribution, the blue line refers to the 10th percentile of the cross-sectional city distribution, the black line refers to the average of the cross-sectional city distribution and the yellow dotted line refers to the aggregate country level. Each series depicts the average of the previous four quarters. In panels 3 and 4, the unstandardized house price to income ratio refers to 2007Q3 and 2018Q3 valuation, respectively.

B. Drivers of House Prices-at-Risk

The estimation results on the drivers of house prices-at-risk across cities are presented in Annex Table 1 and Annex Table 2. In the U.S., house price valuation, proxied by the price-to-income ratio, is associated with a worsening in short-term house price risks.[21] At the aggregate level, a one standard deviation growth in the price-to-income ratio results in a 2.9 percentage point deterioration in downside risks to the U.S. housing market.[22] The association between house price valuation and downside risks to house prices remains statistically significant across all quantiles. In Canada house price valuation is also significantly associated with downside risks to the housing market. Economy-wide, a one standard deviation increase in the price-to-income ratio results in a 1.5 percentage point increase in downside risks to the overall housing market in Canada. The effect of house price valuation on downside risks to house prices in Canada remains true and statistically significant across quantiles. These findings further justify the use of house price valuation as an indicator of housing market risks.

Supply side indicators proxied by housing starts in the U.S. are significantly linked with mitigating short-term risks to house price. At the aggregate level, a one standard deviation growth in housing starts in the U.S. is associated with a 2.3 percentage point decrease in downside risks to housing markets. Housing starts have an alleviating effect on house price risks in most U.S. cities as well. This finding has important economy-wide implications regarding supply restrictions. Tighter supply restrictions like permit controls and zoning taxes that inhibit housing supply may engender risks to housing markets.

On the contrary, housing supply in Canada proxied by residential investment has an ambivalent impact on house prices across Canadian cities. At the country level, an increase in housing supply mitigates risks to housing markets across quantiles. Housing supply also has a mollifying effect at the granular level in many cities including Edmonton, Quebec City, and Ottawa. However, the relationship of housing supply to downside risks is heterogeneous across Canada. Interestingly, residential investment is negatively associated with house price tail risks in major cities like Toronto, Vancouver and Hamilton. The regional differences in the impact of supply on house price risks can perhaps be explained by variation in supply restrictions, including natural barriers in addition to urban containment policies and border limitations. In these cities, increases in supply are insufficient to satisfy demand, and thus supply cannot mitigate housing market risks.[23]

In the U.S. the impact of tighter financial conditions, which incorporates money market conditions, debt and equity market measures, and shadow banking system measures, seems to be somewhat ambiguous across cities and quantiles (Figure 3.3). In metro areas like Austin, Cleveland, Seattle, and San Francisco tighter financial conditions appear to increase downside risks to house prices specifically for the lower quantile; a one standard deviation tightening

[21] In this section, drivers of downside risks refer to the standardized coefficients of the quantile regressions at the 10th percentile.
[22] This calculation is derived from multiplying the coefficient by the standard deviation and then multiplying by 100.
[23] The dearth of developed land and infrastructure is found to be one of the main contributors to the shortage of housing supply in Vancouver and Toronto, given that both cities are surrounded by natural expansion barriers including lakes, seas, and mountains. For a more in-depth analysis of housing supply and overvaluation in Canada, see IMF (2018).

(increase) of financial conditions leads to a 1.7 to 4.8 percentage point increase in house price risks across these cities. This effect varies across quantiles, and for some cities tighter financial conditions appear to mitigate downside risks at a one-year horizon. San Francisco and Seattle seem to be the most sensitive to a tightening in financial conditions. The impact of financial conditions is less severe at the 12-quarter horizon, demonstrating how FCIs capture *current* financial conditions (Annex Figure 3.3).

In Canada, tighter financial conditions, which encompass monetary policy, macroprudential measures and other factors, are associated with downside risks to house prices (Figure 3.4). The effects of financial conditions are mostly channeled through lending standards and mortgage costs. The relationship to financial conditions is uniformly negative across all Canadian cities and statistically significant for most. The most sensitive cities to financial conditions are Toronto, Ottawa, and Calgary, where a one standard deviation tightening (increase) in financial conditions leads to a 1.6 to 3.1 percentage point increase in short-term downside risks. Consistent with the United States, the impact of financial conditions is moderated in the long run, further emphasizing how the FCI captures current financial conditions (Annex Figure 3.4).

The dynamics of housing markets in global cities are partially driven by capital flows, which seem to both amplify and mitigate downside risks to house prices across the U.S. (Figure 3.1).[24] The two types of capital flows included in the model are foreign direct investment (FDIs) and other capital flows. FDI refers to long-term investments, while other capital flows consists of investment that is not classified as portfolio investment or foreign direct investment. Typically, other capital flows refer to bank transactions from foreigners.[25] In some U.S. cities FDI seems to alleviate risks to house prices. In particular, FDI inflows to the U.S. is significantly associated with a reduction of about 1 to 2 percentage points in house prices at risk in tech friendly cities like Seattle and Portland, Oregon in the short term. However, this positive relationship does not hold in the long term. At a 12-quarter horizon, FDI inflows is significantly associated with around a 6 to 8 percentage points increase in house price risks in cities like Tampa, Detroit, and Minneapolis. This finding is congruent to previous studies which observe FDI to be detrimental to the macroeconomy.[26]

FDIs are generally associated with mollifying downside risks to housing markets in Canadian cities (Figure 3.2). The relationship is the most evident in Calgary, Toronto, Ottawa, and Quebec City; a one percentage point increase in FDI inflow to Canada is significantly associated with a reduction of about ½ to 1 percentage points in house prices at risk in these cities. Given that mining and oil extraction make up the majority of FDI inflows in Canada, it is unsurprising that FDI has the largest effect on Canada's major oil-producing cities like Calgary (Globerman, 2019). In contrast to the United States, the influence of FDI inflows in Canada is even more

[24] Recent studies document the link between foreign capital inflows and housing market co-movement in major cities like London, Tokyo, and New York (Alter, Dokko, and Seneviratne, 2018).
[25] While direct/large real estate transactions would be captured in the FDI category, smaller transactions (i.e., residential) may not be properly captured in the BOP statistics and be reflected in other investment inflows (e.g., if foreigners first bring in deposits through a bank to then buy the property).
[26] Previous literature suggests that FDI may negatively impact growth via distortions in the domestic economy (Easterly, 1993; Borensztein et al. 1998). Further, Aizenman and Jinjarak (2009) find a strong positive association between current account deficits and house price appreciation.

strongly associated with placating house price risks in the long run. In Quebec City, Toronto, and Hamilton, an increase in FDI inflows in Canada is associated with a 1.5 to 2.5 percentage point decrease in house price risks at the 12-quarter horizon.

While FDI inflows tend to have a mitigating influence on house prices-at-risk in both the U.S. and Canada in the short run, other capital flows appear to have the opposite effect. In the U.S., across almost all major cities tested, other capital flows have a significantly negative effect on housing markets. Interestingly, the sensitivity to other capital flows is correlated with the level of foreign openness across cities, as proxied by the share of immigrants to total population (Annex Figure 4).[27] The effects are especially evident in Sun Belt economies like Las Vegas, Los Angeles, Miami, and San Diego, where investment may be more attractive (Figure 3.1). The effects of other capital flows on house price risks is more ambiguous in the long run (Annex Figure 3.1). This may be attributed to the type of capital inflow, since other capital flows incorporate short-term transactions which might initially reflect bank deposits by foreigners which might be further invested in residential real estate at a later stage.

Other capital flows appear to predict a significantly negative effect on the housing market risks in major Canadian cities like Vancouver, Ottawa, and Hamilton in the short term as well (Figure 3.2). The largest effects are seen in Vancouver, where speculative capital inflows might have partially contributed to the recent housing market boom. It appears that other capital flows are inconsequential to long-term house price risks across all Canadian cities aside from Hamilton, which can perhaps be attributed to the transitory nature of the types of flows included in other capital flows.

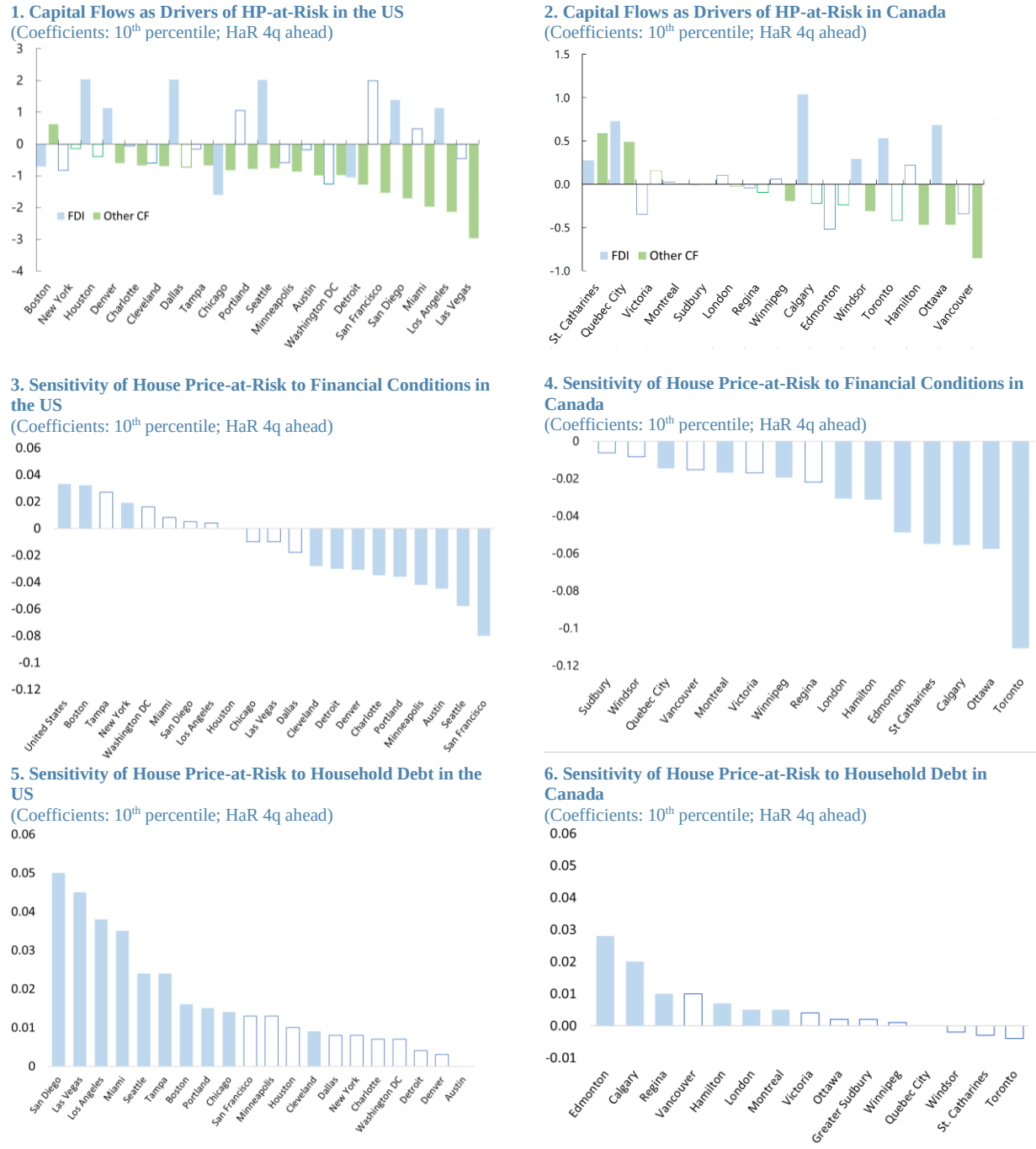
The contributions of other variables including household debt and oil varies across cities in both the U.S. and Canada. Household debt is generally positive in the short term. This finding supports the theory that ease of access to credit can stimulate growth in the near term, and thus household income could increase. However, household debt is found to worsen housing market risks at a 12-quarter horizon, reflecting the negative effects of high household indebtedness in the long term. This intertemporal tradeoff is consistent with the existing literature on downside risks to growth (Adrian et al., 2018). In both Canada and the U.S., oil appears to have a mostly insignificant effect on house prices-at-risk.

At the aggregate level, overvaluation seems to be the largest contributor to short-term downside risks to housing markets in the U.S., while other factors which include oil and household debt seem to have a mostly mitigating, albeit minimal, effect overtime until around the GFC (Annex Figure 5.1). Contributions to house price risks somewhat vary by city. Comparing contributions to Los Angeles' house price risks to contributions to Chicago's house price risks exemplifies the variation across cities. While capital flows are a significant contributor to short-term tail risks in Chicago, the association with capital flows is of lesser magnitude in Los Angeles, where overvaluation and supply side factors dominate downside risks (Annex Figure 5.3, 5.5). While

[27] This finding is consistent with Ari, Puy and Shi (forthcoming), which finds that shocks to foreign countries disproportionally increase house prices in areas which have a higher concentration of immigrant population originating from the crisis country.

there is some variation in house price risks across cities, city-level valuation appears to be the main contributor to house price risk across cities.

Figure 3. Drivers of Short-term House Prices-at-risk



Source: CREA; Statistics Canada; Haver; IMF staff calculations.

Notes: Colored bars indicate statistical significance at the 10 percent level or higher. Outlined bars indicate insignificant coefficients.

Contributions to short-term downside risks of the housing market in Canada varies somewhat by city as well. House price risks have worsened significantly over the last few years in Toronto,

exacerbated by increased overvaluation and constrained supply. Vancouver's housing market risks coincide with major movements in Toronto's downside risks, though Vancouver's is mostly driven by capital flows (Annex Figure 5.4, 5.6).

At the aggregate level and across cities, valuation appears to have a large contribution to risks to housing markets. Overall, tail risks to the U.S. housing market have seemed to improve immensely in the past few years, while tail risks to Canadian house prices have generally increased, reflecting tighter financial conditions, overvaluation, and different types of capital flows.

VI. MICRO-LEVEL EVIDENCE: RISKY DEBT

Given the significant influence of household debt on future house price risks, identifying which types of households are more indebted is necessary to truly ascertain the riskiness of the credit buildup and the potential systemic risk it poses. Examining household balance sheets allows for better identification of the amount of debt held by financially fragile households. The debt servicing ratio, loan-to-value ratio, and debt-to-income ratio can provide insightful information about the financial constraints imposed on households as a result of indebtedness.[28] Furthermore, these indicators provide a sense of potential amplification effects should there be a housing market bust, given that a fall in house prices will be more disruptive if these risk indicators are high.

In general, private sector leverage has been steadily increasing since global financial conditions were loosened to stimulate demand following the GFC. While accommodative financial conditions are meant to increase demand, high household leverage can create borrowing constraints that may not be offset by the benefits of lower interest rates (Eggertsson and Krugman, 2012; Korinek and Simsek, 2016). An excessive level of household indebtedness is found to increase household vulnerability to shocks (Baker 2015; Zabai 2017). High levels of household debt coinciding with policy rates close to the zero lower bound heightens financial system vulnerabilities, as monetary policy can no longer serve as an adequate tool to increase demand by alleviating the debt burden. The debt-to-income ratio is a common measure of household indebtedness, which is the ratio of total household debt to disposable income. The loan-to-value ratio is the ratio of the final value of the mortgage loan to the value of the principal residence. This serves as a measure of household wealth. The debt servicing ratio is the ratio of monthly payments to disposable income.[29] The debt servicing ratio captures other aspects of household debt burden given that it considers interest rates and maturities. Drehmann and Juselius (2012) establish that the debt servicing ratio acts as an accurate signal of a nearing financial crisis and is associated with the size of the subsequent loss in output. Nonetheless, debt service ratio can also be misleading, especially in a low-for-long interest rate environment, and thus macroprudential policies should address this externality.

[28] This analysis is conducted at the aggregated level, given that household debt from survey data is not available at the city level.

[29] Monthly payments include mortgage instalments and credit card payments. Disposable income includes government transfers.

Overall, household sector vulnerabilities reflected in household debt-to-income, household debt-to-GDP ratio, and debt servicing ratio, are useful indicators of potential risks to an economy. Given that vulnerabilities appear heightened in Canada, a closer look at these indicators can provide valuable insight into the tractability of these risks. When taking these factors into consideration, it appears that downside risks to housing markets have recently fallen in the United States, while having increased in Canada, signaling mounting risks. We further identify and quantify these potential risk factors.

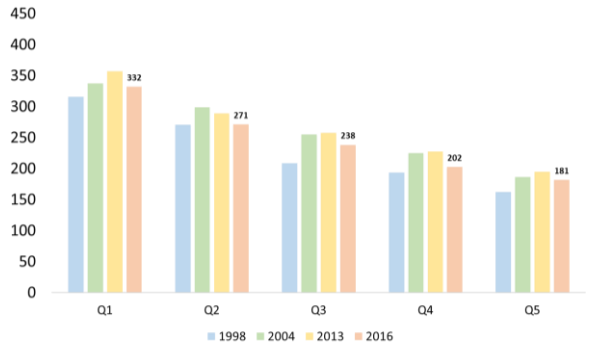
In this paper, financially weak households are defined by two characteristics. The first measure are those households whose debt servicing ratio is above 40 percent. The second measure are those households whose debt-to-income ratio is above 350 percent. Debt of these financially weak households underpins the household "risky debt" concept. Alternative definitions of risky debt are considered for robustness. These include households with a debt-to-income ratio above 450 percent and households with a debt-to-income ratio above 550 percent. In this paper, the amount of risky debt held by households who also have a loan-to-value ratio greater than 80 percent is used as a proxy to measure the share of risky debt not covered by assets. In the event of a house price shock that causes house prices to decline, households with high leverage coinciding with loan-to-value ratios above 80 percent will most likely not be able to alleviate their debt, and the associated bankruptcy and foreclosure costs would leave these households with high loan-to-value ratios extremely vulnerable.

From a micro-level perspective, across all income quantiles the median household debt-to-income ratio has declined from 2013 to 2016 in the U.S., converging back to 1998 levels (Figure 4.1). There is more dispersion across income quantiles in Canada (Figure 4.2). Though the household debt-to-income ratio has declined for low income households (defined as those below the 20^{th} percentile of income distribution) from 2012 to 2016, lower income borrowers still appear to be particularly vulnerable, especially when compared to 1999 levels. The amount of debt accumulated by poorer borrowers climbed from about 2.5 times their annual income in 1999 to about 3.5 times in 2016, indicating increased financial distress.

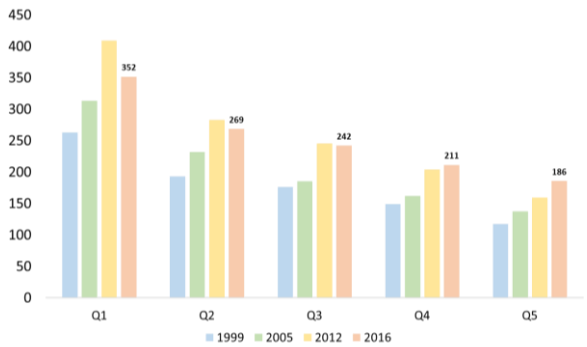
A closer look at the financial state of indebted households in the U.S. shows that the share of risky debt in the U.S. has decreased since 2004 when considering the debt servicing ratio and debt-to-income ratio. The share of debt held by borrowers with a debt-to-income ratio above 350 decreased from about 42 percent of total debt in 2013 to about 39 percent in 2016, implying an improvement in the amount of debt held by risky borrowers (Figure 4.3). When considering the debt servicing ratio, the share of debt held by borrowers with a debt servicing ratio greater than 40 percent has declined by about 5 percentage points since 2004 to about 20 percent of total debt, further demonstrating an improvement in the 'quality' of debt in the U.S. (Figure 4.5). Additionally, there has been minimal change in the amount of risky debt not covered by assets (i.e., mortgage debt held by highly indebted households with a loan-to-value ratio greater than 80 percent).

Figure 4. Household Indebtedness

1. Debt-to-Income (DTI) in the US
(Median, by income quantile)

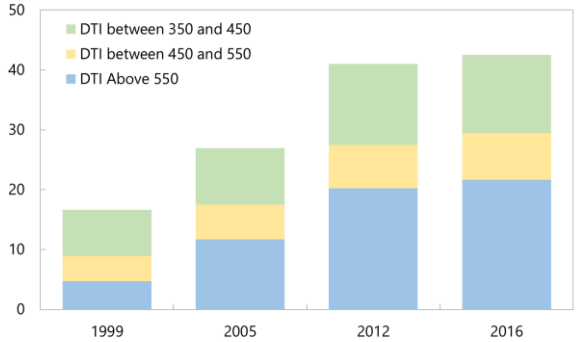


2. Debt-to-Income (DTI) in Canada
(Median, by income quantile)

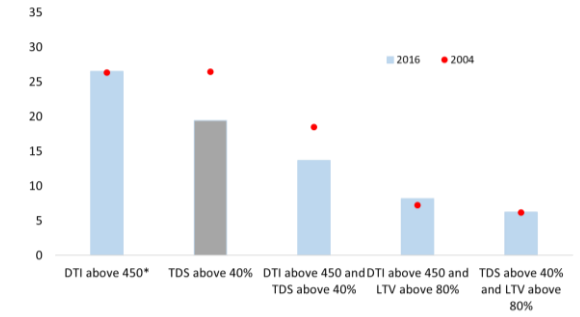


3. Household Risky Debt in the US, 1998-2016
(In percent of total debt)

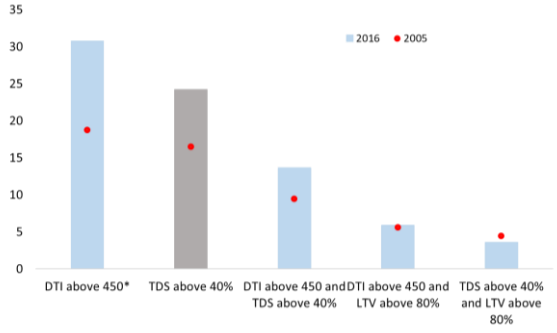
4. Household Risky Debt in Canada, 1999-2016
(In percent of total debt)



5. Share of Risky Debt in the US, 2016
(In percent of total debt)



6. Share of Risky Debt in Canada, 2016
(In percent of total debt)



Sources: Statistics Canada's Survey of Financial Security, US Survey of Consumer Finances, IMF staff calculations.
Note: DTI ratio is calculated as total amount of debt divided by household disposable income, including government transfers. TDS is the ratio of mortgage payments plus credit card payments divided by disposable income, including government transfers. LTV is the ratio of mortgage loan (final value) to the value of the principal residence.

The outlook is less optimistic when looking at the share of risky debt in Canada as of 2016.[30] From 2012 to 2016, Canadian households experienced a small increase in the share of debt belonging to borrowers with a debt-to-income ratio above 350, which stood at about 41 percent of total debt as of 2016 (Figure 4.4). Additionally, since 2005 the share of risky debt has increased significantly when considering both the debt-to-income ratio and the debt servicing ratio, signifying increasing financial vulnerabilities (Figure 4.6). However, the share of risky debt not covered by assets has remained stable since 2005 and is comparable to U.S. levels.

VII. ROBUSTNESS

To ensure goodness-of-fit, a variety of country- and city-level variables were tested, with the Pseudo R^2 as guidance for determining which variables to incorporate in the baseline model (Annex Table 5, Annex Table 6). Further details about the construction and transformations of the variables used are available in Table 2. To analyze the soundness of the results presented in the previous section, the same model is tested with a 12-quarter horizon. The results are available in Annex Table 3 and Annex Table 4. Any notable differences have been mentioned in the previous section and will be further elaborated.

Consistent with expectations, the influence of capital flows, financial conditions and household debt are each contingent upon the horizon. FDI being significantly impactful to housing markets in the long run reflects the long-term complexion of this type of investment which includes sizable foreign investment into real estate, as opposed to other capital flows which are composed of banking capital, trade credits, and official government flows. Furthermore, financial condition indices are typically used to capture the current states of financial markets based on a combination of immediate financial variables including asset prices and currency prices, and thus the FCI is not expected to have a sizable influence on long-term house price risks. As discussed in detail throughout this paper, there have been several studies emphasizing the detrimental long-term effects of household debt and thus the negative association between long-term house price risks and household debt is unsurprising. There is no significant difference in the coefficients of the supply indicators, overvaluation, or oil indicating these variables are all robust to the horizon. These findings are generally consistent across both Canada and the United States, at the country and city-level.

Across quantiles, the influence of valuation is harmonious, indicating that the influence of valuation is robust to different stages of economic growth.[31] This result holds across cities in both the U.S. and Canada (Annex Table 1, Annex Table 2). Similarly, across quantiles in both the U.S. and Canada household debt is mostly positive in the short run, though there are some outliers. As discussed, the impact of capital flows varies across cities, though the relationship

[30] Recently, Bilyk and teNyenhuis (2018) assessed the impact of policy changes such as the tightening of mortgage insurance rules and the revision of Guideline B-20 on the Canadian mortgage market. This study shows that fewer low-ratio mortgages were originated to highly indebted borrowers in 2018 compared to the previous year. At the same time, the distribution of new borrowers has moderately improved, and the overall mortgage activity has significantly slowed, with the caveat that the revision of the Guideline B-20 coincided with a substantial increase in interest rates.

[31] In the context of this paper, the 10th percentile represents periods of house price busts, the 90th percentile represents periods of house price booms, and the median represents periods of average growth.

remains broadly consistent across quantiles, implying that the impact of capital flows on house price risks remains the same during boom and bust periods. Looking at the influence of different variables across quantiles provides valuable insights into how certain risk factors behave at the left tail of the distribution, which constitutes periods of low growth. Consistent with empirical findings of the "Growth-at-Risk" literature, it appears that financial conditions are more strongly associated with future house prices at the left tail of the distribution than at the median. In addition, the influence of supply factors and oil vary across quantiles, suggesting that the relationship varies at different stages of the house price cycle.

Additionally, the validity of the results is tested using a variety of different variables and transformations. In order to allow for differences in timing effects, various lags were tested, including 1 and 4 quarter lags on capital flow measures, financial conditions, and supply measures. Alternative types of capital inflows were also considered, including portfolio investment. To test the validity of the results from the risky debt analysis, different definitions of risky debt were also considered. Alternative combinations of DTI and LTV ratios were contemplated, including DTI above 350 and 550 percent, and LTV above 90 percent. The results prove to be generally robust to alternative specifications.

VIII. CONCLUSION

The health of housing markets and household indebtedness is an important pillar for financial stability. The sheer exposure of the financial sector to housing through various channels such as mortgages and asset backed securities creates a strong link to systemic risk. In addition, the nexus between household balance sheets, house prices, and consumption reinforces these mechanisms.

This paper analyzes the state of housing markets and credit cycles in both the United States and Canada. In general, our findings suggest that the U.S. housing market has become less risky with improving credit conditions and fundamentals, especially when compared to the GFC. At the same time, there is substantial heterogeneity across cities and forecast horizons. In contrast to the U.S., the housing market in Canada has gradually deteriorated over the past few years, with an increasing amount of household leverage and housing market risks rising to levels last seen around the GFC.

This paper finds that house price risks are influenced by a variety of factors, both national and regional. This finding extends the results of previous empirical studies which posit that house prices fluctuate with movements in national and regional trends. Using a sample of 37 cities with quarterly data from 1983-2018, this paper identifies housing overvaluation, supply-side drivers, financial conditions, household debt and capital flows all to be significantly associated with risks to house prices, though the effect varies by city and horizon. Similarly, the sensitivity of future house price risks to capital inflows appears to correlate with foreign openness. Building off these results, this paper takes a closer look at household debt in both the U.S. and Canada. Notably, the level of household debt in the U.S. has decreased in recent years, along with the share of debt held by risky borrowers. On the contrary, it seems that the level of household debt in Canada has increased in recent years, coinciding with the share of debt held by risky borrowers. Considering the relationship between household debt and house price risks, this finding highlights some potential vulnerabilities to the housing market in Canada.

Given the impact of housing markets on macro stability, it is worth further exploring policies to combat the risks identified in this paper. For instance, macroprudential policies targeting highly leveraged households could be deployed to mitigate potential externalities and lessen systemic risks. In particular, borrower-based policy instruments could be tightened to better safeguard the household sector against unexpected shocks. Furthermore, policies regarding capital flows and real estate tax policies may also address house price risks and therefore should be further examined (IMF 2019a). Importantly, macroprudential policies could consider the heterogeneity of household indebtedness and housing market imbalances across regions. Similarly, supply-side policies targeting zoning ordinances can be implemented to alleviate overvaluation imbalances. Highly inelastic housing supply coinciding with rising demand restricts the effectiveness of macroprudential and tax-based policies in targeting housing demand and thus the transmission to house prices (IMF 2018).

Table 1. City List

United States		Canada	
Austin	Miami	Calgary	Winnipeg
Boston	Minneapolis	Edmonton	Ottawa
Charlotte	New York	Hamilton	Greater Sudbury
Chicago	Philadelphia	London	St. Catharines
Cleveland	Phoenix	Montreal	
Dallas	Portland	Quebec City	
Denver	San Diego	Regina	
Detroit	San Francisco	Toronto	
Houston	Seattle	Vancouver	
Las Vegas	Tampa	Victoria	
Los Angeles	Washington DC	Windsor	

Table 2. Variable Descriptions

United States			Canada		
Variable	Description	Source	Variable	Description	Source
Real House Price Growth	The year-on-year change in the city-level real house price index, deflated by regional CPI	FRED, S&P/Case-Shiller, U.S. Federal Housing Finance Agency	Real House Price Growth	The year-on-year change in the city-level house price index, deflated by provincial CPI	Haver, Statistics Canada
House price-to-income	The ratio of the city-level house price index to state-level real median income, interpolated using real national disposable income per capita	FRED, U.S. Census Bureau, Haver	House price-to-income	The ratio of the city-level nominal house prices to nominal provincial disposable income	Haver, Statistics Canada, CREA
Housing Starts	Year-on-year change in state-level housing starts	Haver, Bank of Tokyo-Mitsubishi UFJ, FRED	Residential Investment	Provincial-level residential investment scaled by provincial GDP	Haver, Statistics Canada
Financial Conditions Index (FCI)	National financial conditions index	Chicago Federal Reserve Bank	Financial Conditions Index (FCI)	National financial conditions index	IMF
Household Debt	First difference in the country-level household debt-to-GDP ratio	BIS, Haver	Household Debt	First difference in the country-level household debt-to-GDP ratio	BIS, Haver
Other Capital Flows	Four-quarter moving average of the annualized Other Capital inflows to GDP	IMF BPM6	Other Capital Flows	Four-quarter moving average of the annualized Other Capital inflows to GDP	IMF BPM6
Foreign Direct Investment (FDI)	Four-quarter moving average of the annualized FDI inflows to GDP	IMF BPM6	Foreign Direct Investment (FDI)	Four-quarter moving average of the annualized FDI inflows to GDP	IMF BPM6
Oil	Quarter-on-quarter change in the West Texas Intermediate Crude Oil Price Index	FRED	Oil	Quarter-on-quarter change in the West Texas Intermediate Crude Oil Price Index	FRED

Table 3. Country-level Summary Statistics

United Sates

Variable	Obs	Mean	Std. Dev	Min	Max
House Price Growth (YoY)	146	0.014	0.052	-0.137	0.110
House Price-to-Income	146	1.131	0.154	0.883	1.469
Housing Starts (YoY)	146	0.007	0.190	-0.704	0.616
FCI	146	-0.287	0.597	-0.900	2.940
Δ Household Debt (% of GDP)	146	0.201	0.758	-1.900	2.800
FDI (% of GDP)	146	0.014	0.008	0.002	0.037
Other Capital Flows (% of GDP)	146	0.016	0.015	-0.036	0.057
Oil (QoQ)	146	0.005	0.148	-0.704	0.393

Canada

Variable	Obs	Mean	Std. Dev	Min	Max
House Price Growth (YoY)	146	-0.024	0.042	-0.134	0.099
House Price-to-Income	146	0.938	0.079	0.740	1.091
Residential Investment (% of GDP)	146	0.013	0.004	0.006	0.022
FCI	146	-0.141	0.282	-0.704	1.065
Δ Household Debt (% of GDP)	146	0.405	0.731	-1.200	3.700
FDI (% of GDP)	146	0.024	0.018	-0.002	0.085
Other Capital Flows (% of GDP)	146	0.012	0.014	-0.016	0.065
Oil (QoQ)	146	0.005	0.148	-0.704	0.393

Table 4. City-level Summary Statistics

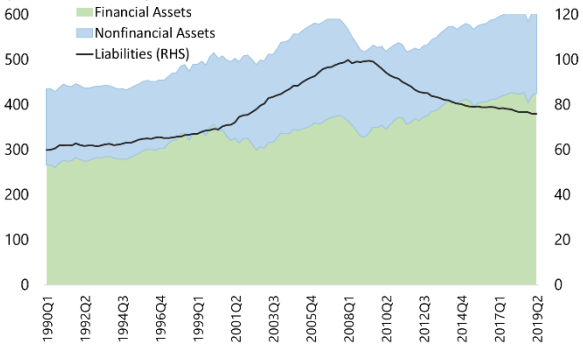
United States		Real House Price Growth				House Price-to-Income				Housing Starts (YoY)			
City	Obs	Mean	Std. Dev.	Min	Max	Mean	Std. Dev.	Min	Max	Mean	Std. Dev.	Min	Max
Atlanta	146	0.009	0.049	-0.140	0.094	1.365	0.311	0.869	2.196	0.012	0.270	-1.048	0.749
Austin	146	0.019	0.062	-0.239	0.109	1.547	0.275	1.221	2.289	0.002	0.252	-0.878	0.541
Boston	146	0.029	0.080	-0.138	0.253	1.646	0.247	1.334	2.241	-0.001	0.258	-0.790	0.759
Charlotte	146	0.012	0.037	-0.116	0.075	1.249	0.190	0.896	1.702	0.022	0.205	-0.854	0.573
Chicago	146	0.012	0.051	-0.139	0.097	1.266	0.192	0.837	1.567	0.007	0.277	-0.979	0.882
Cleveland	146	0.002	0.038	-0.172	0.090	1.187	0.252	0.607	1.751	-0.001	0.218	-0.543	0.805
Dallas	146	0.006	0.047	-0.116	0.112	1.546	0.451	0.988	2.595	0.002	0.252	-0.878	0.541
Denver	146	0.019	0.053	-0.084	0.125	1.327	0.235	0.995	2.281	0.017	0.308	-1.078	0.802
Detroit	146	0.007	0.070	-0.236	0.121	1.149	0.238	0.683	1.681	0.007	0.270	-0.785	0.972
Houston	146	0.003	0.047	-0.129	0.111	1.584	0.427	1.147	3.096	0.002	0.252	-0.878	0.541
Las Vegas	146	0.008	0.115	-0.361	0.412	0.995	0.242	0.539	1.478	0.016	0.360	-1.252	0.888
Los Angeles	146	0.028	0.098	-0.262	0.295	1.451	0.263	1.074	2.164	0.009	0.280	-0.845	0.851
Miami	146	0.023	0.094	-0.298	0.228	1.542	0.318	1.169	2.561	-0.002	0.266	-0.957	0.676
Minneapolis	146	0.013	0.050	-0.134	0.100	1.511	0.261	1.034	2.031	0.007	0.257	-0.644	0.879
New York	146	0.028	0.076	-0.121	0.233	1.582	0.230	1.267	2.187	0.009	0.307	-1.458	1.229
Philadelphia	146	0.019	0.054	-0.079	0.143	1.518	0.271	1.111	2.263	0.000	0.216	-0.700	0.847
Phoenix	146	0.014	0.098	-0.250	0.366	1.359	0.344	0.848	2.549	0.012	0.320	-1.131	0.961
Portland	146	0.025	0.061	-0.120	0.168	1.245	0.141	0.909	1.575	0.024	0.229	-0.793	0.687
San Diego	146	0.025	0.088	-0.241	0.292	1.420	0.236	1.092	2.096	0.009	0.280	-0.845	0.851
San Francisco	146	0.040	0.085	-0.160	0.211	1.485	0.227	1.085	1.960	0.009	0.280	-0.845	0.851
Seattle	146	0.030	0.069	-0.129	0.269	1.327	0.150	1.008	1.717	0.024	0.229	-0.793	0.687
Tampa	146	0.017	0.080	-0.232	0.206	1.542	0.324	1.082	2.545	-0.002	0.266	-0.957	0.676
Washington DC	146	0.022	0.072	-0.204	0.232	1.532	0.225	1.186	2.128	0.002	0.217	-0.593	0.709

Canada		Real House Price Growth				House Price-to-Income				Residential Investment (% of GDP)			
City	Obs	Mean	Std. Dev.	Min	Max	Mean	Std. Dev.	Min	Max	Mean	Std. Dev.	Min	Max
Calgary	146	0.040	0.092	-0.149	0.586	0.886	0.156	0.611	1.216	0.006	0.002	0.002	0.010
Edmonton	146	0.030	0.087	-0.121	0.418	0.896	0.166	0.692	1.284	0.006	0.002	0.002	0.010
Hamilton	146	0.033	0.043	-0.066	0.192	0.852	0.249	0.483	1.503	0.006	0.001	0.003	0.011
London	146	0.033	0.039	-0.035	0.199	0.959	0.154	0.658	1.394	0.006	0.001	0.003	0.011
Montreal	146	0.034	0.033	-0.006	0.167	0.825	0.228	0.485	1.324	0.005	0.002	0.003	0.010
Quebec City	146	0.032	0.031	-0.020	0.094	0.866	0.193	0.548	1.284	0.005	0.002	0.003	0.010
Regina	146	0.043	0.056	-0.028	0.309	0.857	0.226	0.657	1.305	0.003	0.002	0.001	0.008
Toronto	146	0.035	0.076	-0.181	0.325	0.870	0.242	0.509	1.575	0.006	0.001	0.003	0.011
Vancouver	146	0.009	0.065	-0.254	0.181	0.818	0.253	0.418	1.362	0.008	0.002	0.004	0.013
Victoria	146	-0.004	0.058	-0.162	0.142	0.812	0.244	0.425	1.340	0.008	0.002	0.004	0.013
Windsor	146	0.016	0.033	-0.065	0.123	0.974	0.138	0.661	1.365	0.006	0.001	0.003	0.011
Winnipeg	146	0.036	0.032	-0.011	0.160	0.879	0.208	0.645	1.254	0.004	0.001	0.002	0.007
Ottawa	146	0.031	0.035	-0.026	0.147	0.895	0.152	0.634	1.154	0.006	0.001	0.003	0.011
Greater Sudbury	146	0.016	0.029	-0.029	0.140	0.921	0.200	0.591	1.213	0.006	0.001	0.003	0.011
St. Catharines	146	0.035	0.042	-0.052	0.152	0.896	0.198	0.542	1.514	0.006	0.001	0.003	0.011

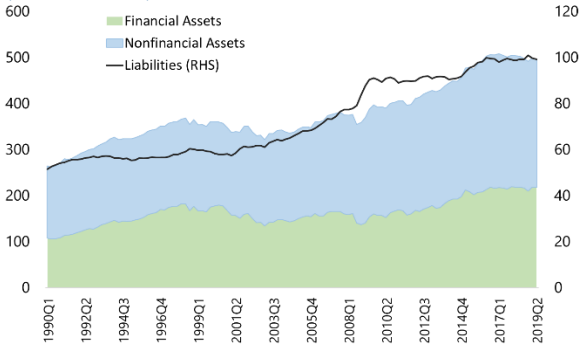
ANNEX

Annex Figure 1. Household Balance Sheets: Canada vs United States

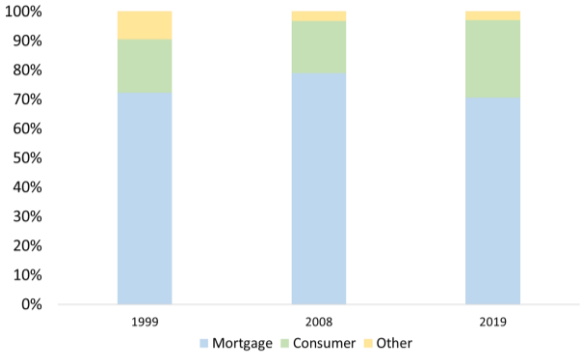
1. Household Indebtedness and Wealth in the US
(Percent of GDP)



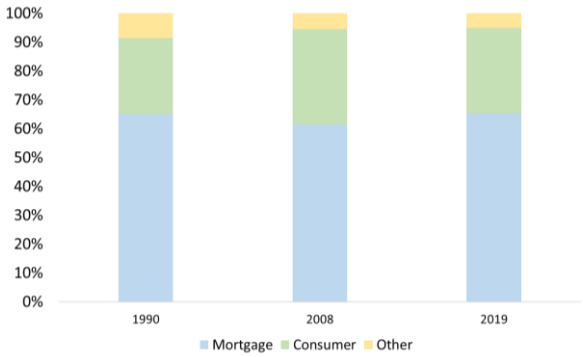
2. Household Indebtedness and Wealth in Canada
(Percent of GDP)



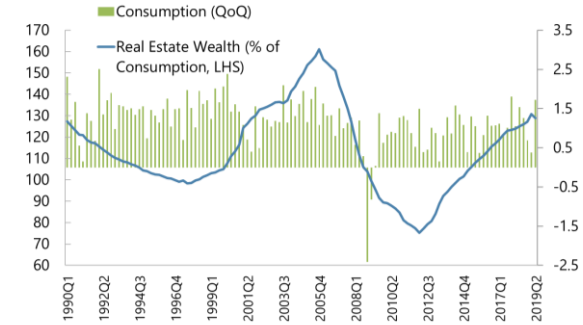
3. Composition of Household Debt in the US
(Percent)



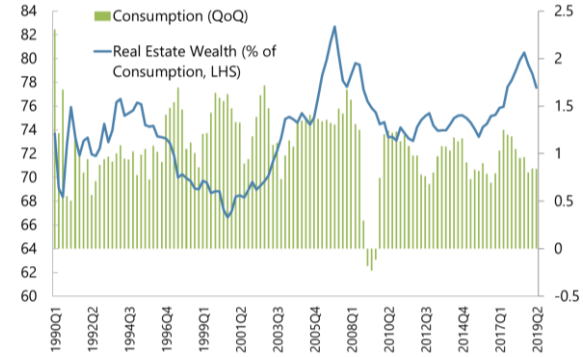
4. Composition of Household Debt in Canada
(Percent)



5. Real Estate Wealth and Consumption in the US
(Percent)



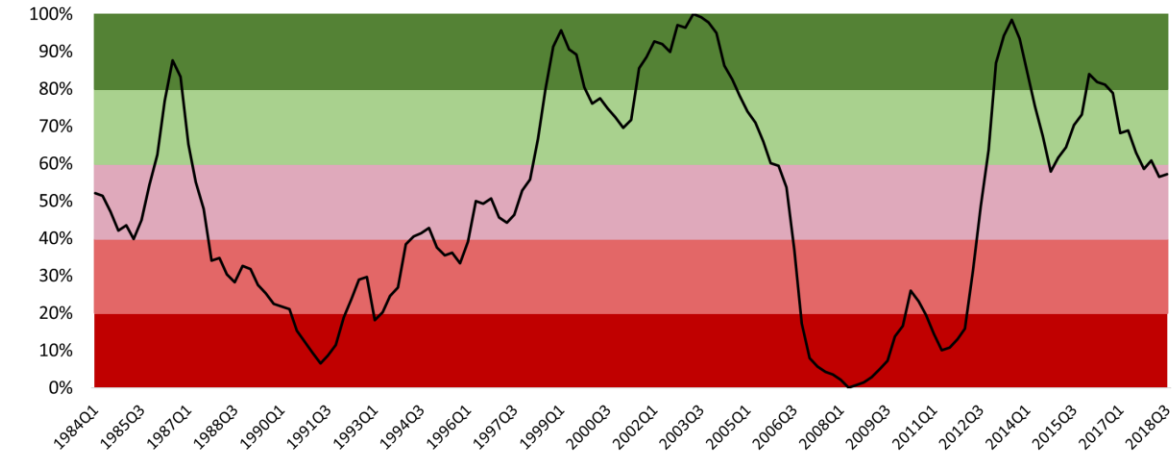
6. Real Estate Wealth and Consumption in Canada
(Percent)



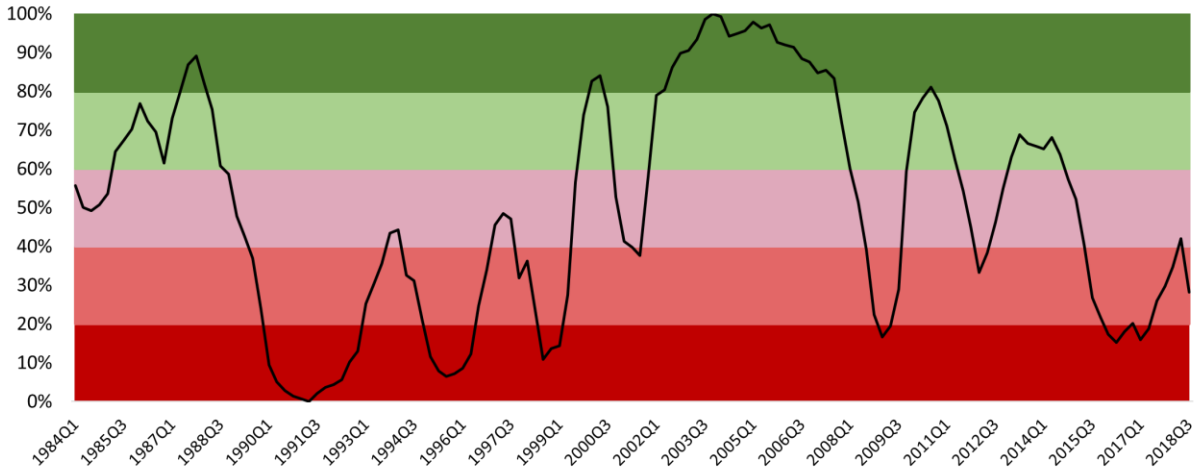
Sources: IFS, Statistics Canada, FRED, IMF staff calculations.
Note: Real estate wealth in Canada includes residential and non-residential structures.

Annex Figure 2. Historical Housing Market Risks

1. United States House Prices-at-risk Percent Rank, 4 Quarters Ahead



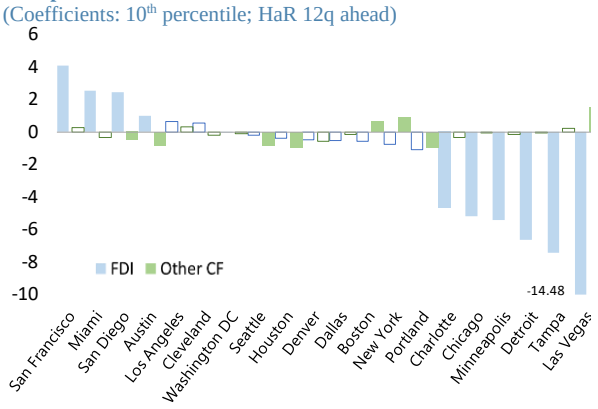
2. Canada House Prices-at-risk Percent Rank, 4 Quarters Ahead



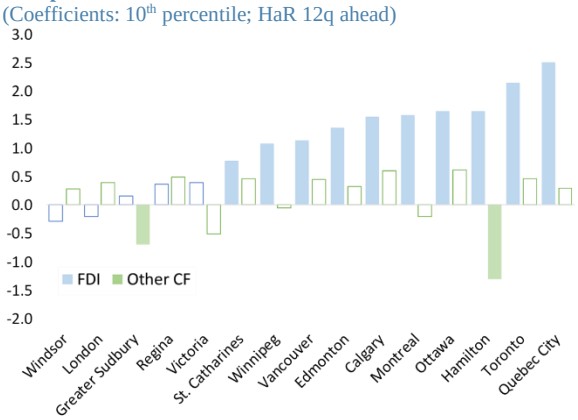
Note: The color shading depicts the percentile rank of the house prices-at-risk (5 percent HaR) from 1984Q1 onward. Forecast Horizon = 4 quarters ahead. A lower percentile corresponds to higher downside risk.

Annex Figure 3. Drivers of Long-term House Prices-at-risk

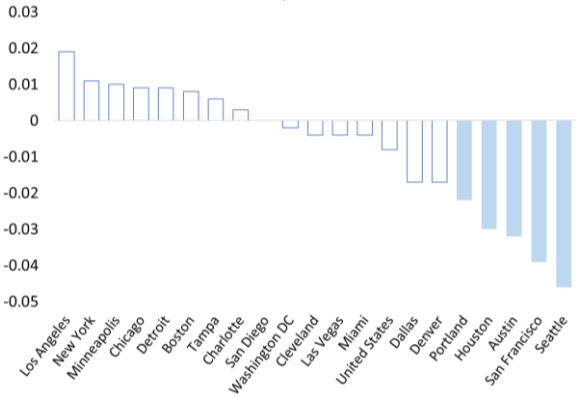
1. Capital Flows as Drivers of HP-at-Risk in the US
(Coefficients: 10th percentile; HaR 12q ahead)



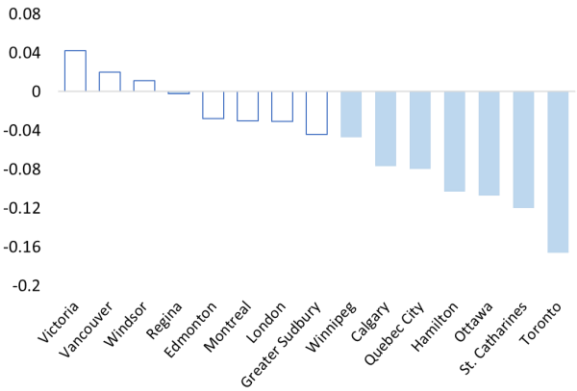
2. Capital Flows as Drivers of HP-at-Risk in Canada
(Coefficients: 10th percentile; HaR 12q ahead)



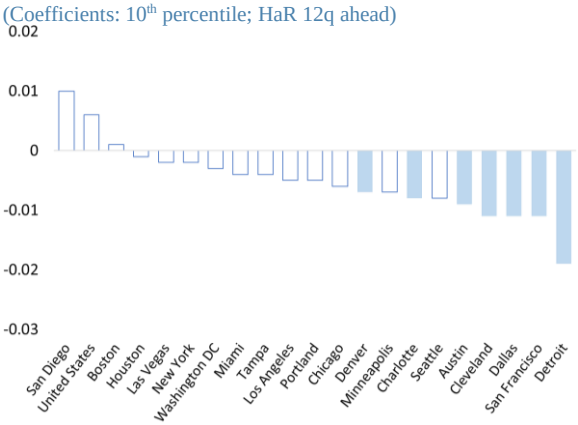
3. Sensitivity of House Price-at-Risk to Financial Conditions in the US
(Coefficients: 10th percentile; HaR 12q ahead)



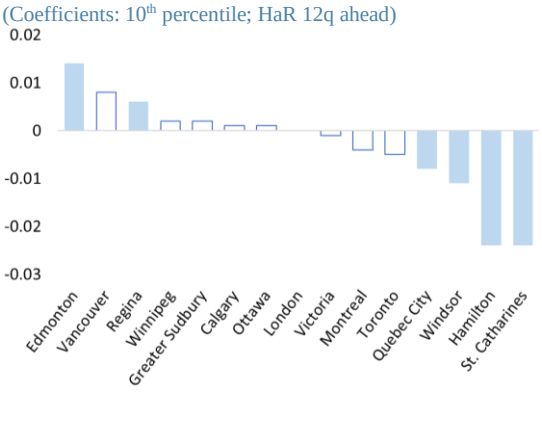
4. Sensitivity of House Price-at-Risk to Financial Conditions in Canada
(Coefficients: 10th percentile; HaR 12q ahead)



5. Sensitivity of House Price-at-Risk to Household Debt in the US
(Coefficients: 10th percentile; HaR 12q ahead)

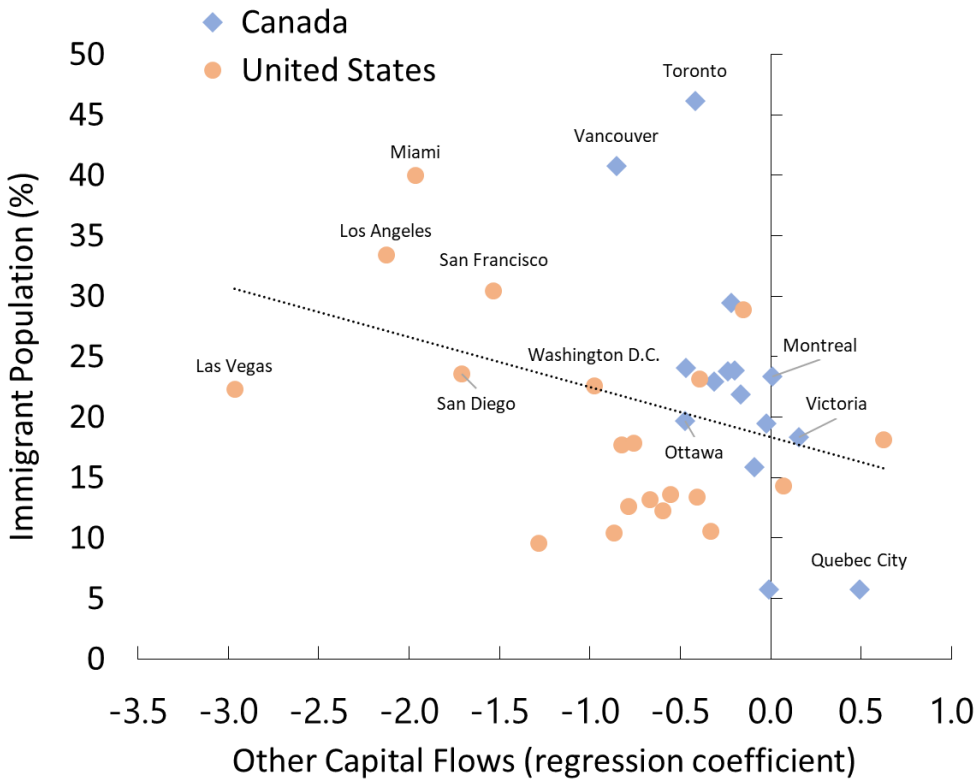


6. Sensitivity of House Price-at-Risk to Household Debt in Canada
(Coefficients: 10th percentile; HaR 12q ahead)



Source: CREA; Statistics Canada; Haver; IMF staff calculations.
Notes: Colored bars indicate statistical significance at the 10 percent level or higher. Outlined bars indicate insignificant coefficients.

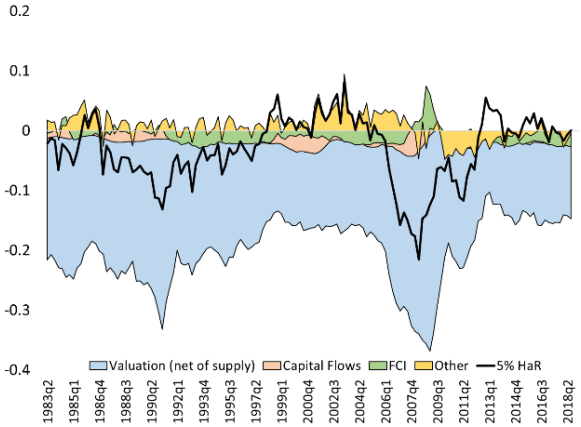
Annex Figure 4. Foreign Openness and Sensitivity to Capital Inflows



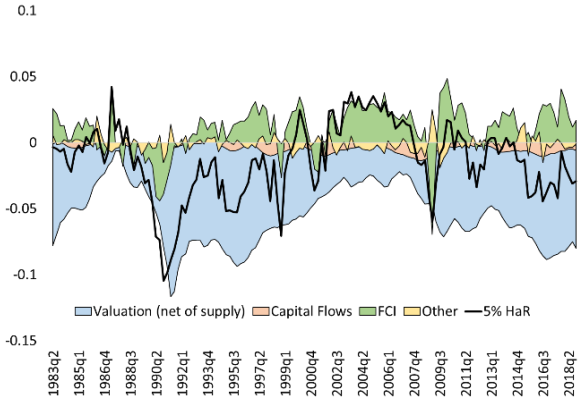
Source: American Community Survey, Statistics Canada, IMF staff calculations.
Notes: Immigrant population is the ratio of immigrants to total population of that respective area. The other capital flows coefficient refers to the 10th percentile quantile regression at 4q-ahead forecast horizon. Foreign openness is proxied by the 2017 immigration data for the United States and 2016 immigration data for Canada.

Annex Figure 5. Contributions to Short-term House Price Risks

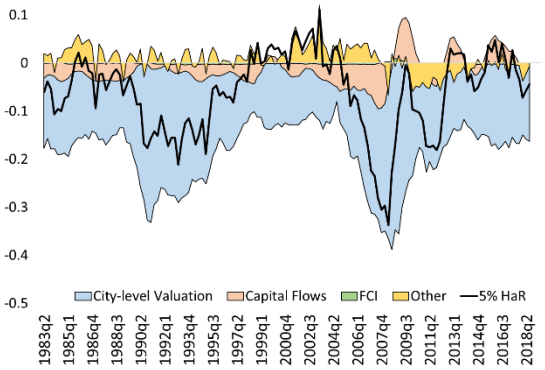
1. Contribution to the US' House Price Risks



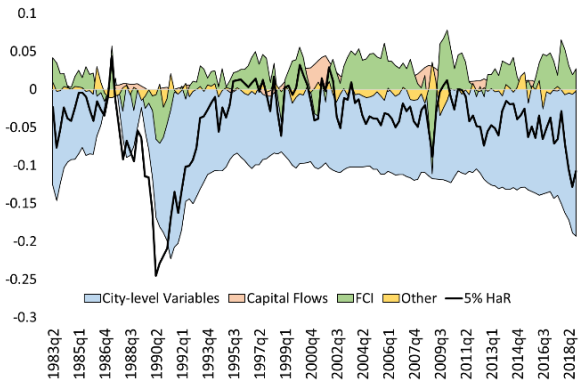
2. Contribution to the Canada's House Price Risks



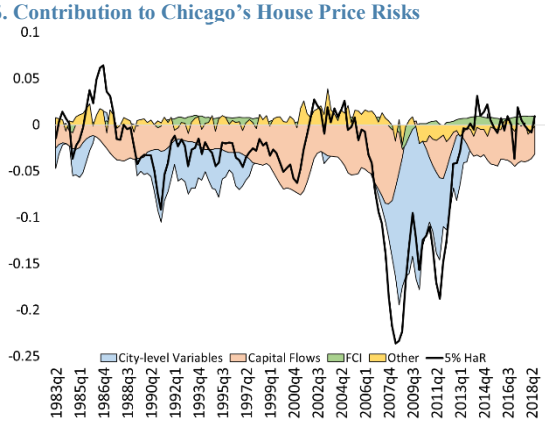
3. Contribution to Los Angeles's House Price Risks



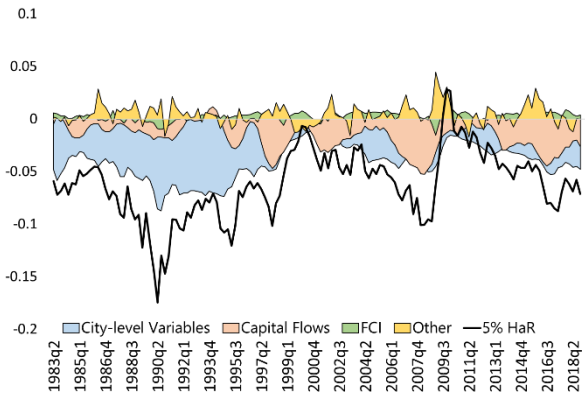
4. Contribution to Toronto's House Price Risks



5. Contribution to Chicago's House Price Risks



6. Contribution to the Vancouver's House Price Risks



Source: BIS; Statistics Canada; Haver; IMF staff calculations.

Note: Variable contributions are calculated using the coefficients at the 10th percentile.

Annex Table 1. United States: Short-term City-level Coefficients

Tau	Variable	Austin	Boston	Charlotte	Chicago	Cleveland	Dallas	Denver	Detroit	Houston	Las Vegas	Los Angeles	Miami	Minneapolis	New York	Philadelphia	Phoenix	Portland	San Diego	San Francisco	Seattle	Tampa	Washington DC	United States
0.1	House Price-to-Income	-0.210***	-0.204***	-0.019	-0.050**	-0.031	-0.017	-0.036	-0.022	-0.042**	-0.115	-0.141***	-0.124***	-0.032	-0.160***	-0.101***	-0.214***	-0.182***	-0.177***	-0.124***	-0.226***	-0.139***	-0.137***	-0.190***
		(0.062)	(0.028)	(0.031)	(0.024)	(0.021)	(0.020)	(0.024)	(0.025)	(0.021)	(0.081)	(0.025)	(0.021)	(0.027)	(0.021)	(0.025)	(0.052)	(0.041)	(0.024)	(0.037)	(0.041)	(0.019)	(0.019)	(0.018)
	Housing Starts	-0.027	0.029*	0.079***	0.040***	0.049***	0.077***	0.032**	0.020	0.083***	0.078***	0.053*	0.073**	0.046***	0.005	0.037	0.081**	-0.038*	0.065***	0.041	-0.004	0.094***	0.018	0.120***
		(0.043)	(0.017)	(0.025)	(0.014)	(0.015)	(0.021)	(0.013)	(0.017)	(0.021)	(0.027)	(0.031)	(0.031)	(0.017)	(0.008)	(0.029)	(0.034)	(0.022)	(0.020)	(0.034)	(0.017)	(0.021)	(0.024)	(0.030)
	FCI	-0.045**	0.032***	-0.035***	-0.012	-0.028***	-0.018	-0.031*	-0.030***	-0.000	-0.013	0.004	0.008	-0.042***	0.019**	0.004	0.019	-0.036*	0.005	-0.080***	-0.058***	0.027	0.016	0.033**
		(0.020)	(0.007)	(0.013)	(0.008)	(0.009)	(0.015)	(0.016)	(0.008)	(0.011)	(0.026)	(0.019)	(0.019)	(0.012)	(0.009)	(0.011)	(0.032)	(0.020)	(0.015)	(0.028)	(0.011)	(0.019)	(0.011)	(0.016)
	Household Debt	-0.000	0.016**	0.007	0.014*	0.009***	0.008	0.003	0.004	0.010	0.045**	0.038***	0.035***	0.013	0.008	0.016**	0.027***	0.015*	0.050***	0.013	0.024***	0.024**	0.007	0.031***
		(0.006)	(0.007)	(0.005)	(0.007)	(0.003)	(0.006)	(0.005)	(0.008)	(0.010)	(0.018)	(0.012)	(0.013)	(0.008)	(0.006)	(0.008)	(0.008)	(0.008)	(0.008)	(0.010)	(0.005)	(0.010)	(0.009)	(0.006)
	FDI	-0.174	-0.709*	-0.063	-1.606**	-0.600	0.077***	1.134**	-1.054*	2.039***	-0.460	1.129*	0.486	-0.588	-0.822	0.630	-1.252	1.049	1.392**	1.989	2.012***	-0.159	-1.259	-0.825*
		(0.855)	(0.430)	(0.860)	(0.724)	(0.683)	(0.021)	(0.382)	(0.690)	(0.668)	(1.295)	(0.694)	(0.691)	(0.776)	(0.508)	(0.673)	(1.382)	(0.731)	(0.755)	(1.309)	(0.661)	(0.839)	(0.632)	(0.886)
	Other Capital Flows	-0.984***	0.626***	-0.659***	-0.823***	-0.698***	-0.017	-0.599*	-1.283***	-0.391	-2.964***	-2.127***	-1.966***	-0.868***	-0.150	-0.330	0.069	-0.786*	-1.708***	-1.533***	-0.760***	-0.670**	-0.977***	-0.408
		(0.320)	(0.370)	(0.262)	(0.377)	(0.189)	(0.020)	(0.250)	(0.336)	(0.284)	(0.517)	(0.334)	(0.421)	(0.314)	(0.299)	(0.368)	(0.592)	(0.271)	(0.558)	(0.534)	(0.360)	(0.402)	(0.282)	(0.363)
	Oil	-0.045	0.021	-0.026	-0.006	-0.027	-0.033	-0.003	-0.036	0.014	-0.120	-0.091*	-0.018	-0.027	-0.003	-0.050*	-0.025	-0.032	-0.103**	0.040	-0.063**	0.004	-0.033	-0.042
		(0.037)	(0.022)	(0.021)	(0.027)	(0.017)	(0.039)	(0.035)	(0.023)	(0.028)	(0.081)	(0.050)	(0.036)	(0.027)	(0.019)	(0.029)	(0.058)	(0.034)	(0.044)	(0.052)	(0.029)	(0.046)	(0.035)	(0.033)
	Intercept	0.279***	0.310***	-0.005	0.062	0.014	0.019	0.002	0.014	0.007	0.072	0.160***	0.163***	0.022	0.235***	0.109***	0.250***	0.170***	0.199***	0.095	0.242***	0.184***	0.209***	0.207***
		(0.095)	(0.047)	(0.043)	(0.037)	(0.033)	(0.027)	(0.038)	(0.033)	(0.038)	(0.085)	(0.044)	(0.029)	(0.048)	(0.037)	(0.041)	(0.068)	(0.047)	(0.038)	(0.062)	(0.053)	(0.038)	(0.033)	(0.023)
	AR	0.540***	0.875***	0.725***	0.809***	0.598***	-0.732**	0.572***	0.798***	0.190	0.577***	0.510***	0.616***	0.685***	0.861***	0.705***	0.559***	0.629***	0.480***	0.432**	0.232**	0.726***	0.814***	0.657***
		(0.133)	(0.062)	(0.097)	(0.097)	(0.104)	(0.307)	(0.093)	(0.081)	(0.254)	(0.077)	(0.096)	(0.145)	(0.150)	(0.065)	(0.121)	(0.085)	(0.113)	(0.091)	(0.172)	(0.093)	(0.105)	(0.083)	(0.103)
0.5	House Price-to-Income	-0.070	-0.170***	0.004	-0.100***	-0.026	0.598***	-0.070***	-0.029	-0.056***	-0.140***	-0.174***	-0.127***	-0.070***	-0.157***	-0.109***	-0.131***	-0.150***	-0.129***	-0.174***	-0.197***	-0.118***	-0.148***	-0.188***
		(0.047)	(0.016)	(0.024)	(0.019)	(0.021)	(0.132)	(0.021)	(0.024)	(0.009)	(0.048)	(0.019)	(0.027)	(0.024)	(0.016)	(0.015)	(0.026)	(0.036)	(0.017)	(0.030)	(0.032)	(0.028)	(0.016)	(0.030)
	Housing Starts	0.103***	0.021	0.065**	0.046***	0.043***	0.000	0.030**	0.048**	0.056***	0.054***	0.002	0.049	0.030**	0.022	0.025	0.100***	-0.006	0.037**	-0.036	-0.016	0.093***	0.025	0.074***
		(0.031)	(0.020)	(0.029)	(0.013)	(0.014)	(0.010)	(0.015)	(0.021)	(0.010)	(0.018)	(0.019)	(0.035)	(0.012)	(0.021)	(0.017)	(0.026)	(0.027)	(0.016)	(0.027)	(0.018)	(0.026)	(0.021)	(0.021)
	FCI	0.002	0.028***	-0.028**	-0.003	-0.018	1.553***	-0.007	-0.011	-0.010	-0.006	0.021**	0.016	-0.007	0.020**	0.012	0.016	-0.042**	0.017**	-0.015	-0.049***	0.022*	0.018***	0.034***
		(0.015)	(0.009)	(0.011)	(0.010)	(0.011)	(0.542)	(0.011)	(0.010)	(0.006)	(0.022)	(0.010)	(0.018)	(0.010)	(0.010)	(0.011)	(0.019)	(0.019)	(0.008)	(0.012)	(0.008)	(0.012)	(0.007)	(0.007)
	Household Debt	-0.009**	0.016**	0.001	0.015**	0.005	-0.008*	-0.004	0.001	0.003	0.029**	0.017*	0.011	0.005	0.012	0.004	0.018***	0.009	0.021**	0.013	0.007	0.008	0.009	0.015***
		(0.004)	(0.007)	(0.004)	(0.007)	(0.004)	(0.004)	(0.006)	(0.008)	(0.004)	(0.011)	(0.009)	(0.015)	(0.007)	(0.008)	(0.008)	(0.006)	(0.007)	(0.008)	(0.011)	(0.006)	(0.008)	(0.008)	(0.005)
	FDI	0.152	-0.732*	0.146	-1.455**	-0.531	0.084***	0.128	-0.966	1.278***	-0.270	-1.091**	-0.080	-0.740	-1.184**	-1.186	-0.133	0.543	0.633*	-0.246	1.577***	-0.006	-0.687	-1.213***
		(0.661)	(0.489)	(0.466)	(0.737)	(0.831)	(0.015)	(0.433)	(0.822)	(0.498)	(0.900)	(0.516)	(0.610)	(0.561)	(0.489)	(0.828)	(0.765)	(0.665)	(0.498)	(0.965)	(0.297)	(0.693)	(0.786)	(0.342)
	Other Capital Flows	-0.251	0.768***	-0.181	-0.070	-0.306	-0.008	-0.217	-0.647**	-0.035	-1.053*	-1.308***	-1.578***	-0.216	-0.126	-0.140	-0.042	-0.622**	-0.951***	-1.081***	-0.226	-0.212	-0.372	-0.186
		(0.295)	(0.240)	(0.313)	(0.211)	(0.210)	(0.015)	(0.324)	(0.348)	(0.228)	(0.617)	(0.493)	(0.494)	(0.279)	(0.329)	(0.255)	(0.410)	(0.289)	(0.477)	(0.375)	(0.207)	(0.334)	(0.325)	(0.251)
	Oil	0.017	-0.012	-0.019	-0.009	-0.017	-0.023	-0.027	-0.017	0.012	0.006	-0.061*	0.011	-0.020	0.004	0.008	-0.037	-0.037*	-0.034	-0.058	-0.031	-0.001	-0.024	-0.031*
		(0.030)	(0.019)	(0.023)	(0.023)	(0.020)	(0.028)	(0.023)	(0.029)	(0.015)	(0.045)	(0.032)	(0.030)	(0.024)	(0.030)	(0.026)	(0.032)	(0.021)	(0.026)	(0.038)	(0.025)	(0.030)	(0.025)	(0.017)
	Intercept	0.098	0.269***	-0.026	0.131***	0.020	0.017	0.082***	0.040	0.055***	0.117**	0.273***	0.194***	0.108***	0.252***	0.175***	0.155***	0.167***	0.174***	0.245***	0.225***	0.171***	0.226***	0.231***
		(0.069)	(0.028)	(0.035)	(0.030)	(0.035)	(0.023)	(0.031)	(0.030)	(0.018)	(0.049)	(0.032)	(0.038)	(0.041)	(0.027)	(0.033)	(0.038)	(0.041)	(0.026)	(0.036)	(0.042)	(0.045)	(0.030)	(0.035)
	AR	0.633***	0.845***	0.745***	0.642***	0.551***	-0.073	0.647***	0.798***	0.120	0.525***	0.720***	0.716***	0.575***	0.778***	0.636***	0.468***	0.446***	0.574***	0.688***	0.289***	0.658***	0.767***	0.751***
		(0.155)	(0.060)	(0.112)	(0.125)	(0.075)	(0.312)	(0.093)	(0.081)	(0.145)	(0.070)	(0.087)	(0.144)	(0.093)	(0.059)	(0.083)	(0.082)	(0.078)	(0.064)	(0.095)	(0.058)	(0.107)	(0.073)	(0.085)
0.9	House Price-to-Income	-0.026	-0.171***	-0.024	-0.074***	-0.014	0.595***	-0.097***	-0.033	-0.060***	-0.157***	-0.204***	-0.109***	-0.080***	-0.162***	-0.099***	-0.131***	-0.089***	-0.166***	-0.165***	-0.184***	-0.110***	-0.161***	-0.201***
		(0.024)	(0.013)	(0.024)	(0.015)	(0.022)	(0.086)	(0.014)	(0.024)	(0.007)	(0.056)	(0.016)	(0.018)	(0.014)	(0.021)	(0.025)	(0.029)	(0.022)	(0.017)	(0.027)	(0.024)	(0.025)	(0.020)	(0.031)
	Housing Starts	0.067**	0.025	0.040**	0.033**	0.024	0.001	0.029***	0.050***	0.037**	0.052**	-0.016	0.060**	0.030***	0.035*	0.039**	0.094***	0.026	0.020	0.001	0.021	0.107***	-0.005	0.082***
		(0.031)	(0.016)	(0.019)	(0.014)	(0.021)	(0.012)	(0.010)	(0.018)	(0.018)	(0.023)	(0.017)	(0.028)	(0.010)	(0.020)	(0.019)	(0.023)	(0.020)	(0.018)	(0.025)	(0.016)	(0.021)	(0.018)	(0.017)
	FCI	-0.003	0.039***	-0.020*	-0.002	-0.011	0.680*	-0.008	0.001	-0.012**	0.006	0.026**	0.006	-0.003	0.033***	0.015	0.012	-0.027**	0.021**	-0.011	-0.028**	0.023	0.024**	0.043***
		(0.009)	(0.010)	(0.011)	(0.007)	(0.009)	(0.441)	(0.011)	(0.008)	(0.006)	(0.022)	(0.011)	(0.014)	(0.010)	(0.009)	(0.009)	(0.014)	(0.011)	(0.010)	(0.010)	(0.011)	(0.015)	(0.010)	(0.008)
	Household Debt	-0.013***	0.020***	-0.006	0.017***	0.003	-0.008*	-0.006	-0.006	-0.001	0.008	0.005	0.019**	0.009**	0.013*	0.009	0.010	0.002	0.014**	0.004	0.003	0.014**	0.004	0.017***
		(0.004)	(0.005)	(0.003)	(0.004)	(0.004)	(0.004)	(0.005)	(0.006)	(0.003)	(0.010)	(0.008)	(0.007)	(0.004)	(0.007)	(0.006)	(0.008)	(0.004)	(0.006)	(0.007)	(0.005)	(0.006)	(0.007)	(0.004)
	FDI	-0.829**	-1.320***	-0.112	-0.575	0.043	0.045*	-0.448	-0.654	0.738**	-1.306	-1.330**	0.185	-0.564	-1.807***	-1.404*	-0.417	-0.015	0.354	1.941*	1.197***	-0.268	-0.846	-1.457***
		(0.300)	(0.404)	(0.356)	(0.473)	(0.632)	(0.026)	(0.443)	(0.564)	(0.339)	(1.150)	(0.607)	(0.549)	(0.643)	(0.424)	(0.661)	(0.502)	(0.349)	(0.503)	(1.093)	(0.348)	(0.702)	(0.539)	(0.497)
	Other Capital Flows	0.090	0.446**	0.065	0.035	0.044	-0.007	0.045	-0.354	0.108	-0.671	-0.602**	-0.981**	0.226	0.038	0.079	0.286	-0.229	-0.074	-0.698**	-0.256	0.102	-0.180	-0.046
		(0.202)	(0.199)	(0.199)	(0.231)	(0.241)	(0.010)	(0.200)	(0.389)	(0.194)	(0.715)	(0.367)	(0.538)	(0.212)	(0.293)	(0.244)	(0.467)	(0.253)	(0.424)	(0.305)	(0.183)	(0.326)	(0.241)	(0.286)
	Oil	0.041*	-0.016	0.002	0.006	-0.023	0.006	-0.009	-0.006	-0.009	-0.029	-0.028	-0.063***	-0.009	0.008	0.018	-0.016	-0.035*	-0.016	-0.033	-0.014	-0.006	-0.006	-0.014
		(0.022)	(0.019)	(0.024)	(0.015)	(0.022)	(0.022)	(0.022)	(0.021)	(0.016)	(0.042)	(0.022)	(0.024)	(0.018)	(0.023)	(0.029)	(0.020)	(0.021)	(0.021)	(0.035)	(0.024)	(0.024)	(0.025)	(0.015)
	Intercept	0.064*	0.307***	0.033	0.108***	0.012	0.005	0.138***	0.060*	0.078***	0.192***	0.334***	0.189***	0.134***	0.295***	0.181***	0.181***	0.122***	0.242***	0.236***	0.235***	0.180***	0.270***	0.264***
		(0.038)	(0.021)	(0.036)	(0.025)	(0.032)	(0.020)	(0.024)	(0.031)	(0.013)	(0.073)	(0.030)	(0.032)	(0.029)	(0.036)	(0.048)	(0.045)	(0.028)	(0.025)	(0.030)	(0.030)	(0.047)	(0.038)	(0.037)
	AR	0.607***	0.782***	0.554***	0.480***	0.408***	0.003	0.637***	0.740***	0.164	0.573***	0.771***	0.654***	0.429***	0.733***	0.659***	0.496***	0.521***	0.628***	0.713***	0.479***	0.611***	0.769***	0.703***
		(0.070)	(0.048)	(0.082)	(0.076)	(0.117)	(0.213)	(0.117)	(0.078)	(0.100)	(0.099)	(0.077)	(0.076)	(0.069)	(0.057)	(0.100)	(0.108)	(0.071)	(0.073)	(0.099)	(0.100)	(0.107)	(0.103)	(0.104)

Note: The dependent variable is city-level residential house price year-on-year growth, 4 quarters ahead. Household debt, FDI, and other capital flows are scaled by GDP. FCI is the price-based financial conditions index. House price to income is the city-level house price over state-level income. Housing starts is the log growth of state-level housing starts. Oil is the quarter-on-quarter growth of the oil price index.

Annex Table 2. Canada: Short-term City-level Coefficients

Tau	Variable	Calgary	Edmonton	Hamilton	London	Montreal	Quebec City	Regina	Toronto	Vancouver	Victoria	Windsor	Winnipeg	Ottawa	Greater Sudbury	St. Catharines	Canada
0.1	House Price-to-Income	-0.249***	-0.241***	-0.016	-0.075***	-0.001	-0.073***	-0.024	-0.065**	0.037**	0.079***	-0.024	0.017	-0.101***	-0.010	-0.149***	-0.187***
		(0.093)	(0.028)	(0.028)	(0.020)	(0.011)	(0.014)	(0.022)	(0.029)	(0.018)	(0.021)	(0.040)	(0.017)	(0.021)	(0.012)	(0.043)	(0.036)
	Residential Investment	-3.849	7.954**	-13.114*	9.007***	1.321	12.668***	-4.731***	-12.629**	-9.040***	-10.669***	5.291*	-4.110**	13.839***	8.849***	8.655	7.391***
		(6.678)	(3.371)	(7.050)	(2.735)	(1.777)	(1.817)	(1.582)	(6.192)	(1.422)	(3.028)	(3.149)	(1.859)	(2.184)	(1.565)	(6.684)	(1.509)
	FCI	-0.056**	-0.049**	-0.031*	-0.031***	-0.017**	-0.015**	-0.022	-0.111***	-0.015	-0.017	-0.008	-0.019***	-0.058***	-0.006	-0.055***	-0.069***
		(0.024)	(0.019)	(0.017)	(0.010)	(0.008)	(0.007)	(0.016)	(0.025)	(0.013)	(0.020)	(0.007)	(0.005)	(0.013)	(0.006)	(0.016)	(0.017)
	Household Debt	0.020**	0.028***	0.007*	0.005*	0.005***	-0.000	0.010**	-0.004	0.010	0.004	-0.002	0.001	0.002	0.002	-0.003	-0.002
		(0.008)	(0.004)	(0.004)	(0.003)	(0.002)	(0.003)	(0.004)	(0.006)	(0.006)	(0.004)	(0.003)	(0.003)	(0.005)	(0.002)	(0.007)	(0.005)
	FDI	1.037***	-0.520	0.217	0.104	0.024	0.733***	-0.044	0.536***	-0.341	-0.350	0.294***	0.056	0.684***	-0.014	0.274*	-0.115
		(0.357)	(0.318)	(0.135)	(0.110)	(0.122)	(0.060)	(0.187)	(0.198)	(0.217)	(0.260)	(0.114)	(0.084)	(0.191)	(0.072)	(0.155)	(0.221)
	Other Capital Flows	-0.219	-0.239	-0.469*	-0.023	0.011	0.493***	-0.091	-0.416	-0.853***	0.156	-0.313*	-0.198**	-0.472**	-0.012	0.586**	-0.165
		(0.571)	(0.259)	(0.266)	(0.146)	(0.121)	(0.105)	(0.271)	(0.319)	(0.227)	(0.296)	(0.175)	(0.090)	(0.223)	(0.149)	(0.268)	(0.194)
	Oil	0.030	-0.018	-0.014	-0.010	-0.014	-0.002	-0.016	-0.057	-0.050*	-0.005	-0.014	-0.019**	-0.028	0.000	0.025	-0.038
		(0.043)	(0.042)	(0.024)	(0.022)	(0.010)	(0.011)	(0.022)	(0.039)	(0.028)	(0.028)	(0.015)	(0.008)	(0.020)	(0.009)	(0.041)	(0.033)
	Intercept	0.171***	0.144***	0.056**	0.018	-0.012*	-0.026***	0.033***	0.072*	0.016	-0.030	-0.024	-0.003	-0.007	-0.052***	0.055	0.052***
		(0.047)	(0.025)	(0.028)	(0.026)	(0.007)	(0.010)	(0.011)	(0.037)	(0.019)	(0.027)	(0.038)	(0.008)	(0.016)	(0.012)	(0.047)	(0.013)
	AR	0.245***	0.136*	0.758***	0.162*	0.390***	0.238***	0.171**	0.559***	0.079	0.399***	0.328*	0.375***	-0.040	0.218**	0.171	0.291**
		(0.075)	(0.073)	(0.226)	(0.088)	(0.060)	(0.084)	(0.073)	(0.125)	(0.075)	(0.152)	(0.178)	(0.076)	(0.075)	(0.085)	(0.202)	(0.126)
0.5	House Price-to-Income	-0.137***	-0.081***	-0.021	-0.082***	-0.044***	-0.091***	-0.034**	-0.038**	-0.032	-0.013	-0.106***	-0.040***	-0.089***	-0.020***	-0.098***	-0.147***
		(0.036)	(0.025)	(0.015)	(0.010)	(0.010)	(0.014)	(0.015)	(0.017)	(0.021)	(0.018)	(0.033)	(0.015)	(0.023)	(0.007)	(0.021)	(0.041)
	Residential Investment	-4.071	0.859	0.816	11.616***	3.265*	8.294***	-2.413	2.102	-4.135	-8.769***	2.774	3.853*	7.228***	6.369***	2.902	5.153***
		(3.476)	(2.862)	(3.628)	(2.601)	(1.881)	(1.436)	(1.789)	(3.880)	(3.807)	(1.765)	(2.240)	(2.165)	(2.123)	(1.791)	(3.831)	(1.742)
	FCI	-0.064***	-0.050***	-0.043**	-0.027***	-0.032***	-0.009*	-0.025***	-0.060***	-0.014	-0.013	-0.013	-0.038***	-0.037***	-0.006	-0.041**	-0.023**
		(0.016)	(0.011)	(0.017)	(0.005)	(0.006)	(0.005)	(0.008)	(0.016)	(0.021)	(0.016)	(0.011)	(0.007)	(0.012)	(0.006)	(0.016)	(0.009)
	Household Debt	0.007	0.012***	0.000	0.002	0.004*	-0.000	0.011***	0.002	0.020***	0.013***	-0.000	0.007***	0.005	-0.000	0.001	0.005***
		(0.004)	(0.004)	(0.002)	(0.002)	(0.002)	(0.001)	(0.003)	(0.003)	(0.005)	(0.004)	(0.003)	(0.002)	(0.003)	(0.002)	(0.003)	(0.002)
	FDI	0.347**	-0.202	0.161	0.070	0.432***	0.626***	0.053	0.316**	-0.260	-0.051	-0.127	-0.231**	0.484***	-0.029	0.003	-0.161
		(0.171)	(0.368)	(0.170)	(0.061)	(0.090)	(0.123)	(0.164)	(0.145)	(0.245)	(0.201)	(0.098)	(0.104)	(0.165)	(0.078)	(0.166)	(0.148)
	Other Capital Flows	-0.128	-0.447**	-0.226	0.037	-0.010	0.465***	-0.057	-0.126	-0.171	-0.134	-0.012	0.060	-0.206	-0.047	0.421*	-0.364**
		(0.269)	(0.193)	(0.219)	(0.093)	(0.092)	(0.093)	(0.218)	(0.144)	(0.505)	(0.222)	(0.163)	(0.177)	(0.249)	(0.127)	(0.248)	(0.151)
	Oil	-0.026	-0.018	-0.023	-0.003	-0.004	-0.005	0.012	-0.051**	-0.036	0.033	-0.008	-0.022**	-0.014	-0.006	-0.027	-0.024*
		(0.020)	(0.021)	(0.024)	(0.008)	(0.011)	(0.012)	(0.015)	(0.023)	(0.029)	(0.038)	(0.014)	(0.011)	(0.013)	(0.010)	(0.022)	(0.014)
	Intercept	0.144***	0.077***	0.016	0.030*	0.014	0.028***	0.045***	0.018	0.065***	0.080***	0.098**	0.036***	0.039*	-0.011	0.077***	0.077***
		(0.018)	(0.020)	(0.016)	(0.017)	(0.009)	(0.009)	(0.011)	(0.023)	(0.022)	(0.021)	(0.038)	(0.012)	(0.021)	(0.011)	(0.018)	(0.017)
	AR	0.222**	0.396***	0.605***	0.096	0.520***	0.386***	0.558***	0.474***	0.462***	0.740***	0.261**	0.475***	0.287***	0.286***	0.469***	0.445***
		(0.099)	(0.087)	(0.093)	(0.102)	(0.080)	(0.070)	(0.127)	(0.085)	(0.125)	(0.078)	(0.114)	(0.106)	(0.109)	(0.099)	(0.098)	(0.067)
0.9	House Price-to-Income	-0.081	-0.201**	-0.058***	-0.205***	-0.062***	-0.122***	-0.058***	-0.150***	-0.131***	-0.116***	-0.163***	-0.039	-0.120***	-0.090**	-0.154***	-0.168***
		(0.096)	(0.083)	(0.015)	(0.030)	(0.018)	(0.020)	(0.021)	(0.033)	(0.021)	(0.019)	(0.023)	(0.028)	(0.019)	(0.036)	(0.026)	(0.058)
	Residential Investment	-8.799	-7.906	-1.540	13.137*	1.053	13.473***	-0.891	40.126***	7.334	-9.961***	3.521	-0.286	2.667	16.107***	10.875***	3.702
		(10.870)	(6.979)	(3.875)	(6.885)	(3.025)	(3.199)	(3.518)	(7.586)	(6.160)	(3.278)	(2.525)	(5.806)	(3.533)	(2.344)	(2.610)	(2.878)
	FCI	-0.031	-0.069*	-0.029*	-0.043***	-0.031***	-0.009	-0.056***	-0.087***	0.020	-0.020	-0.040***	-0.035***	-0.055***	-0.019**	-0.025	-0.021
		(0.041)	(0.036)	(0.016)	(0.011)	(0.011)	(0.008)	(0.016)	(0.029)	(0.031)	(0.017)	(0.011)	(0.013)	(0.014)	(0.010)	(0.022)	(0.016)
	Household Debt	0.013	0.015**	0.003	0.006**	0.002	-0.003	0.004	0.014*	0.019***	0.017***	0.014**	0.015***	-0.004	0.008*	0.007**	0.012***
		(0.011)	(0.007)	(0.004)	(0.003)	(0.002)	(0.002)	(0.004)	(0.008)	(0.005)	(0.005)	(0.006)	(0.005)	(0.005)	(0.005)	(0.004)	(0.003)
	FDI	-0.725*	-0.577	-0.236**	-0.591***	-0.364*	0.499***	0.100	-0.923***	-0.250	-0.730***	-0.180	-0.160	0.294	-0.061	-0.710***	-0.652***
		(0.401)	(0.392)	(0.120)	(0.166)	(0.204)	(0.088)	(0.147)	(0.289)	(0.428)	(0.253)	(0.177)	(0.165)	(0.199)	(0.259)	(0.223)	(0.120)
	Other Capital Flows	-0.925	-0.521	-0.031	0.576**	0.300	0.444***	1.316**	-0.797*	0.611	1.365***	-0.460	0.112	0.144	-0.042	0.841**	0.820*
		(0.609)	(0.847)	(0.321)	(0.281)	(0.215)	(0.159)	(0.634)	(0.422)	(0.624)	(0.427)	(0.295)	(0.364)	(0.238)	(0.222)	(0.417)	(0.423)
	Oil	-0.004	-0.065	-0.021	-0.041***	-0.045***	-0.020	0.007	-0.112**	-0.008	-0.034	-0.055	-0.036	-0.009	0.007	-0.002	-0.057*
		(0.062)	(0.064)	(0.017)	(0.015)	(0.012)	(0.013)	(0.020)	(0.045)	(0.036)	(0.031)	(0.037)	(0.033)	(0.018)	(0.017)	(0.019)	(0.030)
	Intercept	0.200***	0.299***	0.090***	0.172***	0.066***	0.054***	0.059***	-0.003	0.110**	0.215***	0.181***	0.058***	0.118***	0.033	0.132***	0.142***
		(0.054)	(0.059)	(0.018)	(0.024)	(0.012)	(0.012)	(0.013)	(0.032)	(0.047)	(0.032)	(0.027)	(0.015)	(0.026)	(0.033)	(0.027)	(0.018)
	AR	0.958**	0.739***	0.987***	0.427*	1.168***	0.344**	1.098***	0.550***	0.296***	0.648***	0.363**	0.849***	0.760***	-0.011	0.311*	0.703***
		(0.374)	(0.126)	(0.103)	(0.230)	(0.269)	(0.164)	(0.232)	(0.160)	(0.108)	(0.092)	(0.144)	(0.239)	(0.230)	(0.178)	(0.165)	(0.102)

Note: The dependent variable is city-level residential house price year-on-year growth, 4 quarters ahead. Household debt, FDI, residential investment, and other capital flows are scaled by GDP. FCI is the price-based financial conditions index. House price to income is at the city level. Residential investment is the city-level residentital investment as a share of provincial-level GDP. Oil is the quarter-on-quarter growth of the oil price index.

Annex Table 3. United States: Long-term City-level Coefficients

Tau	Variable	Atlanta	Boston	Charlotte	Chicago	Cleveland	Dallas	Denver	Detroit	Houston	Las Vegas	Los Angeles	Miami	Minneapolis	New York	Philadelphia	Phoenix	Portland	San Diego	San Francisco	Seattle	Tampa	Washington DC	United States
0.1	House Price-to-Income	0.138***	-0.016	0.061*	0.024	0.057***	0.048*	0.038**	0.038	-0.001	-0.028	0.094**	0.056	0.015	-0.014	-0.007	-0.015	0.028	0.085***	0.172***	0.016	-0.009	-0.002	0.023
		(0.035)	(0.021)	(0.034)	(0.030)	(0.018)	(0.028)	(0.018)	(0.027)	(0.023)	(0.037)	(0.043)	(0.056)	(0.018)	(0.014)	(0.024)	(0.028)	(0.020)	(0.026)	(0.025)	(0.019)	(0.036)	(0.032)	(0.031)
	Housing Starts	-0.447	0.656**	-0.355	-0.080	-0.206	-0.154	-0.572	-0.056	-0.983***	1.512*	0.297	-0.325	-0.171	0.896***	-0.162	-1.218***	-0.993***	-0.484*	0.282	-0.827***	0.231	-0.099	-0.029
		(0.005)	(0.003)	(0.004)	(0.003)	(0.003)	(0.002)	(0.004)	(0.005)	(0.003)	(0.009)	(0.005)	(0.004)	(0.003)	(0.003)	(0.003)	(0.004)	(0.003)	(0.003)	(0.007)	(0.003)	(0.005)	(0.002)	(0.003)
	FCI	0.007	0.008	0.003	0.009	-0.004	-0.017	-0.017	0.009	-0.030***	-0.004	0.019	-0.004	0.010	0.011	-0.001	-0.046***	-0.022**	-0.003	-0.039***	-0.046***	0.006	-0.002	-0.008
		(0.019)	(0.010)	(0.019)	(0.010)	(0.009)	(0.011)	(0.015)	(0.010)	(0.011)	(0.041)	(0.019)	(0.022)	(0.012)	(0.011)	(0.014)	(0.016)	(0.010)	(0.012)	(0.012)	(0.012)	(0.035)	(0.014)	(0.016)
	Household Debt	-0.014***	0.001	-0.008***	-0.006	-0.011***	-0.011***	-0.007**	-0.019***	-0.001	-0.002	-0.005	-0.004	-0.007	-0.002	-0.006***	-0.003	-0.005	0.010***	-0.011**	-0.008	-0.004	-0.003	0.006***
		(0.003)	(0.003)	(0.003)	(0.004)	(0.003)	(0.002)	(0.003)	(0.004)	(0.002)	(0.007)	(0.004)	(0.005)	(0.004)	(0.002)	(0.002)	(0.004)	(0.004)	(0.003)	(0.004)	(0.005)	(0.006)	(0.002)	(0.002)
	FDI	0.450	-0.594	-4.709*	-5.188***	0.566	-0.531	-0.476	-6.657**	-0.418	-14.484***	0.624	2.570***	-5.456***	-0.771*	-2.388	-3.974**	-1.106	2.438***	4.079***	-0.182	-7.452**	-0.034	-4.113***
		(0.015)	(0.006)	(0.025)	(0.016)	(0.013)	(0.015)	(0.006)	(0.027)	(0.008)	(0.037)	(0.017)	(0.009)	(0.015)	(0.005)	(0.017)	(0.018)	(0.010)	(0.007)	(0.007)	(0.011)	(0.032)	(0.010)	(0.013)
	Other Capital Flows	0.028	0.030	0.033	0.037	0.022	0.014	0.007	-0.003	-0.035	0.064	0.090**	0.015	0.032	0.040*	0.023	-0.009	0.019	0.030	-0.049	-0.030	0.003	0.010	-0.011
		(0.031)	(0.030)	(0.034)	(0.026)	(0.023)	(0.023)	(0.023)	(0.043)	(0.029)	(0.071)	(0.043)	(0.052)	(0.022)	(0.024)	(0.035)	(0.022)	(0.025)	(0.026)	(0.039)	(0.035)	(0.038)	(0.044)	(0.024)
	Oil	-0.038	0.407***	0.181*	0.206***	-0.062	0.077	0.140**	0.114	0.141**	0.591***	0.301***	0.400***	0.265***	0.375***	0.216***	0.337***	0.282***	0.389***	0.120**	0.201***	0.557***	0.398***	0.513***
		(0.060)	(0.046)	(0.106)	(0.061)	(0.046)	(0.052)	(0.058)	(0.081)	(0.056)	(0.112)	(0.057)	(0.060)	(0.078)	(0.026)	(0.059)	(0.092)	(0.040)	(0.031)	(0.060)	(0.052)	(0.108)	(0.065)	(0.032)
	Intercept	0.014	-0.262***	-0.103	-0.121***	0.035	-0.059**	-0.109**	-0.032	-0.098***	-0.497***	-0.239***	-0.309***	-0.138***	-0.247***	-0.137***	-0.237***	-0.217***	-0.318***	-0.137***	-0.160***	-0.331***	-0.274***	-0.431***
		(0.033)	(0.027)	(0.063)	(0.044)	(0.026)	(0.024)	(0.043)	(0.051)	(0.032)	(0.105)	(0.032)	(0.038)	(0.044)	(0.014)	(0.029)	(0.063)	(0.030)	(0.021)	(0.042)	(0.041)	(0.058)	(0.036)	(0.029)
	AR	0.178**	0.299***	0.224*	0.187	0.522***	0.180	0.252*	0.247*	0.025	0.028	0.000	-0.042	0.281**	0.128**	0.234***	-0.221***	-0.010	-0.019	-0.256***	-0.118	0.016	0.065	-0.184**
		(0.082)	(0.051)	(0.114)	(0.124)	(0.142)	(0.205)	(0.132)	(0.143)	(0.175)	(0.099)	(0.063)	(0.135)	(0.131)	(0.060)	(0.067)	(0.061)	(0.099)	(0.053)	(0.067)	(0.121)	(0.111)	(0.054)	(0.078)
0.5	House Price-to-Income	0.124***	-0.008	0.078***	0.046*	0.081***	0.028	0.043***	0.098***	0.014	0.042	0.118***	0.080*	0.017	0.004	0.009	-0.020	0.003	0.064**	0.163***	0.025	0.054**	0.038	0.021
		(0.024)	(0.014)	(0.024)	(0.024)	(0.013)	(0.025)	(0.014)	(0.026)	(0.021)	(0.034)	(0.020)	(0.047)	(0.018)	(0.017)	(0.020)	(0.041)	(0.024)	(0.029)	(0.022)	(0.019)	(0.025)	(0.033)	(0.039)
	Housing Starts	0.093	0.483**	-0.441***	0.104	-0.309	-0.146	-0.215	0.029	-0.514***	1.278**	-0.378	-0.181	0.174	0.823***	-0.051	-1.376***	-0.472	0.022	-0.145	-0.739**	-0.086	0.329	-0.161
		(0.002)	(0.002)	(0.001)	(0.003)	(0.002)	(0.001)	(0.002)	(0.004)	(0.002)	(0.006)	(0.004)	(0.003)	(0.003)	(0.002)	(0.002)	(0.003)	(0.003)	(0.003)	(0.005)	(0.004)	(0.002)	(0.003)	(0.002)
	FCI	0.002	0.012	-0.017*	0.012	-0.001	-0.022**	-0.012	0.009	-0.018**	0.026	0.006	-0.008	0.000	0.026**	0.005	-0.060***	-0.043***	-0.006	-0.034**	-0.038***	0.005	0.018	-0.018
		(0.018)	(0.012)	(0.010)	(0.009)	(0.006)	(0.010)	(0.011)	(0.013)	(0.008)	(0.023)	(0.016)	(0.023)	(0.012)	(0.010)	(0.011)	(0.019)	(0.015)	(0.015)	(0.015)	(0.012)	(0.015)	(0.016)	(0.014)
	Household Debt	-0.013***	0.004	-0.005***	-0.000	-0.005***	-0.007***	-0.011***	-0.019***	-0.001	0.002	0.002	-0.002	-0.006**	-0.000	-0.002	-0.003	-0.008**	0.007**	-0.006**	-0.001	0.003	0.003	0.004*
		(0.003)	(0.003)	(0.002)	(0.003)	(0.001)	(0.001)	(0.002)	(0.004)	(0.002)	(0.004)	(0.005)	(0.004)	(0.003)	(0.002)	(0.002)	(0.006)	(0.003)	(0.003)	(0.003)	(0.004)	(0.003)	(0.002)	(0.002)
	FDI	0.594	-0.815	-0.203	-3.714**	0.669	-0.234	-0.404	-1.123	0.099	-8.956**	1.456	2.543***	-3.313*	-1.000*	-1.211	-2.016	-1.294	1.837**	2.968***	1.269	-0.479	-1.288	-1.358*
		(0.007)	(0.007)	(0.005)	(0.018)	(0.004)	(0.006)	(0.004)	(0.011)	(0.005)	(0.039)	(0.011)	(0.006)	(0.017)	(0.006)	(0.009)	(0.015)	(0.013)	(0.008)	(0.007)	(0.010)	(0.007)	(0.010)	(0.008)
	Other Capital Flows	0.046	0.051**	0.010	0.037**	0.014	0.025	0.015	0.033	-0.009	-0.031	0.029	0.032	0.039*	0.047**	-0.006	0.002	0.030	0.043	-0.003	-0.032	0.017	0.023	-0.000
		(0.033)	(0.023)	(0.014)	(0.018)	(0.011)	(0.021)	(0.023)	(0.023)	(0.021)	(0.050)	(0.055)	(0.036)	(0.020)	(0.021)	(0.024)	(0.030)	(0.028)	(0.028)	(0.040)	(0.035)	(0.031)	(0.039)	(0.023)
	Oil	-0.006	0.466***	0.060*	0.275***	-0.012	0.089***	0.124***	-0.034	0.156***	0.450***	0.262***	0.278***	0.201**	0.415***	0.257***	0.280***	0.273***	0.369***	0.176***	0.273***	0.345***	0.464***	0.376***
		(0.051)	(0.062)	(0.032)	(0.055)	(0.024)	(0.028)	(0.045)	(0.054)	(0.036)	(0.089)	(0.060)	(0.073)	(0.079)	(0.033)	(0.049)	(0.099)	(0.035)	(0.040)	(0.042)	(0.047)	(0.058)	(0.053)	(0.060)
	Intercept	0.000	-0.285***	-0.040*	-0.179***	0.001	-0.060***	-0.086***	0.054	-0.103***	-0.373***	-0.197***	-0.209***	-0.108***	-0.260***	-0.162***	-0.204***	-0.201***	-0.287***	-0.139***	-0.214***	-0.225***	-0.295***	-0.328***
		(0.030)	(0.036)	(0.022)	(0.032)	(0.017)	(0.014)	(0.032)	(0.040)	(0.021)	(0.057)	(0.032)	(0.048)	(0.041)	(0.019)	(0.028)	(0.078)	(0.023)	(0.023)	(0.027)	(0.036)	(0.039)	(0.029)	(0.055)
	AR	0.195	0.243***	0.203**	0.098	0.533***	0.091	0.191***	0.227**	-0.113	0.018	-0.048	-0.083	0.235	0.117**	0.143**	-0.243***	-0.092	0.016	-0.275***	-0.240**	0.099	0.058	-0.072
		(0.122)	(0.056)	(0.090)	(0.086)	(0.074)	(0.122)	(0.073)	(0.101)	(0.096)	(0.059)	(0.055)	(0.135)	(0.148)	(0.055)	(0.064)	(0.073)	(0.108)	(0.078)	(0.060)	(0.119)	(0.106)	(0.069)	(0.121)
0.9	House Price-to-Income	0.082***	-0.025*	0.069***	0.080***	0.037**	0.038	0.026***	0.096***	0.010	0.025	0.079***	0.102***	0.039*	-0.001	-0.001	0.006	-0.026**	0.087***	0.110***	0.007	0.061**	0.022	0.028
		(0.015)	(0.015)	(0.019)	(0.028)	(0.016)	(0.025)	(0.009)	(0.012)	(0.025)	(0.017)	(0.019)	(0.033)	(0.022)	(0.021)	(0.021)	(0.035)	(0.013)	(0.014)	(0.028)	(0.028)	(0.024)	(0.022)	(0.040)
	Housing Starts	0.017	0.607**	-0.436**	0.047	-0.052	-0.299	-0.467*	-0.094	-0.175	-0.084	0.543	-0.023	0.493**	0.617**	-0.317	-1.131***	-0.790***	0.286	-0.634**	-0.547*	0.135	0.435**	-0.445*
		(0.002)	(0.003)	(0.002)	(0.004)	(0.002)	(0.002)	(0.002)	(0.003)	(0.003)	(0.007)	(0.004)	(0.002)	(0.002)	(0.003)	(0.003)	(0.003)	(0.002)	(0.003)	(0.003)	(0.003)	(0.002)	(0.002)	(0.003)
	FCI	-0.030**	0.020**	-0.019**	0.016	0.001	-0.031***	-0.041***	0.015	-0.018	0.021	0.012	0.001	0.003	0.026*	0.028	-0.044*	-0.053***	0.008	-0.023	-0.041**	0.022	0.021*	0.026*
		(0.014)	(0.009)	(0.008)	(0.016)	(0.014)	(0.009)	(0.007)	(0.015)	(0.012)	(0.028)	(0.015)	(0.022)	(0.014)	(0.015)	(0.021)	(0.023)	(0.008)	(0.011)	(0.020)	(0.016)	(0.014)	(0.012)	(0.015)
	Household Debt	-0.013***	0.004**	-0.004***	0.003	-0.008***	-0.008***	-0.008***	-0.019***	-0.002	0.002	0.005	0.002	-0.005**	0.001	0.002	0.004	-0.005***	0.009**	-0.003	-0.002	0.003	0.005***	0.008***
		(0.002)	(0.002)	(0.001)	(0.003)	(0.001)	(0.001)	(0.001)	(0.003)	(0.002)	(0.003)	(0.003)	(0.003)	(0.003)	(0.002)	(0.001)	(0.005)	(0.002)	(0.004)	(0.003)	(0.003)	(0.003)	(0.001)	(0.001)
	FDI	0.389	-0.717	-0.705	-0.790	0.520**	-0.494	0.012	-1.003***	-0.348	-1.414	0.354	3.097***	-1.090	-0.660	-0.942	-0.647	-0.156	1.574**	2.791**	0.766	-0.695	-0.135	-0.993*
		(0.004)	(0.004)	(0.005)	(0.008)	(0.002)	(0.004)	(0.003)	(0.004)	(0.004)	(0.012)	(0.010)	(0.007)	(0.009)	(0.007)	(0.008)	(0.007)	(0.004)	(0.008)	(0.012)	(0.005)	(0.006)	(0.005)	(0.006)
	Other Capital Flows	0.017	0.058*	0.007	0.015	0.005	0.010	0.003	-0.000	-0.001	-0.022	-0.034	0.022	0.042	0.071***	0.013	0.017	0.027	-0.005	-0.051	-0.008	0.006	-0.010	0.002
		(0.025)	(0.032)	(0.010)	(0.027)	(0.016)	(0.018)	(0.016)	(0.030)	(0.022)	(0.034)	(0.040)	(0.033)	(0.028)	(0.024)	(0.026)	(0.026)	(0.029)	(0.044)	(0.041)	(0.036)	(0.023)	(0.018)	(0.014)
	Oil	-0.020	0.482***	0.077**	0.239***	-0.036*	0.111***	0.149***	-0.043	0.136***	0.287***	0.372***	0.200***	0.177***	0.428***	0.312***	0.297***	0.229***	0.382***	0.333***	0.246***	0.327***	0.401***	0.396***
		(0.030)	(0.029)	(0.035)	(0.066)	(0.021)	(0.023)	(0.033)	(0.028)	(0.043)	(0.088)	(0.074)	(0.043)	(0.053)	(0.050)	(0.060)	(0.098)	(0.025)	(0.045)	(0.055)	(0.061)	(0.063)	(0.049)	(0.061)
	Intercept	0.023	-0.282***	-0.042*	-0.161***	0.036**	-0.061***	-0.093***	0.088***	-0.078***	-0.240***	-0.242***	-0.141***	-0.097***	-0.258***	-0.182***	-0.209***	-0.155***	-0.274***	-0.217***	-0.175***	-0.198***	-0.249***	-0.314***
		(0.017)	(0.015)	(0.025)	(0.042)	(0.016)	(0.015)	(0.023)	(0.025)	(0.027)	(0.062)	(0.043)	(0.027)	(0.028)	(0.026)	(0.028)	(0.072)	(0.020)	(0.028)	(0.036)	(0.046)	(0.040)	(0.030)	(0.042)
	AR	0.106	0.290***	0.183*	0.137	0.411***	0.016	-0.023	0.197***	-0.083	-0.058	-0.031	-0.042	0.390***	0.133**	0.164**	-0.150	-0.084	-0.073	-0.231***	-0.108	0.196**	0.069	0.068
		(0.093)	(0.067)	(0.099)	(0.157)	(0.096)	(0.074)	(0.059)	(0.054)	(0.086)	(0.053)	(0.118)	(0.117)	(0.149)	(0.061)	(0.072)	(0.115)	(0.078)	(0.089)	(0.075)	(0.083)	(0.086)	(0.104)	(0.050)

Note: The dependent variable is city-level residential house price year-on-year growth, 12 quarters ahead. Household debt, FDI, and other capital flows are scaled by GDP. FCI is the price-based financial conditions index. House price to income is the city-level house price over state-level income. Housing starts is the log growth of state-level housing starts. Oil is the quarter-on-quarter growth of the oil price index

Annex Table 4. Canada: Long-term City-level Coefficients

Tau	Variable	Calgary	Edmonton	Hamilton	London	Montreal	Quebec City	Regina	Toronto	Vancouver	Victoria	Windsor	Winnipeg	Ottawa	Greater Sudbury	St. Catharines	Canada
0.1	House Price-to-Income	-0.540***	-0.586***	0.008	-0.499***	-0.092	-0.271***	-0.075**	-0.304	-0.150*	0.040	-0.155	0.011	-0.199***	-0.043	-0.214*	-1.415***
		(0.076)	(0.066)	(0.038)	(0.091)	(0.075)	(0.026)	(0.032)	(0.289)	(0.083)	(0.075)	(0.103)	(0.046)	(0.052)	(0.044)	(0.113)	(0.156)
	Residential Investment	-6.398	-13.148*	-18.466**	5.450	10.313	21.079***	-15.972***	-10.124	-24.322***	-32.999***	-4.408	-6.439	9.325**	10.901**	-6.174	48.930***
		(4.438)	(7.252)	(8.755)	(5.268)	(10.626)	(4.064)	(4.104)	(12.320)	(4.062)	(5.369)	(6.031)	(4.889)	(4.223)	(4.703)	(10.717)	(5.727)
	FCI	-0.077***	-0.028	-0.103**	-0.031	-0.030	-0.080***	-0.002	-0.166***	0.020	0.042	0.011	-0.047*	-0.107***	-0.044	-0.120***	-0.067***
		(0.024)	(0.031)	(0.042)	(0.029)	(0.037)	(0.026)	(0.020)	(0.047)	(0.029)	(0.038)	(0.014)	(0.026)	(0.034)	(0.027)	(0.034)	(0.019)
	Household Debt	0.001	0.014***	-0.024***	0.000	-0.004	-0.008***	0.006*	-0.005	0.008	-0.001	-0.011***	0.002	0.001	0.002	-0.024***	0.007*
		(0.003)	(0.004)	(0.005)	(0.004)	(0.005)	(0.002)	(0.003)	(0.009)	(0.006)	(0.006)	(0.002)	(0.003)	(0.003)	(0.004)	(0.005)	(0.003)
	FDI	1.553***	1.359***	1.649***	-0.207	1.572**	2.506***	0.366	2.143***	1.126***	0.388	-0.294	1.072***	1.642***	0.153	0.774***	-1.446**
		(0.226)	(0.489)	(0.291)	(0.439)	(0.644)	(0.156)	(0.506)	(0.323)	(0.388)	(0.750)	(0.242)	(0.314)	(0.369)	(0.334)	(0.287)	(0.564)
	Other Capital Flows	0.591	0.326	-1.312***	0.393	-0.210	0.291	0.491	0.454	0.448	-0.523	0.279	-0.051	0.615	-0.709**	0.458	0.148
		(0.388)	(0.408)	(0.504)	(0.240)	(0.482)	(0.325)	(0.444)	(0.526)	(0.363)	(0.426)	(0.331)	(0.281)	(0.441)	(0.322)	(0.316)	(0.313)
	Oil	-0.008	0.061	-0.022	-0.001	-0.016	-0.060**	0.017	-0.005	0.021	0.044	0.009	-0.086**	-0.061	-0.056	-0.040	-0.038
		(0.021)	(0.056)	(0.052)	(0.030)	(0.049)	(0.029)	(0.021)	(0.058)	(0.070)	(0.056)	(0.025)	(0.039)	(0.043)	(0.037)	(0.055)	(0.035)
	Intercept	0.497***	0.519***	0.072	0.464***	0.006	0.070***	0.136***	0.225	0.213***	0.158*	0.194	0.007	0.062*	-0.042	0.214***	0.625***
		(0.049)	(0.065)	(0.050)	(0.104)	(0.019)	(0.015)	(0.017)	(0.184)	(0.037)	(0.083)	(0.125)	(0.024)	(0.038)	(0.055)	(0.076)	(0.075)
	AR	0.052	0.150	1.380***	0.854***	0.373	0.843***	0.339***	-0.045	0.723***	1.157***	0.371	0.499***	0.681***	0.489**	0.876***	0.498***
		(0.041)	(0.120)	(0.314)	(0.237)	(0.356)	(0.166)	(0.100)	(0.144)	(0.191)	(0.351)	(0.361)	(0.187)	(0.215)	(0.239)	(0.308)	(0.133)
0.5	House Price-to-Income	-0.211***	-0.177***	-0.017	-0.083***	-0.025**	-0.084***	-0.047**	-0.058***	0.011	0.025	-0.056**	0.014	-0.104***	-0.008	-0.119***	-0.181***
		(0.079)	(0.066)	(0.025)	(0.070)	(0.049)	(0.022)	(0.049)	(0.172)	(0.084)	(0.054)	(0.062)	(0.044)	(0.039)	(0.023)	(0.101)	(0.158)
	Residential Investment	3.544	3.272	-1.859	9.067***	3.719*	11.172***	-1.535	0.541	-9.373***	-11.744***	4.616**	-2.854	11.205***	5.685***	6.138	6.591***
		(4.887)	(8.681)	(7.129)	(6.371)	(9.158)	(4.344)	(5.382)	(13.878)	(4.795)	(2.718)	(4.310)	(5.971)	(3.614)	(2.933)	(6.077)	(5.032)
	FCI	-0.063***	-0.042***	-0.047***	-0.024***	-0.024***	-0.016**	-0.016**	-0.076***	-0.011	-0.011	-0.013**	-0.021***	-0.044***	-0.008	-0.056***	-0.049***
		(0.022)	(0.031)	(0.024)	(0.023)	(0.030)	(0.024)	(0.030)	(0.051)	(0.034)	(0.030)	(0.013)	(0.017)	(0.028)	(0.020)	(0.025)	(0.015)
	Household Debt	0.013***	0.022***	0.003	0.003	0.001	0.001	0.010***	0.006	0.017***	0.013**	0.000	0.005*	0.004	0.001	-0.002	0.000
		(0.006)	(0.003)	(0.004)	(0.003)	(0.004)	(0.002)	(0.004)	(0.007)	(0.005)	(0.004)	(0.002)	(0.003)	(0.002)	(0.002)	(0.006)	(0.003)
	FDI	0.277	-0.307	0.135	0.068	0.345**	0.649***	-0.229	0.274***	-0.175	-0.200	0.062	-0.074	0.588***	-0.163	0.084	-0.033
		(0.299)	(0.437)	(0.236)	(0.349)	(0.434)	(0.178)	(0.616)	(0.509)	(0.419)	(0.352)	(0.177)	(0.207)	(0.257)	(0.221)	(0.245)	(0.411)
	Other Capital Flows	-0.294	-0.342	-0.331	0.003	0.032	0.359***	0.005	-0.192	-0.341	-0.152	-0.151	-0.249*	-0.311	-0.037	0.953***	-0.184
		(0.254)	(0.369)	(0.458)	(0.291)	(0.317)	(0.232)	(0.407)	(0.585)	(0.320)	(0.280)	(0.281)	(0.247)	(0.380)	(0.303)	(0.700)	(0.242)
	Oil	-0.030*	-0.009	-0.028	-0.003	-0.006	-0.005	0.004	-0.071***	-0.004	0.027	-0.013	-0.014	-0.020	-0.017*	-0.009	-0.034**
		(0.030)	(0.045)	(0.027)	(0.039)	(0.042)	(0.028)	(0.035)	(0.060)	(0.059)	(0.060)	(0.030)	(0.022)	(0.047)	(0.034)	(0.041)	(0.026)
	Intercept	0.154***	0.129***	0.014	0.038**	-0.007	0.002	0.058***	0.028	0.047	0.046	0.024	0.001	0.018	-0.024***	0.056*	0.068***
		(0.042)	(0.064)	(0.044)	(0.095)	(0.025)	(0.022)	(0.022)	(0.099)	(0.035)	(0.037)	(0.059)	(0.024)	(0.031)	(0.024)	(0.079)	(0.081)
	AR	0.138***	0.265**	0.591***	0.114	0.412***	0.242***	0.209**	0.393***	0.376***	0.588***	0.295***	0.431***	0.158*	0.337***	0.279*	-0.376***
		(0.068)	(0.099)	(0.257)	(0.232)	(0.391)	(0.175)	(0.169)	(0.297)	(0.188)	(0.148)	(0.222)	(0.168)	(0.118)	(0.269)	(0.260)	(0.084)
0.9	House Price-to-Income	-0.418***	-0.522***	-0.014	-0.522***	-0.109***	-0.283***	-0.108**	-0.119	-0.147***	-0.068	-0.454***	0.013	-0.293***	-0.103***	-0.407***	-1.459***
		(0.098)	(0.076)	(0.029)	(0.086)	(0.027)	(0.035)	(0.047)	(0.093)	(0.051)	(0.050)	(0.040)	(0.059)	(0.052)	(0.023)	(0.089)	(0.139)
	Residential Investment	-5.045	12.545*	-35.862***	-0.364	-6.777	22.111***	-13.724**	0.531	-35.904***	-45.696***	-4.625	-13.860	16.475***	25.470***	1.601	53.075***
		(8.267)	(6.545)	(9.125)	(7.172)	(6.977)	(4.748)	(6.265)	(9.052)	(6.016)	(3.155)	(3.690)	(12.370)	(5.499)	(3.290)	(5.147)	(4.200)
	FCI	-0.132***	-0.067***	-0.073**	-0.007	-0.069***	-0.072***	-0.067*	-0.118***	0.065	0.080*	-0.007	-0.083***	-0.151***	-0.041***	-0.119***	-0.028
		(0.034)	(0.023)	(0.029)	(0.024)	(0.014)	(0.017)	(0.039)	(0.033)	(0.046)	(0.042)	(0.013)	(0.028)	(0.023)	(0.012)	(0.021)	(0.023)
	Household Debt	0.004	0.006	-0.014***	-0.003	-0.004***	-0.006	0.003	-0.004	0.001	-0.005**	-0.009***	0.000	0.006**	0.004***	-0.010**	-0.000
		(0.004)	(0.004)	(0.003)	(0.004)	(0.001)	(0.004)	(0.003)	(0.004)	(0.003)	(0.002)	(0.002)	(0.003)	(0.002)	(0.001)	(0.005)	(0.005)
	FDI	0.349	0.044	0.657***	-0.550**	0.959***	2.353***	0.730	0.952***	-0.879	0.421	-0.925***	0.549	1.940***	-0.467***	0.281	-1.488***
		(0.494)	(0.302)	(0.252)	(0.268)	(0.249)	(0.248)	(0.472)	(0.332)	(0.560)	(0.370)	(0.134)	(0.410)	(0.263)	(0.163)	(0.276)	(0.302)
	Other Capital Flows	-0.589	-2.604***	-2.823***	1.003***	-0.014	0.846**	0.452	-1.289***	2.510**	-0.078	-0.026	-0.422	-0.283	0.043	0.012	-0.313
		(0.708)	(0.633)	(0.743)	(0.350)	(0.267)	(0.420)	(0.867)	(0.488)	(1.257)	(0.759)	(0.168)	(0.763)	(0.520)	(0.351)	(0.872)	(0.421)
	Oil	-0.008	-0.013	-0.028	-0.047	-0.050*	-0.028	0.042	-0.180***	-0.037	0.017	0.003	-0.071*	-0.047	-0.048***	-0.117***	-0.058
		(0.039)	(0.023)	(0.041)	(0.032)	(0.027)	(0.026)	(0.048)	(0.046)	(0.087)	(0.072)	(0.029)	(0.040)	(0.056)	(0.014)	(0.045)	(0.042)
	Intercept	0.479***	0.490***	0.259***	0.558***	0.139***	0.106***	0.181***	0.142*	0.435***	0.430***	0.547***	0.080*	0.143***	-0.011	0.396***	0.677***
		(0.044)	(0.055)	(0.059)	(0.109)	(0.036)	(0.025)	(0.022)	(0.085)	(0.061)	(0.053)	(0.045)	(0.043)	(0.041)	(0.024)	(0.072)	(0.079)
	AR	-0.013	-0.008	2.036***	1.088***	1.698***	0.871***	0.741***	0.855***	0.857*	1.601***	0.338***	1.307**	0.486***	0.112	1.070***	0.593***
		(0.092)	(0.064)	(0.384)	(0.227)	(0.209)	(0.224)	(0.163)	(0.191)	(0.439)	(0.133)	(0.120)	(0.615)	(0.158)	(0.120)	(0.240)	(0.120)

Note: The dependent variable is city-level residential house price year-on-year growth, 12 quarters ahead. Household debt, FDI, residential investment, and other capital flows are scaled by GDP. FCI is the price-based financial conditions index. House price to income is at the city level. Residential investment is the city-level residentital investment as a share of provincial-level GDP. Oil is the quarter-on-quarter growth of the oil price index.

Annex Table 5. United States: Pseudo-R^2 Across Cities, One-year Ahead

Tau	United States	Atlanta	Austin	Chicago	Dallas	Denver	Detroit	Las Vegas	Los Angeles	Miami	Minneapolis	New York	Philadelphia	Phoenix	San Diego	San Francisco	Seattle	Washington D.C.
0.1	0.60	0.56	0.50	0.65	0.49	0.46	0.66	0.55	0.52	0.63	0.56	0.57	0.36	0.59	0.52	0.37	0.53	0.56
0.25	0.56	0.49	0.41	0.54	0.43	0.51	0.57	0.42	0.52	0.50	0.49	0.58	0.39	0.52	0.51	0.39	0.47	0.51
0.4	0.53	0.45	0.39	0.46	0.40	0.54	0.52	0.36	0.53	0.46	0.47	0.59	0.41	0.46	0.51	0.42	0.46	0.50
0.5	0.51	0.42	0.40	0.44	0.40	0.55	0.49	0.34	0.51	0.46	0.47	0.60	0.43	0.41	0.49	0.43	0.46	0.48
0.6	0.47	0.41	0.40	0.43	0.41	0.54	0.45	0.33	0.49	0.46	0.46	0.59	0.45	0.37	0.47	0.42	0.46	0.49
0.75	0.45	0.37	0.39	0.43	0.46	0.52	0.40	0.37	0.49	0.47	0.43	0.59	0.48	0.36	0.43	0.38	0.43	0.50
0.9	0.45	0.34	0.36	0.40	0.56	0.48	0.40	0.44	0.48	0.49	0.37	0.62	0.53	0.43	0.36	0.31	0.43	0.47
Average	0.51	0.43	0.41	0.48	0.45	0.51	0.50	0.40	0.51	0.50	0.46	0.59	0.44	0.45	0.47	0.39	0.46	0.50

Annex Table 6. Canada: Pseudo-R^2 Across Cities, One-year Ahead

Tau	Canada	Calgary	Edmonton	Hamilton	London	Montreal	Quebec City	Regina	Toronto	Vancouver	Victoria	Windsor	Winnipeg	Ottawa	Sudbury	St. Catharines
0.1	0.46	0.41	0.42	0.47	0.40	0.34	0.51	0.27	0.44	0.51	0.36	0.37	0.27	0.34	0.23	0.37
0.25	0.41	0.31	0.31	0.42	0.43	0.37	0.54	0.23	0.37	0.37	0.31	0.28	0.24	0.36	0.25	0.37
0.4	0.39	0.28	0.29	0.38	0.45	0.43	0.56	0.24	0.33	0.32	0.33	0.27	0.29	0.38	0.27	0.36
0.5	0.40	0.26	0.29	0.38	0.45	0.45	0.57	0.27	0.32	0.29	0.34	0.30	0.34	0.36	0.29	0.38
0.6	0.42	0.23	0.30	0.40	0.45	0.45	0.56	0.31	0.32	0.28	0.36	0.34	0.37	0.36	0.32	0.40
0.75	0.45	0.20	0.30	0.45	0.45	0.45	0.51	0.38	0.35	0.26	0.42	0.40	0.42	0.36	0.37	0.44
0.9	0.55	0.22	0.36	0.55	0.53	0.49	0.47	0.52	0.52	0.31	0.44	0.40	0.43	0.44	0.44	0.55
Average	0.44	0.27	0.32	0.43	0.45	0.43	0.53	0.32	0.38	0.33	0.37	0.34	0.34	0.37	0.31	0.41

Annex Table 7. Survey Descriptions

United States

Dataset	Description	Source
Survey of Consumer Finances (SCF)	Survey data on household balance sheets, income and demographics. The analysis uses four waves of survey data; 1999, 2004, 2013, and 2016.	Federal Reserve Board

Canada

Dataset	Description	Source
Survey of Financial Security (SFS)	Survey data on household assets and debts. The analysis uses four waves of survey data; 1999, 2005, 2012 and 2016	Statistics Canada

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