Global House Price Fluctuations: Synchronization and Determinants*

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Abstract: We examine the dynamic properties of house price fluctuations across eighteen advanced economies over the past forty years. We ask two specific questions: First, how synchronized are housing cycles across these countries? Second, what are the main shocks driving movements in global and national house prices? To address these questions, we estimate common components in house prices and various macroeconomic and financial variables. We then evaluate the roles played by a variety of shocks, including shocks to monetary policy, productivity, credit, and uncertainty, in explaining house price fluctuations using several VAR and FAVAR models. We find that house prices tend to be synchronized across countries and the degree of synchronization has increased over time. We document that global interest rate shocks have a significant effect on global house prices. However, global monetary policy shocks *per se* do not appear to have a sizeable impact on global house price movements. Interestingly, uncertainty shocks appear to be important in explaining fluctuations in global house prices.

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I. Introduction

During the past decade, house prices in many advanced countries have moved in tandem. They increased unusually rapidly prior to the global financial crisis, but they declined sharply since then. Highly synchronized gyrations in housing markets coincided with deep recessions and severe financial disruptions in a number of advanced countries over the past five years. In this paper, we ask two specific questions to have a better understanding of fluctuations in housing markets and their implications for the global economy: First, how synchronized are housing cycles across countries? Second, what are the main shocks driving movements in global and national house prices?

Our interest in house prices is clearly motivated by recent developments, but there are also simpler, and probably more fundamental reasons, to study the dynamics of housing markets because of the key role housing plays in modern societies. First, housing satisfies peoples' need for shelter. Second, housing activities account for an important fraction of GDP and household expenditures. Third, housing is the main asset and mortgage debt is the main liability held by households in advanced countries. Therefore, large house price movements, by affecting households' net wealth and their capacity to borrow and spend could have important macroeconomic implications. From a global perspective, housing is the quintessential non-traded asset yet, there seems to be a relatively high degree of co movement in house price changes across advanced countries. This suggests that house prices could also play an important role in the synchronization of business cycles across the globe.

In theory, interactions between house (and other assets, such as equity) prices and the real economy can be amplified when financial imperfections are present.[1] This amplification largely occurs through the financial accelerator and related mechanisms operating through firms, households and countries' balance sheets. According to these mechanisms, an increase (decrease) in asset prices improves an entity's net worth, enhancing (reducing) its capacity to borrow, invest, and consume. This process, in turn, can lead to further increases (decreases) in house prices and produce general equilibrium effects (e.g., Bernanke and Gertler, 1989; Bernanke, Gertler, and Gilchrist, 1999; Kiyotaki and Moore, 1997; and numerous other studies on the role of financial imperfections). In other words, disturbances in housing markets can translate into much larger cyclical fluctuations in the real economy.

A number of recent theoretical and empirical studies have shown how developments in housing markets can magnify and transmit shocks to the real economy using the financial accelerator mechanism in the context of DSGE models. For example, Iacoviello (2005) constructs a model with firms' collateral constraints connected to real estate and finds that collateral effects are critical to replicate the changes in consumption in response to

[1] Surveys of this literature can be found in Gertler (1988), Claessens, Kose, and Terrones (2012), and Gilchrist and Zakrajšek (2010).

movements in house prices.[2] Other studies have focused on how credit constraints affect macroeconomic fluctuations using a framework where house prices and business investment are linked. Liu, Wang and Zha (2011), for instance, examine the close relationship between land prices and business investment. A series of empirical studies document strong linkages between developments in housing markets and the real economy.[3]

Despite the apparent consensus on the importance of housing market movements for the real economy, our understanding of the extent and sources of synchronization in housing markets is quite limited. A number of studies present evidence on the synchronization of housing cycles across countries, but they report mixed findings on the sources of house price movements. Moreover, the nature and identification of shocks vary significantly across studies making the interpretation of their findings difficult. Some studies emphasize the importance of house price shocks in the transmission and synchronization of house prices. Others argue that interest rate shocks play a key role in driving movements in house prices. There are also other studies highlighting the importance of demand and supply shocks in housing markets and country-specific structural characteristics.[4] We discuss next the three groups of studies analyzing the roles of different types of shocks in explaining house price movements.

The studies in the first group mostly use Global VAR models to analyze the transmission and synchronization of house prices across countries. Ambrogio Cesa-Bianchi (2011), for instance, report that US house price shocks play a significant role in driving global house prices. In contrast, Vansteenkiste and Hiebert (2009) conclude that house price shocks play a relatively minor role in explaining house price spillovers in the euro area. The GVAR methodology does not structurally identify shocks implying that there is no economic interpretation of housing shocks in these studies. In addition, since the methodology characterizes cross-border linkages by averaging variables into a global aggregate, it is not

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[2] Aoki, Proudman and Vlieghe (2004) quantify the effect of shocks on housing investment, house prices and consumption in a model in which houses serve as collateral to reduce agency costs related to borrowing. Other studies analyze the importance of disturbances in housing markets in explaining certain features of business cycles (see Iacoviello (2005), Iacoviello and Pavan (2009), Monacelli Davis and Heathcote (2005) and Monacelli (2009)). Leamer (2007) documents that there are strong linkages between various aspects of cycles in housing markets and business cycles in the United States.

[3] Claessens, Kose and Terrones (2009) present a survey of this literature and document empirical evidence.

[4] Igan and Loungani (2009) document the characteristics of house price cycles in advanced countries and find that long-run price dynamics are mostly driven by local fundamentals such as demographics and construction costs, though market structure and regulatory factors may cause short-run fluctuations. Beltratti and Morana (2010) consider a FAVAR model using the G-7 countries. They identify shocks using Cholesky decompositions and consider demand, supply, house price, stock price, and oil price shocks. They find that both house price and supply shocks are important in explaining global house price movements.

clear how country weights affect the influence of individual countries in the transmission of shocks across borders.[5]

The second group of studies is from a large literature that analyzes the impact of interest rate shocks and/or monetary policy in explaining house prices using VAR models. Some of these studies resort to a simple recursive identification scheme to identify shocks (Assenmacher-Wesche and Gerlach, 2009; Calza et al., 2009; Goodhart and Hoffmann, 2008; Cardarelli, Monacelli, Rebucci, and Sala, 2008). In these studies, shocks to interest rates are often interpreted as monetary policy shocks. Others employ sign restrictions to identify monetary policy shocks (Carstensen et al. 2009; Del Negro and Otrok (2007); Jarocinski and Smets (2008). In his survey of this growing literature, Kuttner (2012) concludes that the evidence suggests "the impact of interest rates on house prices appears to be quite modest."

The third group of studies includes research that employs different methodologies but they also provide mixed results about the importance of different types of shocks in explaining housing cycles. For example, Case, Goetzmann and Rouwenhorst (1999), who study the dynamics of international commercial real estate markets from 1987-1997, report that the comovement among commercial real estate markets is through output linkages. Chirinko et. al (2004) study the interrelationships between stock prices, house prices, and real activity in a 13 country sample. Their work estimates structural VARs country by country to develop systematic cross-country evidence on the importance of shocks to house prices, stock prices, real activity and monetary policy, but they do not identify the sources of movements in house prices. Terrones and Otrok (2004) examine the synchronization of housing prices in a sample of 14 advanced countries using a dynamic factor model from 1970-2004. They find evidence of a global housing cycle, which moves closely with global GDP. Using these global factors, they construct FAVAR models to study how interest rate changes could affect housing prices in the U.S. and U.K. However, they do not identify the sources of these changes either.

Recent research examines the features of housing cycles using classical methods. For example, Claessens, Kose, and Terrones (2010, 2012) report that fluctuations in housing markets around the world exhibit a high degree of synchronization. Moreover, they document that disruptions (booms) in housing markets tend to be more pronounced and longer (shorter) compared to other cyclical episodes. There is also evidence that the duration and amplitude of housing cycles vary widely across geographical areas and through time (Cunningham and Kolet, 2007; Hall, McDermott and Tremewan, 2006). This in turn reflects variations in demand-supply conditions, characteristics of housing finance, and linkages between housing and real activity.[6]

This study contributes to this large body of research focusing on the extent and sources of

[5] Vansteenkiste (2007) consider the same approach in the context of the US states and find that house price shocks in California appear to be an important factor driving prices in other states. Her results also suggest that interest rate shocks play a small role in explaining house prices.

[6] Alvarez et. al. (2010) report that regional housing markets are weakly correlated in the major euro area countries. Leamer (2007) documents that there are strong linkages between various aspects of cycles in housing markets and business cycles in the United States.

synchronization in housing cycles. We extend this literature in four dimensions. First, we study different measures of the synchronization of house prices and analyze how the features of house price cycles compare with cycles in output and other asset prices. Second, we identify shocks driving house prices using various approaches, including a standard recursive method as well as one based on sign restrictions that can be derived from structural models. Third, we employ a series of VAR and FAVAR models to analyze different types of shocks in explaining movements in global and national house prices. Finally, we consider the impact of shocks on housing cycles in different countries and over time.

In section II, we introduce our database and methodology. The database comprises quarterly series of house prices and many other financial variables and output of 18 advanced countries over the period 1971:1–2011:3. In order to study the global dimensions of house prices and other variables in our sample, we construct a global factor for each of these variables. In section III, we present the main features of housing cycles and analyze the extent of synchronization of housing cycles across countries using different approaches. In section IV, we employ a set of VAR and FAVAR models to analyze the importance of a variety of shocks in driving house prices. Section V concludes.

II. Database and Methodology

II.1. Database

Our main dataset includes quarterly series of GDP, house prices, equity prices, credit, and the short- and long-term interest rates of 18 advanced OECD countries for the period 1971:1–2011:3. We concentrate on this period because it is a common denominator for the cross-country data we need to analyze the synchronization of cycles in house prices in the advanced OECD countries.

We provide a systematic examination of the synchronization of house prices and the sources of this synchronization over two different sub-periods. The first sub-period, 1971:1-84:4, witnessed a set of common shocks associated with sharp fluctuations in the price of oil and contractionary monetary policy in major industrial economies. We call this period "pre-globalization period." The second period, 1985:1-2011:3, represents the globalization period in which there were dramatic increases in the volume of cross-border trade in both goods and assets. This period also covers a substantial portion of the so-called "Great Moderation" era (see Blanchard and Simon (2001) and Stock and Watson (2005)) as well as the latest global financial crisis, and coincides with a rapid increase in trade and financial linkages among the advanced countries and a broader converge of their business cycles (see Kose, Otrok, and Whiteman, 2008). This demarcation is helpful for differentiating the impact of common shocks from that of globalization on the degree of comovement of housing cycles.

House prices correspond to various measures of indices of house or land prices depending on the source country, as collected by the OECD and the Global Property Guide. Equity prices are share price indices weighted with market value of outstanding shares. Our measure of

credit is aggregate claims on the private sector by deposit money banks. This measure is also used in earlier cross-country studies on credit dynamics (see Mendoza and Terrones, 2008; and Claessens, Kose, and Terrones, 2010 and 2012). We deflate the nominal credit, equity and house price series using the CPI to obtain real variables.

We track aggregate business cycles with real GDP. Our GDP data are chained volume series from the OECD. The short-term interest rates correspond to nominal short term government bill rates, generally Treasury Bill Rates, and are from the IFS. The long-term rates typically are long-term government bonds.

We also use measures of uncertainty, reserves, credit spreads and default rates. Uncertainty is constructed using the volatility of daily equity prices from the Global Financial Database. Reserves series correspond to total reserves and they are obtained from IFS and the FRB of Saint Louis database (FRED). Unlike the other variables, credit spread and default rates series are available for only the U.S. In order to measure credit spreads, we use corporate bond spreads. In particular, these spreads are the yield differences between Moody's Seasoned Aaa and Baa corporate bonds for the U.S. The Aaa bonds are "judged to be the highest quality with minimal credit" risk while the Baa bonds are "subject to moderate credit risk and possess certain speculative characteristics".[7] The default rate series corresponds to the monthly rates for Moody's rated U.S. speculative-grade corporate bonds from the Moody's Investor Service. As in the case of credit spreads, we take the observation of the last month of each quarter as our quarterly default rates. Meeks (2012) uses a similar default rate series to identify credit shocks.[8]

Before constructing our factors and estimating the VAR models, we make appropriate transformations in each data series. In particular, we take four-quarter growth rates of house prices, credit, equity prices, and GDP. All variables are seasonally adjusted and expressed in percentages.

II.2. Methodology

Since our objective is to analyze the extent and sources of synchronization of house price fluctuations, we undertake our exercise in three steps. First, we study the main features of house price movements by paying special attention to their international synchronization. For

[7] There is no single accepted measure of credit spreads as the recent literature on the importance of credit shocks employs various alternative ones. For instance, Meeks (2012) uses a measure of credit spreads defined in terms of a risky bond portfolio that belongs to Moody's B1/B2 category. Such a portfolio is described by Moody's as being subject to "high credit risk". Gilchrist, Yankov and Zakrajsek (2009) take a panel of credit spreads and estimate a common factor of these spreads as their measure.

[8] We provide a detailed list of the data series and their sources in Appendix I *(to be added in the next version)*.

this purpose, we use a range of approaches, including basic correlations and concordance statistics. Second, we estimate the common components (global factors) in each variable. Our 18 country sample is representative of the advanced economies and the world economy. The latter reflects the fact that this country group accounts for slightly more than 60 percent of global GDP over the 1971–2011 period (in PPP exchange rates). Third, we use a set of VAR and FAVAR (Factor Augmented VAR) models to analyze the importance of various shocks that could explain fluctuations in house prices. We briefly explain next the estimation of global factors and VAR models.

Estimation of Global Factors. To estimate the global factors, we extract the first principal component of each variable using our database. There are, of course, alternative approaches to construct global equivalents of these variables. For example, we could employ a full-fledged dynamic factor model, as in Kose, Otrok, and Whiteman (2003). Their method is particularly useful to estimate different common factors simultaneously, such as global, regional, and country-specific factors. However, the global factor obtained with a dynamic factor model is quite similar to the first principal component. We use the simpler approach since we are only interested in the global component of each variable.

Figure 1 presents some of the estimated global factors. The estimated factors are broadly consistent with a number of well-known cyclical episodes in the global economy. For instance, the downturns in the estimated global house price factor coincide with the well-known declines in house prices in advanced countries. The downturn during the latest episode is particularly striking because of its highly synchronous nature and its depth. The global factor of output captures recessions of the mid-70s, early 1980s, early 1990s, early 2000s, and the latest episode of 2007–09. The estimated factors of the other variables also reveal interesting patterns. For example, the global credit factor indicates that the episodes we discuss above were also associated with declines in credit.

VAR Models. The VAR models we estimate can be represented by:

$$y_t = a_{(0)} + A_{(1)}y_{(t-1)} + A_{(2)}y_{t-2} + \ldots. + A_{(l)}y_{t-l} + u_t \,; t = 1, \ldots, T,$$

where y_t is an $m \times 1$ vector of variables at date t, A_i is an $m \times m$ coefficient matrix for each lag of the variable vector with $a_{(0)}$ being the constant term. u_t is the vector of one-step ahead prediction error. We consider two types of models, which differ only in terms of the set of variables in the y_t vector. The first type is a FAVAR model that mostly includes a mix of the estimated global factors and some country specific variables, such as default rate and spreads. [9] The second type is a standard VAR model that only contains the global factors or

[9] This model follows the work of Bernanke, Bovin, and Eliasz (2005) who developed the factor-augmented VAR (FAVAR) to study the effects of monetary policy in a closed economy framework.

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country specific variables. In our estimation, the lag length, l, is kept at four. We present a discussion of the identification of shocks and the use of these models in section IV.

III. House Price Fluctuations: Basic Facts

We start this section with a brief discussion of the basic features of house prices, equity prices, credit, interest rates and output. We then study the degree of comovement between house price fluctuations, output and other financial variables within countries using simple correlation and concordance measures. We conclude with a study of the synchronization of house prices and other variables using different approaches.

III.1. Basic Features: Growth, Volatility and Comovement

House prices in the advanced economies grew almost at the same pace as economic activity but house price growth rate has accelerated over recent years. Over the past four decades, real house prices in these economies have grown at an average rate of 2¼ percent per year, slightly slower than the growth of output. The pace of real house price growth, however, has changed over time—slower during the pre-globalization period (1971:1-1984:4) and faster during the globalization period (1985:1-2011:3) (**Table 1**).[10]

Real house prices in the advanced economies are volatile, with an average standard deviation of house price increases of almost 7½ percent per year. The volatility of house prices has, however, fallen over time, partly reflecting the widespread reduction in inflation and macroeconomic volatility in advanced countries prior to the crisis.[11] Compared with equity prices, house prices in the advanced countries have registered slower growth in absolute terms, but they tend to exhibit a larger coefficient of variation. While the coefficients of variation for both housing and equity have risen in the globalization period, the former has done at a much faster pace.

House prices and economic activity tend to move hand-in-hand over the business cycle. House price movements can affect both the net wealth of households and the balance sheet of firms and banks. A drop in house prices, for instance, can have a negative wealth effect on households reducing their consumption and residential investment, deteriorate the collateral of firms dampening their investment, and weaken bank balance sheets by increasing non-

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Bernanke, Bovin, and Eliasz (2005) compare FAVARs that treat estimated factors as data as is done here, with more sophisticated Bayesian estimates that account for uncertainty in the estimated factors. They find that there is no real gain from the more computationally intensive Bayesian methods for this type of problem.

[10] The growth of real house prices differs significantly across countries (ranging from less than ½ percent per year in Germany, Japan, and Switzerland to over 3 percent per year in Spain, and United Kingdom) and over time. House price volatility also varies significantly across countries, and is generally higher the more rapid the rate of underlying house price growth, although this relationship has weakened over the past decade. Interestingly, there is no strong evidence that house price volatility is directly related to the volatility of output.

[11] See, for instance, Stock and Watson, 2003, and Kose, Prasad, and Terrones, 2004.

performing loans reducing their lending. Likewise, changes in economic activity, reflected in households' disposable income and profit and employment prospects, can lead to movements in house prices.

More concretely, simple correlations between house prices and some key macroeconomic and financial variables suggest three key results (**Table 2**): [12] First, real house prices in the advanced economies are procyclical, rising in an expansion and falling in a recession. The average correlation between real house price growth and output growth is close to 0.5 over 1971-2011. The strength of the co movement between real house prices and output, however, varies across countries, being weakest in Australia, Canada, Italy, and Switzerland and strongest in Denmark, Finland, Ireland, and the United Kingdom. The procyclicality of house prices can be a reflection of the strong linkages between these prices and private sector absorption. However, there does not appear to be evidence of a strong lead/lag pattern between house prices and economic activity (**Table 3**).

Second, there is a relatively high degree of comovement between real house prices and real credit in the advanced economies (**Table 2**). The strong relationship can be a reflection of that housing is used as collateral in mortgage lending and that house price movements affect the borrowing capacity of households and firms (Kiyotaki and Moore, 1997). These effects seem to be particularly stronger in bank-based economies (i.e., Germany and Japan) than in market-based economies (i.e., United States and United Kingdom). There is also evidence that credit often leads real house prices, consistent with the findings of Mendoza and Terrones (2008).

Third, there appears to be virtually no contemporaneous correlation between housing and stock prices and between housing and interest rates (**Table 3**). However, real house prices often lead movements in equity prices, particularly in Denmark, Finland, and Ireland.[13] The lack of comovement between real house prices and interest rates suggests that the availability of credit, where lending standards are below normal, might be one of the dominant drivers of house price movements in the advanced economies. Indeed, the recent house price boom was primarily fueled by ample liquidity in the financial sector.

III.2. Synchronization of House Prices

The world economy has become more integrated over the past two and a half decades, reflecting rising trade and financial linkages. Some researchers have argued that increased international linkages have led to more synchronized business cycles.[14] Indeed, the degree of

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[12] Comovement is measured as the contemporaneous correlation between the growth rates of real house prices and the corresponding aggregate of interest (for instance, output).

[13] Quan and Titman (1998) find no significant contemporaneous correlation between the growth of real estate prices and stock prices for a sample of 17 industrial countries.

[14] Economic theory does not provide a clear guidance concerning the impact of increased trade and financial linkages on the degree of business-cycle synchronization, and the evidence is similarly ambiguous (see Hirata, Kose, and Otrok, 2012; Kose, Prasad, and Terrones, 2003; and Doyle and

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comovement of output growth across advanced economies has increased over the globalization period (**Table 4**). With increasingly integrated financial markets, stock prices and interest rates across advanced countries have also become more synchronized. **Figure 2** presents the distributions of cross-country correlations of house prices, equity prices, credit and output in each sub-period and full sample. These figures show that the increase over time in the degree of correlations in these variables is statistically significant (in particular, the Kolmogorov-Smirnoff tests indicate that there are statistically significant differences across distributions in the pre-globalization and globalization periods).

What are the implications of increased international linkages for the synchronization of house prices? While housing is the quintessential nontradable asset, house price cycles across countries may be synchronized if the forces driving house prices (such as shocks to output, credit and interest rates) tend to move together across countries.[15] There is growing evidence that house prices in some advanced economies have moved in tandem, at least during certain periods.[16] When examining the international co movement of house prices across advanced economies, the following two facts stand out. First, house prices in advanced economies tend to move together—although the strength of the synchronization is not high. The average cross-country correlation of real house prices is close to 0.2. This finding is consistent with those reported previously in the literature for other sample periods.

Second, house prices have become more synchronized over time. The increase in the degree of synchronization has been especially pronounced over the last six years, as house prices in several advanced economies have fallen since 2006. This finding appears to be associated with similar developments in the real and financial sectors—i.e. increased degree of synchronization of national business cycles, monetary policies (as proxied by short-term interest rates) and fluctuations in credit markets.

In addition to simple correlation statistics, we study the degree of synchronization of house prices across countries using the concordance index developed by Harding and Pagan (2002b). This index provides the fraction of time that the two series are in the same phase of their respective cycles. This definition implies that the two series are perfectly procyclical (countercyclical), if the concordance index is equal to unity (zero). To analyze the degree of synchronization of house prices and other variables across countries, we first compute the

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Faust, 2003). Differences in empirical findings stem from the use of different sample composition, time coverage, and construction of the "world" aggregates.

[15] There have also been structural changes in the functioning of financial markets due to various financial market reforms. However, the financial sector reform across the advanced economies has varied in speed and depth. This has resulted in segmented-mortgage markets, which has probably affected the extent of synchronization of credit and housing markets across countries.

[16] For instance, Claessens, Kose, and Terrones (2012) report that there has been an increase in the degree of synchronization of house prices over time. Helbling and Terrones (2003) also find evidence of synchronization of house price booms/busts across countries, which, they argue, is the reflection of the synchronization of monetary policy and financial liberalization—in addition to general business cycle linkages.

concordance statistic for each country pair, and then calculate the average of the relevant statistic for each variable.

For the full sample, cycles in the real economy display the highest degree of synchronization, whereas housing cycles exhibit the lowest degree **(Table 6)**.[17] Temporal changes in the degree of synchronization based on the concordance metric align with our findings based on correlations. The degree of concordance in all variables has increased over time. In the case of house prices, for example, the fraction of synchronized cycles has increased from 51 percent to more than 63 percent.

There is a large research program focusing especially on the synchronization of equity prices. These studies also document that cross-country correlations of equity and other asset prices have increased not only among advanced countries and emerging economies in the past two decades, but also between these two groups (Ehrmann, Fratzscher, and Rigobon, 2005). This is to be expected since asset markets have become ever more closely integrated because of technological advances and the liberalization of financial markets, and the associated rapid increase in gross international financial flows.[18] Besides financial integration, the importance of financial development, the liquidity and depth of equity markets and real integration, including trade intensity, have been shown to affect the degree of comovement of asset prices across countries.[19]

III.3. Variance Explained by Common Factors

We also study the fraction of variance explained by the common factors to get a better sense of the synchronization of house price fluctuations. As explained earlier, we estimate the first principal component to determine the common factor in each variable. The common factor explains almost one-third of the variation in the growth rate of real house prices (**Table 6**). Perhaps more importantly, the fraction of the variance of house prices explained by the common factor has increased over time from about 20 percent during the pre-globalization period to about 35 percent during the globalization period. In parallel to our previous findings, the common factor of each variable has become more important in explaining its variance over time.

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[17] Hiebert and Vanteenskiste (2009) analyze the house price co-movement in the euro area, and show that spillovers from country specific house price shocks are relatively low.

[18] Evidence shows that much of the increase in the degree of financial market integration is due to *de jure* capital account liberalization, with stock return correlations and market betas increasing after liberalization.See Bekaert and Harvey (2000), Goetzman and others (2005) and Quinn and Voth (2008).

[19] Forbes and Chinn (2004) and Beine and Candelon (2007) show that both bilateral financial and trade intensity drive synchronization of equity prices. Dellas and Hess (2005) show the liquidity and depth of equity markets to determine the synchronization of equity returns. The adoption of a single currency (Walti, 2008), and less real exchange rate volatility, and asymmetry in output growth (Tavares, 2009) also increase correlations.

The sources of synchronization of house prices has been an interest of recent research. Otrok and Terrones (2004) document that the comovement of house prices across countries is explained by both real and financial global factors. They argue that examples of global factors include the global business cycles and the world interest rate. In addition, the common factor is positively correlated across industrial countries with the depth of mortgage markets (as measured by mortgage-to-GDP ratios) and gains in home ownership ratios (reflecting cross country structures and policies aimed at fostering home ownership).[20]

We also examine the cross-country correlations of the common factors to get a sense of the degree of synchronization of global aggregates (**Table 7**). There are two major observations: First, the common factor of house prices is highly correlated with the factors of credit and output. Second, the correlations between the common factor of house prices and the factors of credit and output have declined over time. These observations suggest that, at a very preliminary level, the links between housing markets and real activity have become weaker over time and house price dynamics have increasingly moved away from fundamentals. In the case of credit, the increased integration of housing finance into the broader financial sector during the globalization period has probably made credit less important in driving house prices in the advanced economies.[21]

IV. Explaining House Price Fluctuations

In the previous section, we established that house price movements across the world are synchronized. This is an interesting empirical fact in and of itself, but it naturally leads to the question of why they are synchronized. In this section, we study how a sequence of shocks affects house prices. The structural shocks are identified by imposing various restrictions on VARs we described in section II. We begin by identifying a set of largely reduced form shocks using a recursive scheme (Cholesky decomposition of the reduced form variance covariance matrix). We then more formally identify a sequence of structural shocks, including monetary, credit, productivity and uncertainty. Our first set of results focuses on how global versions of these shocks (characterized by their common components) affect global house prices. We then supplement these findings at the global level with G-7 and country specific results in an appendix.

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[20] The impact of global factors on house prices consequently varies across individual countries, in part dependent on the development of the local mortgage markets, income growth, and structural and policy factors such as tax/subsidies (Otrok and Terrones, 2004). For example, global factors appear to explain about 70 percent of house price movements in the United Kingdom and the United States, but only about 3 percent in New Zealand.

[21] We also analyze the linkages between global and national house prices and other financial variables and output using a series of Granger causality tests. Both interest rates and output tend to Granger cause house prices. We will include those results in the next version of the paper.

IV.1. Identification of Structural Shocks

The identification of structural shocks (monetary, technology etc.) in the VAR framework has generated an enormous literature. To identify shocks we use either the Cholesky decomposition, which imposes a temporal order on the responses, or sign restrictions. In identifying shocks, we attempt to include the same variables in each VAR to the greatest extent possible. However, due to the need to implement sign restrictions, there is some variation across models. The shock identification used here is not unique to this paper as the restrictions imposed have been shown elsewhere to be derived from economic theory. We briefly provide some intuition to motivate the theory but do not write down the corresponding structural models.

Our first identification strategy uses a simple recursive structure. The variables we include in the VAR are the global components estimated in the previous section. The order we use is output and house price growth first, then interest rates followed by credit growth and equity. This setup is motivated by the fact that real variables likely adjust slower than asset market variables. This VAR provides preliminary evidence on what types of global shocks are likely to matter and motivates the more structural identification approach that follows.

Our second identification strategy involves the use of a set of sign restrictions imposed on impulse responses following Uhlig (2005).[22] This identification approach allows us to produce impulse responses that are qualitatively consistent with standard theoretical predictions. We keep the horizon for sign restrictions at four quarters to maintain symmetry across shocks. The selection of four quarters also captures the idea that the impact of each shock lasts for at least a year.[23] We now briefly discuss the identification of productivity, monetary, credit and uncertainty shocks we employ.

Productivity shocks. These shocks have a long history in economics as being an important driver of output. In the international business cycle literature, Crucini, Kose and Otrok (2011) find that much of the common cycle in output can be attributed to common productivity. Here we study instead the role of productivity on driving house prices. Towards this objective, we use the identifying restrictions derived in Peersman and Straub (2009). They show that for a wide class of DSGE models following a positive productivity shock, output rises and inflation falls. The intuition for the decline in inflation is simply that, in a New

[22] Uhlig (2005) considers the importance of monetary policy shocks by imposing sign restrictions on the impulse responses of prices, nonborrowed reserves, and the federal funds rate.

[23] The selection of horizon length closely follows Peersman and Straub (2009) who also use the same length to identify productivity shocks for the Euro area. There are some studies that keep the sign restriction horizon shorter than the one we use. For instance, Uhlig (2005) identifies monetary policy shocks by keeping the sign restrictions horizon at 2 quarters. In the context of credit market shocks for the U.S., Meeks (2012) identifies a credit shock by imposing sign restrictions on spreads for 2 quarters and those on defaults for 12 quarters. We have conducted sensitivity exercises to check the robustness of our results to alternative identification restrictions and horizon assumptions. All of our main results are robust to these variations.

Keynesian model, productivity increases lower marginal cost which, in turn, drives inflation in that model.

They also argue that wages should rise following a positive productivity shock. This is true in models with Walrasian labor markets. However, Otrok and Pourpourides (2011) find that micro-level wage data is inconsistent with the prediction of models with Walrasian labor markets. We therefore do not impose this restriction since it is not robust.[24] The FAVAR model which we use to study the productivity shocks includes the growth rates of equity, reserves, output and house prices as well as the levels of long term interest rates, inflation, and short term interest rates.

Monetary policy shocks. As we discuss in the introduction, there is a large literature analyzing the potential impact of monetary policy shocks on house prices. By changing interest rates and the cost of borrowing central banks may affect house prices. For example, Del Negro and Otrok (2007) find that the impact of monetary shocks on house prices is statistically and economically significant for the United States from 1986-2005. To identify monetary shocks, we use the sign restrictions of Uhlig (2005). The restrictions are that in response to the monetary shock short-term interest rates rise, reserves fall, and inflation declines (for the first 3 periods). The FAVAR model we use to examine these shocks is similar to the previous one, except we use credit growth instead of equity growth.

Credit market shocks. The recent global financial crisis is suggestive that credit markets are important for economic activity. Helbling, Huidrom, Kose and Otrok (2011), for instance, examine the implications of credit market shocks for the evolution of the growth of global output. They document that while global credit supply shocks on average do not seem to affect global output; they matter in some specific periods, such as the recent crisis. Here, we study the role played by shocks to credit markets in driving global house price cycles.

For the purposes of identification here, we use the sign restrictions proposed by Meeks (2012). The restrictions imply that, after a negative credit supply shock, credit falls while the spread between low grade and high grade corporate bond yields rise. An additional restriction that Meeks proposes is that default rates do not rise. This restriction is designed to ensure that the shock is a pure supply shock and not an endogenous response of lenders to adverse economic news. We find similar results both with and without the restrictions on defaults so we report only one set of results. An important data limitation here is that we have default and spread data only for the United States. We use these series as proxies for the world in our FAVAR models with the global components. In addition, since the default series are available since the late 1980s only, we are unable to run our models for the pre-globalization period for the credit shocks. The FAVAR we utilize to study credit market shocks is similar to the previous one except that we use spreads and default rates instead of reserves and long-term interest rates.

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[24] An alternative approach to identifying TFP shocks is to order productivity first and applying the Cholesky decomposition. This of course requires good productivity data, which we have for the US but not the world. In the next version of the paper, we plan to present results for the US using this alternative.

Uncertainty shocks. Recently, there has been significant interest in understanding the role uncertainty plays in driving economic fluctuations. Bloom (2009) finds that increases in uncertainty have a pronounced and long-lived negative impact on output and employment. We follow his identification strategy and place a measure of stock market uncertainty into our VAR with equity prices, and real and nominal variables. Identification is achieved using a recursive ordering with stock price growth first, uncertainty second, followed by short- and long-term interest rates, house price growth, inflation and output growth. There are three main differences with the setup of Bloom (2009). First, he uses data on wages, employment, and hours instead of interest rates and house prices. Second, his data is monthly. Third, he uses HP filtered levels for aggregates with trends while we use growth rates. We experimented with the levels and growth rates in a FAVAR with US variables and obtained similar results.[25] The FAVAR model we use in this case is similar to the previous one except that we substitute uncertainty and equity growth instead of spread and default rates.

IV.2. Global Evidence on the Sources of Synchronization of House Prices

IV.2.1. Recursive Identification

The responses of global house price growth to the innovations in all variables in the FAVAR are depicted in **Figure 3.** Global interest rate shocks have a significant but delayed negative impact on global house prices when considering the full set of 18 advanced countries. This finding is in many ways not surprising as the increase in the synchronization of house price cycles coincides with an increase in the synchronization of interest rates, as noted earlier. Moreover, the significant impact of global interest rate shocks on global house prices is also consistent with other findings in the earlier literature analyzing the impact of national interest rate shocks on the domestic house prices (Kuttner, 2012). This result is commonly interpreted to mean that monetary policy drives house prices.

Our interpretation of this result is that surprise shocks to interest rates—which may be market driven or originate from the actions of the Central Bank—drive down house prices by increasing the cost of borrowing. Mortgage credit is indeed the most important source of financing that households' have in many of these countries. However, there are important differences across countries with the Netherlands, United States and United Kingdom showing the highest mortgage-to-GDP ratios and France, Italy and Japan showing the lowest. More specifically, interest rate shocks can be driven by factors other than just monetary policy decisions. Interestingly, when we consider the same FAVAR model with the global components using the G-7 countries' series (instead of the sample of 18 countries), the fragility of this result quickly becomes obvious. In particular, the results indicate that an increase in the G-7 interest rates actually increase house prices [these results will be included in an appendix in the next version]. We present results based on a more rigorous identification strategy for monetary policy shocks in the next sub-section.

[25] These results will be included in an appendix in the next version.

The response of global house prices to an increase in global credit is positive and significant. Not surprisingly, in both sub-periods, when there is robust growth in credit, house prices tend to appreciate. House prices seem to not respond to innovations to equity returns in a significant way. This is probably a reflection of the low contemporaneous correlation between these asset prices we documented earlier. Shocks to global output have a modest positive impact on global house prices. We interpret this as suggesting that robust economic growth tends to provide modest support for house price.

Tables 8a-8c present the variance decompositions for global house prices and other variables. In the full sample, global interest rate shocks account for close to 30 percent of the movements in house prices, with credit a more modest 10 percent. Innovations to house prices themselves account for about half of the variation in house prices. We view this as the fraction of movements in house prices that we are unable to explain with the FAVAR model. Interest rate shocks explain a smaller fraction of credit movements over time and both credit and interest rate shocks play a less important role in explaining global house prices during the globalization period.

Our conclusion from these exercises then is that income whether earned (output) or through portfolio (equity returns) have a muted impact on global house prices. On the other hand, the availability of credit and the cost of that credit have significant and persistent impacts on house prices. These results are reduced form in the sense that each shock is likely a combination of underlying structural shocks. However, we find the exercise useful for at least two reasons. First, much of the literature uses this identification and then applies a structural interpretation. By comparing the results from such an exercise with a more structural identification, we can present a better understanding of the current literature and build on it. Second, reduced form evidence is quite valuable in suggesting which structural shocks are likely to matter and hence provides a roadmap for progress.

IV.2.2. Identification with Sign Restrictions

In this section, we use the robust sign restrictions described above to identify structural shocks. **Figures 4a-4c** show the impulse responses of house prices and other variables to credit, monetary policy and productivity shocks.

Monetary policy shocks. Since there is a general perception in the literature that interest rate shocks, which is confirmed above, are an important driver of house prices, we begin with a discussion of our results based on a formal identification of global monetary policy shocks.

The results show that monetary shocks do not appear to have a significant impact on house prices at the global level. This is in contrast to the earlier result that interest rate shocks do drive house prices. These findings suggest that the surprise movements in interest rates that drive house prices seem not to be originating solely from the actions of central banks. In terms of variance decompositions **(Tables 9a-9c)**, the monetary policy shocks explain 12 percent of house price variation in the full sample period. The importance of monetary policy shocks in explaining house prices has, however, not changed much over time.

Credit shocks. We next study the importance of credit supply shocks. The responses of house prices to these shocks are essentially zero. Credit shocks have a negative and significant impact on output response for one year. These account for 14 percent of house price growth and 12 percent of output growth. These variance shares also appear to be stable over time. The reduced form credit shocks identified in Figure 3 had credit shocks playing a positive role on house prices. Here we find that supply side exogenous contractions in credit have not been significant drivers of house prices. One interpretation of this is that credit markets usually function well and hence will not drive house prices on average. This is similar to what Helbling et. al. (2011) find is the case for the impact of credit shocks on the global output cycle. Why then, do we find that credit shocks matter in the recursive setup? In Section 2, we document that credit and house prices move together. The result in Section 3 then is capturing these correlations in a reduced form setting. It is not appropriate, however, to place a structural interpretation to this result.

Productivity shocks. Not surprisingly, global productivity shocks drive up global output. However, their impacts on output, despite being significant, are quite small. These shocks tend to have a positive but insignificant effect on house prices. Given that the impact on shocks to output growth were modest, the insignificant impact of productivity shocks on house prices is not surprising. That is, productivity here matters mostly because it drives up income, which in theory would allow bid to bid up house prices. In practice this economic mechanism is quite weak.

Uncertainty shocks. Our final shock is the uncertainty shock. We present the impulse responses of global house prices, equity prices and output to uncertainty shocks in **Figure 5a**. These shocks reduce output for the full sample period and globalization period. This shows that the results by Bloom (2009) for the U.S. holds for the global economy as well, though the impact is stronger during the globalization period. Our results are a bit weaker in terms of the size of the response relative to Bloom, though the shapes are similar. These shocks account for around 10 percent of output variation **(Table 10a)**. The uncertainty shocks also have a negative and significant impact on equity prices. They explain about 8 percent of equity price variation.

The impact of uncertainty shocks on global house prices is not significant in the full sample. In the first sub-period, the impact is modest and negative. In the second sub-period, the response is positive, significant and of long duration. However, when we focus on the G-7 countries, this shock becomes significant for the full sample and globalization periods (**Figure 5b**). More surprisingly, uncertainty shocks tend to drive up house prices in the G-7 countries. In terms of variance decompositions, the uncertainty shock accounts for 30 percent of house price variation in the G7 during the globalization period (**Table 10b**). In other words, uncertainty plays a central role in explaining why there is a common cycle in house prices. One reason why this is true is that uncertainty seems to be quite common across countries. For example, the correlation of US uncertainty with the uncertainty in the G7 principal component is 0.96. The reason then that house prices have a large common component is that uncertainty matters for house prices and uncertainty in a variable that is largely common across countries.

We interpret these results as follows. First, uncertainty seems to matter only for the core group of G-7 countries. Second, the role that uncertainty plays in explaining house price movements is more pronounced during the globalization period. That is, uncertainty in financial markets (measured by stock market volatility) has a large impact on house prices only during the globalization period. This may be due to the fact that stock market participation has also increased over this period and that housing market has benefited from other vehicles of financing (other than conventional mortgages). Lastly, our finding that the increase in stock market uncertainty drives up house prices is likely due to the fact that when there is heightened uncertainty in a risky asset agents resort to buy more of an asset that is perceived to be relatively safer. This observation is consistent with the empirical facts we report in the previous section: house prices are generally less volatile (or safer) than equity prices during the globalization period. While that may no longer be the perception of many, it was before 2007.

V. Conclusion

We examine the synchronization and sources of house price fluctuations across eighteen advanced countries over the past four decades. We document that, despite the fact that housing is the quintessential non-tradable asset, the degree of comovement of house prices across countries is relatively high. Moreover, the degree of synchronization of house price fluctuations has increased. These findings are supported by various methodologies. In particular, the fraction of variance of house prices explained by the global house price factor has increased over time from about 20 percent during the pre-globalization period to 35 percent in the recent period of globalization.

We then indentify the main drivers of fluctuations in global house prices. Towards this objective, we employ a series of VAR and FAVAR models, with two identification schemes commonly used in the literature--a recursive method and a sign restriction method. We consider how the responses of house prices change to different types of shocks, in different countries, groups of countries (world and G-7), and sub-periods of time.

With the first method, we find that interest rate shocks have a significant effect on house prices. These types of findings have led some observers to claim that monetary policy has been an important driver of house prices in the advanced economies (Taylor, 2008). However, it is not clear what drives interest rate movements: are they market driven or are they simply the result of actions of central banks? To shed light on this issue, we then turn to the identification of monetary policy shocks using a “robust” procedure. Our results suggest that monetary policy shocks do not have a significant impact on house prices. These findings indicate that surprise movements in interest rates that drive house prices might not be solely associated with changes in monetary policy. Although credit market shocks and productivity shocks do not have a sizeable impact on house prices, uncertainty shocks tend to influence house price movements. In fact, one third of the global cycle in house prices can be attributed to uncertainty shocks. This is an economically large role for one shock to explain, and hence an important empirical fact.

The stylized facts and results from various time-series models we report here indicate the necessity of a deeper study of sources of house price movements. Specifically, it is important to reexamine the commonly held belief that monetary policy has been responsible for large fluctuations in house prices in advanced countries prior to the global financial crisis. We are in the process of undertaking new experiments to gain a better understanding of the sources of house price movements. And we plan to report additional findings in the next version of the paper.

[to be continued]

Appendix I. Database

Appendix II. G-7 and Country Specific Results

[to be included]

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Table 1. Summary Statistics

	Mean	Volatility	Coefficient of Variation	Maximum	Minimum
Output					
Full Sample	2.51	2.53	0.99	9.34	-6.39
Pre-Globalization	2.82	2.74	1.03	8.90	-3.29
Globalization	2.35	2.30	1.02	6.80	-5.64
House Prices					
Full Sample	2.20	7.48	0.29	26.40	-14.63
Pre-Globalization	1.23	8.05	0.15	22.09	-12.94
Globalization	2.70	6.75	0.40	21.04	-12.27
Equity Prices					
Full Sample	4.64	24.15	0.19	79.50	-49.49
Pre-Globalization	-0.02	23.22	0.00	62.13	-41.74
Globalization	7.08	23.95	0.30	74.74	-46.56
Credit					
Full Sample	5.30	6.66	0.80	26.46	-10.01
Pre-Globalization	4.80	6.45	0.74	20.25	-7.36
Globalization	5.56	6.32	0.88	22.56	-8.02
Short-term interest rate					
Full Sample	-0.15	2.29	-0.07	8.38	-8.02
Pre-Globalization	0.21	2.76	0.08	7.08	-6.13
Globalization	-0.34	1.88	-0.18	5.47	-6.52
Long-term interest rate					
Full Sample	-0.10	1.30	-0.08	4.01	-3.95
Pre-Globalization	0.27	1.42	0.19	3.55	-3.11
Globalization	-0.30	1.14	-0.26	3.11	-3.27

Source : Authors' calculations

Notes : Mean indicates the average of the growth rate of each variable. Volatility is the standard deviation of the growth rate each variable. Coefficient of variation is the ratio of the mean to the volatility. Maximum (minimum) indicates the maximum (minimum) growth rates of each variable. Full sample covers the period of 1971:1-2011:3, pre-globalization is the sub-period of 1971:1-1984:4, and globalization is the sub-period of 1985:1-2011:3.

Table 2. Within Country Correlations for the Pairs of Countries

	House Prices	Equity Prices	Credit	Short-term interest rate	Long-term interest rate
Output					
Full Sample	0.46	0.29	0.40	0.30	0.16
Pre-Globalization	0.45	0.21	0.50	0.19	-0.02
Globalization	0.48	0.38	0.35	0.39	0.24
House Prices					
Full Sample		0.15	0.47	0.16	0.07
Pre-Globalization		0.08	0.49	0.15	0.01
Globalization		0.16	0.48	0.22	0.14
Equity Prices					
Full Sample			0.11	-0.12	-0.26
Pre-Globalization			0.16	-0.26	-0.39
Globalization			0.11	0.01	-0.15
Credit					
Full Sample				0.20	0.08
Pre-Globalization				0.10	-0.09
Globalization				0.32	0.17
Short-term interest rate					
Full Sample					0.64
Pre-Globalization					0.65
Globalization					0.62

Source : Authors' calculations

Notes : The numbers present the average within country correlation of each pair of variables. Full sample covers the period of 1971:1-2011:3, pre-globalization is the sub-period of 1971:1-1984:4, and globalization is the sub-period of 1985:1-2011:3.

Table 3. Lead/Lag Correlations Between House Prices and the Other Variables

	Lags							Leads					
	-6	-5	-4	-3	-2	-1	0	1	2	3	4	5	6
Output													
Full Sample	0.21	0.24	0.28	0.34	0.39	0.43	0.46	0.43	0.37	0.28	0.18	0.09	0.02
Pre-Globalization	0.16	0.24	0.31	0.39	0.44	0.47	0.45	0.39	0.28*	0.16*	0.05*	-0.05*	-0.11*
Globalization	0.26	0.28	0.31	0.35	0.39	0.43	0.48	0.48	0.45	0.38	0.29	0.19	0.11
Equity Prices													
Full Sample	0.13	0.14	0.16	0.18	0.20	0.19	0.15	0.07	-0.02	-0.11	-0.17	-0.21	-0.22
Pre-Globalization	0.16	0.20	0.23	0.23	0.21	0.17	0.08	-0.03	-0.16*	-0.27*	-0.35*	-0.37*	-0.36*
Globalization	0.13	0.12	0.13	0.16	0.19	0.19	0.16	0.11	0.03	-0.05	-0.11	-0.16	-0.18
Credit													
Full Sample	0.16	0.21	0.26	0.32	0.38	0.43	0.47	0.47	0.45	0.42	0.37	0.33	0.29
Pre-Globalization	0.19	0.25	0.31	0.40	0.45	0.48	0.49	0.44	0.35	0.27*	0.17*	0.1*	0.04*
Globalization	0.14	0.19	0.25	0.31	0.37	0.43	0.48	0.51	0.52	0.51	0.49	0.46	0.43
Short-term interest rate													
Full Sample	-0.13	-0.13	-0.11	-0.08	-0.02	0.06	0.16	0.25	0.30	0.30	0.28	0.22	0.17
Pre-Globalization	-0.22*	-0.22*	-0.19*	-0.14*	-0.05	0.04	0.15	0.24	0.29	0.29	0.24	0.18	0.13
Globalization	-0.05	-0.05	-0.03	0.00	0.06	0.14	0.22	0.31	0.36	0.38	0.35	0.30	0.22
Long-term interest rate													
Full Sample	-0.17	-0.18	-0.18	-0.16	-0.11	-0.03	0.07	0.17	0.24	0.26	0.25	0.21	0.18
Pre-Globalization	-0.3*	-0.32*	-0.32*	-0.29*	-0.23*	-0.12*	0.01	0.15	0.25	0.30	0.30	0.28	0.25
Globalization	-0.09	-0.08	-0.07	-0.05	-0.01	0.06	0.14	0.23	0.28	0.28	0.26	0.23	0.18

Source : Authors' calculations.

Notes : Each cell represents the average within country correlation between house prices and other variables at respective time. At 0 the numbers show the contemporanous correlation between house prices and other variables. The lags columns show the correlation between house prices and other lagged variables, and the leads columns show the correlation between house prices and other lead variables. Full sample covers the period of 1971:1-2011:3, pre-globalization is the sub-period of 1971:1-1984:4, and globalization is the sub-period of 1985:1-2011:3.
* indicates that the difference between the correlations at pre-globalization period globalization period is statistically significant.

Table 4. Cross Country Correlations

	Full Sample	Pre-Globalization	Globalization
Output	0.43	0.32*	0.52
House Prices	0.18	0.14*	0.23
Equity Prices	0.56	0.43*	0.64
Credit	0.26	0.24*	0.30
Short-term interest rate	0.33	0.29*	0.42
Long-term interest rate	0.51	0.44*	0.54

Source : Authors' calculations

Notes : Each cell presents the average cross-country correlations of each variable. Full sample covers the period of 1971:1-2011:3, pre-globalization is the sub-period of 1971:1-1984:4, and globalization is the sub-period of 1985:1-2011:3. * indicates that the difference between the correlations at pre-globalization period globalization period is statistically significant.

Table 5. Concordance Across Countries

	Full Sample	Pre-Globalization	Globalization
Output	80.12	72.95	82.59
House Prices	59.15	51.39	63.21
Equity Prices	71.21	63.14	75.26
Credit	69.66	62.79	73.69

Source : Authors' calculations.

Notes : Each cell refers to concordance statistic for respective cycles across countries. Concordance is calculated as the fraction of time that two cycles are in the same phase. First the concordance for each country pair is calculated, then the median for each variable over the sample is calculated.

Table 6. Variance Explained by Principal Component

	Full Sample	Pre-Globalization	Globalization
Output	0.47	0.38	0.56
House Prices	0.29	0.21	0.35
Equity Prices	0.59	0.46	0.66
Credit	0.32	0.31	0.37
Short-term interest rate	0.39	0.37	0.47
Long-term interest rate	0.55	0.51	0.59

Source : Authors' calculations

Notes : Each cell presents the variance explained by the respective principal component. Full sample covers the period of 1971:1-2011:3, pre-globalization is the sub-period of 1971:1-1984:4, and globalization is the sub-period of 1985:1-2011:3.

Table 7. Correlation Among Principal Components of Variables

	Output	House Prices	Equity Prices	Credit	Short-term interest rate
House Prices					
Full Sample	0.59				
Pre-Globalization	0.81				
Globalization	0.58				
Equity Prices					
Full Sample	0.44	0.32			
Pre-Globalization	0.33	0.13			
Globalization	0.53	0.35			
Credit					
Full Sample	0.53	0.70	0.23		
Pre-Globalization	0.86	0.82	0.31		
Globalization	0.44	0.66	0.18		
Short-term interest rate					
Full Sample	0.49	0.25	-0.04	0.32	
Pre-Globalization	0.38	0.32	-0.20	0.17	
Globalization	0.57	0.32	0.11	0.50	
Long-term interest rate					
Full Sample	0.22	0.05	-0.29	0.03	0.70
Pre-Globalization	0.05	0.08	-0.39	-0.12	0.81
Globalization	0.28	0.15	-0.18	0.17	0.58

Source: Authors' calculations

Notes : Each cell presents the correlation between pairs of principal components of respective variables. Full sample covers the period of 1971:1-2011:3, pre-globalization is the sub-period of 1971:1-1984:4, and globalization is the sub-period of 1985:1-2011:3.

Table 8A. Variance Decompositions (Full Sample, 18 Countries)

Shocks	Forecast Horizon (in quarters)	Equity Prices	House Prices	Credit	Output	Short-term Interest Rates
House Prices	1	0.25	91.77	3.36	3.71	0.91
	4	1.02	74.69	7.03	2.59	14.66
	8	2.97	57.44	7.87	3.87	27.85
	12	4.62	52.53	8.86	5.22	28.76
Equity Prices	1	80.04	11.36	5.80	1.54	1.25
	4	61.07	12.87	12.39	4.62	9.05
	8	51.96	13.32	13.70	7.03	13.98
	12	47.32	14.07	15.95	8.39	14.27
Output	1	4.87	8.41	0.67	84.76	1.30
	4	12.15	26.05	5.00	52.79	4.01
	8	10.96	28.46	7.70	37.93	14.94
	12	11.99	27.99	9.00	35.91	15.12
Short-term Interest Rates	1	0.32	2.39	0.21	6.31	90.77
	4	1.58	4.24	1.60	13.96	78.62
	8	2.65	16.41	4.65	18.29	58.00
	12	3.68	22.24	5.69	19.04	49.36
Credit	1	0.37	4.25	91.96	1.80	1.62
	4	2.22	11.62	69.08	4.61	12.48
	8	4.71	21.07	45.79	5.61	22.81
	12	5.15	22.36	39.11	6.98	26.40

Table 8B. Variance Decompositions (Pre-Globalization, 18 Countries)

Shocks	Forecast Horizon (in quarters)	Equity Prices	House Prices	Credit	Output	Short-term Interest Rates
House Prices	1	0.68	79.27	8.78	9.93	1.33
	4	3.14	52.53	16.81	9.75	17.78
	8	3.58	42.33	14.34	9.79	29.96
	12	4.44	34.24	13.62	12.16	35.54
Equity Prices	1	68.74	5.17	12.23	9.62	4.24
	4	38.01	13.00	27.74	11.64	9.61
	8	25.39	20.50	27.71	13.15	13.25
	12	22.48	20.55	27.24	14.70	15.04
Output	1	1.37	5.42	5.92	75.12	12.17
	4	14.24	8.15	25.87	29.78	21.96
	8	8.71	26.07	17.12	15.13	32.96
	12	10.94	24.53	17.37	16.29	30.88
Short-term Interest Rates	1	0.53	5.19	1.15	4.79	88.35
	4	3.59	14.77	5.35	7.79	68.50
	8	6.61	16.07	9.95	11.27	56.10
	12	6.47	16.24	12.58	12.53	52.19
Credit	1	0.75	8.70	64.17	19.46	6.93
	4	4.76	15.02	34.74	12.90	32.59
	8	4.75	26.12	23.71	10.89	34.53
	12	5.59	25.59	22.56	12.41	33.85

Table 8C. Variance Decompositions (Globalization, 18 Countries)

Shocks	Forecast Horizon (in quarters)	Equity Prices	House Prices	Credit	Output	Short-term Interest Rates
House Prices	1	0.36	92.55	1.30	4.01	1.77
	4	2.00	74.61	3.35	4.75	15.28
	8	5.01	58.80	4.98	8.99	22.21
	12	7.01	53.81	6.56	11.03	21.58
Equity Prices	1	67.33	12.42	9.25	9.31	1.68
	4	49.76	14.41	22.36	8.17	5.31
	8	43.04	14.56	22.55	11.97	7.88
	12	39.61	15.13	23.46	13.83	7.97
Output	1	7.03	9.29	0.56	82.33	0.79
	4	14.77	27.81	3.13	51.10	3.20
	8	12.09	33.61	5.39	37.95	10.95
	12	12.62	31.32	7.70	36.63	11.73
Short-term Interest Rates	1	1.51	9.29	1.37	10.12	77.71
	4	4.94	7.14	5.32	20.80	61.81
	8	5.93	18.91	12.67	18.13	44.37
	12	7.00	26.37	13.62	17.46	35.55
Credit	1	0.70	3.12	89.21	4.97	2.00
	4	1.96	18.13	68.13	7.25	4.53
	8	3.50	42.89	33.80	7.61	12.20
	12	4.25	43.01	25.64	9.58	17.53

Table 9A. Variance Decompositions for Credit Shocks (18 Countries)

Shocks	Forecast Horizon (in quarters)	Spread	Inflation	Short-term Interest Rates	Output	House Prices	Credit	Default
Full Sample	1	2.57	5.85	8.44	9.53	8.49	13.07	17.53
	4	6.28	7.50	10.64	9.77	11.07	13.67	14.33
	8	8.79	8.71	11.96	11.84	13.52	12.96	13.84
	12	9.47	9.66	12.76	12.20	13.60	13.60	13.84
Pre-Globalization	1							
(not available because	4							
of the lack of data)	8							
	12							
Globalization	1	2.57	5.93	8.30	9.15	8.85	12.87	17.68
	4	6.51	7.27	10.23	9.84	11.32	13.43	14.59
	8	9.16	8.44	11.46	12.06	13.60	13.31	13.98
	12	10.01	9.28	12.30	12.73	13.83	13.83	14.18

Table 9B. Variance Decompositions for Monetary Policy Shocks (18 Countries)

Shocks	Forecast Horizon (in quarters)	Reserves	Inflation	Short-term Interest Rates	Output	House Prices	Credit	Long-term Interest Rates
Full Sample	1	18.35	3.25	12.64	11.64	8.65	6.64	10.87
	4	16.39	5.46	11.33	12.66	10.89	8.43	11.19
	8	15.55	6.73	11.27	14.32	12.54	11.31	10.47
	12	15.42	7.77	11.28	14.01	12.48	11.86	9.84
Pre-Globalization	1	16.35	8.28	8.93	10.72	10.27	11.01	11.92
	4	15.52	10.11	11.93	13.06	13.00	13.50	12.16
	8	15.13	12.71	13.11	12.82	13.29	12.70	12.76
	12	14.78	13.45	13.95	13.30	13.64	13.46	13.70
Globalization	1	13.46	4.53	21.06	8.70	9.20	7.42	11.36
	4	13.27	7.15	17.36	9.99	13.86	9.42	12.35
	8	13.32	8.79	15.68	11.88	14.21	13.37	13.12
	12	13.34	9.68	15.14	12.59	14.27	13.95	13.32

Table 9C. Variance Decompositions for Productivity Shocks (18 Countries)

Shocks	Forecast Horizon (in quarters)	Reserves	Inflation	Short-term Interest Rates	Output	House Prices	Credit	Long-term Interest Rates
Full Sample	1	7.39	14.25	7.32	18.18	7.30	7.78	10.73
	4	9.24	14.11	10.47	16.34	7.77	9.83	13.17
	8	10.38	13.98	12.61	15.08	10.56	12.48	13.88
	12	10.77	13.97	13.22	15.05	11.77	13.41	13.87
Pre-Globalization	1	8.50	10.20	10.84	14.91	10.40	11.13	11.81
	4	10.39	11.92	12.24	15.36	12.71	13.72	13.08
	8	11.48	12.91	12.81	14.84	13.72	13.86	13.03
	12	11.79	13.48	13.16	14.30	13.67	13.96	13.29
Globalization	1	4.45	10.82	9.56	19.99	7.66	7.93	10.38
	4	8.81	11.01	12.63	17.61	9.52	10.97	12.16
	8	10.17	11.30	12.81	15.79	12.42	13.63	12.39
	12	11.25	11.78	12.73	15.75	12.96	13.77	12.27

Table 10A. Variance Decompositions (Uncertainty Shocks, 18 Countries)

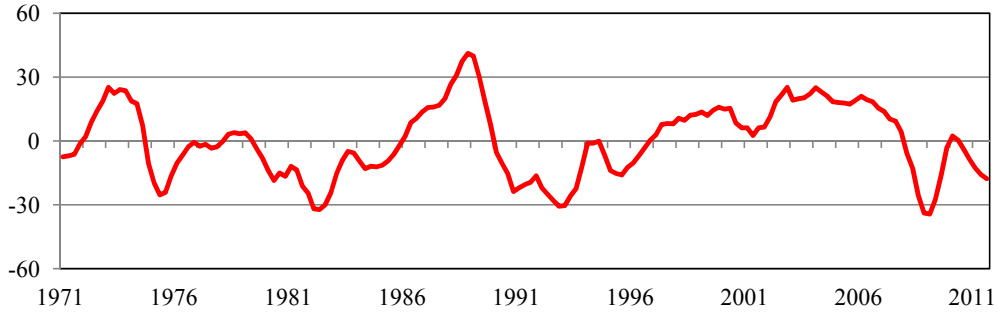
	Forecast Horizon (in quarters)	Full Sample	Pre-Globalization	Globalization
House Prices	1	1.57	6.36	2.39
	4	2.04	15.72	7.99
	8	5.05	14.12	15.10
	12	6.42	14.24	15.87
Equity Prices	1	2.20	2.64	1.88
	4	7.75	14.79	5.88
	8	7.93	16.90	7.28
	12	7.86	19.68	7.92
Output	1	5.74	18.26	4.80
	4	10.63	15.50	9.50
	8	9.89	12.48	9.14
	12	10.12	13.86	11.01

Table 10B. Variance Decompositions (Uncertainty Shocks, G7 Countries)

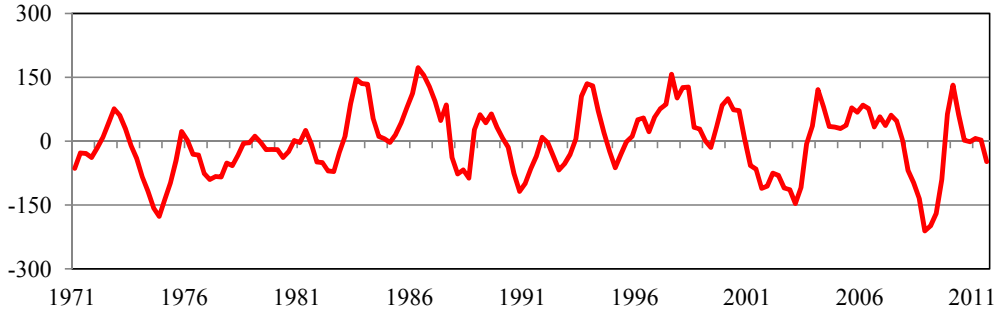
	Forecast Horizon (in quarters)	Full Sample	Pre-Globalization	Globalization
House Prices	1	1.20	6.03	5.56
	4	5.18	9.03	20.74
	8	9.49	11.63	29.07
	12	10.72	12.79	29.10
Equity Prices	1	1.65	2.73	1.80
	4	3.95	8.98	4.97
	8	6.47	11.29	8.71
	12	6.75	12.48	9.17
Output	1	4.09	9.88	5.68
	4	5.13	11.65	4.75
	8	7.53	12.07	15.04
	12	8.39	13.97	15.22

Figure 1. Global Factors of Financial Variables and Output

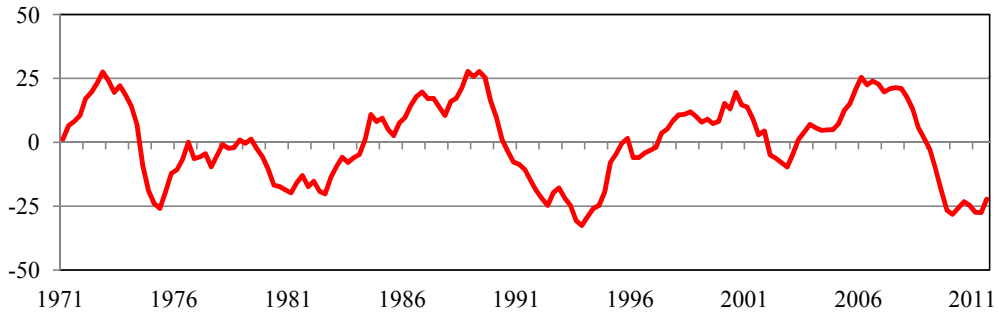
House Prices



Equity Prices



Credit



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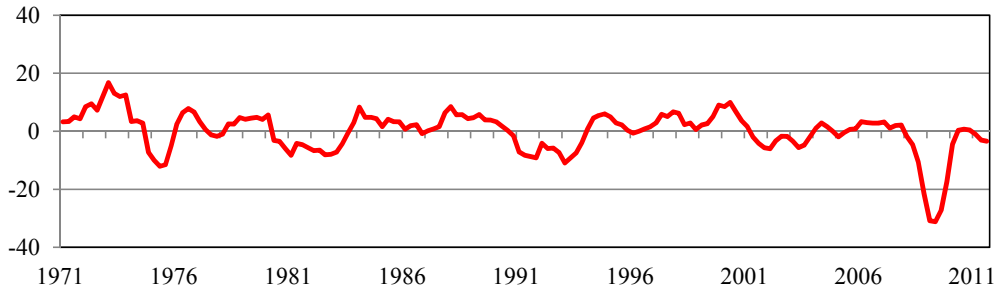
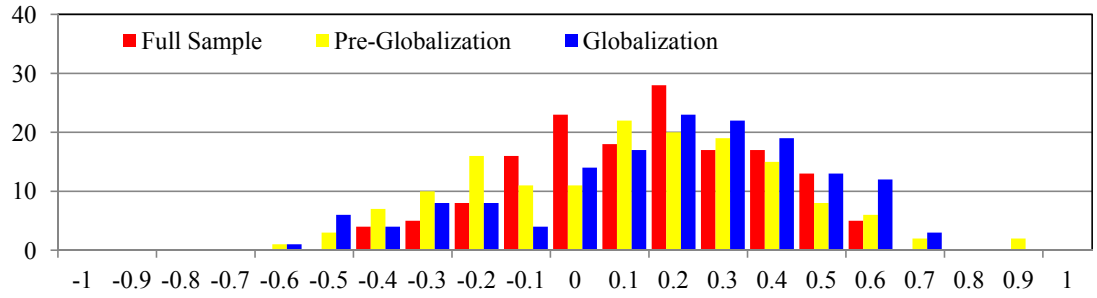


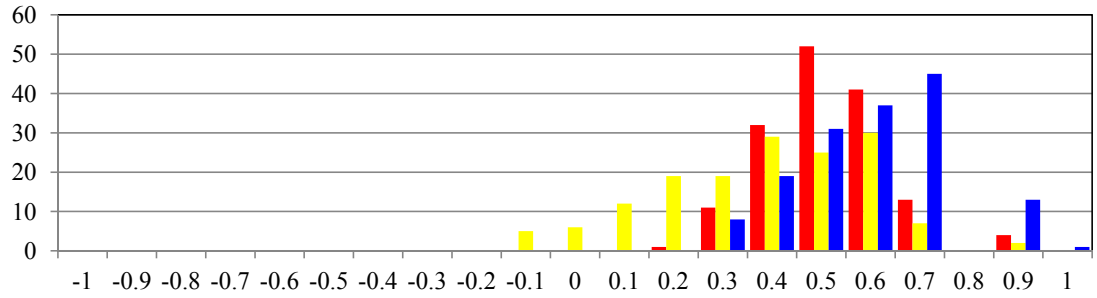
Note: Global factors are computed using the first principal components (growth rates).

Figure 2. Distributions of Cross-Country Correlations

House Prices



Equity Prices



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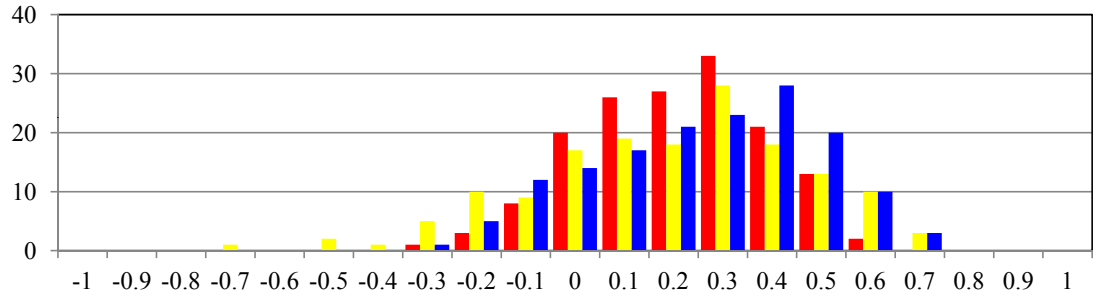

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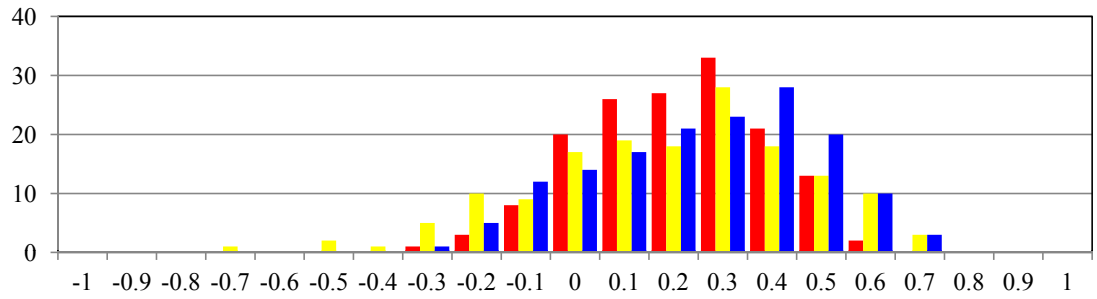


Figure 3. Impulse Response Functions of House Prices (18 Countries)

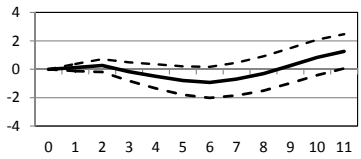
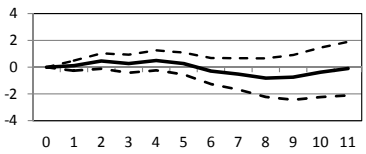
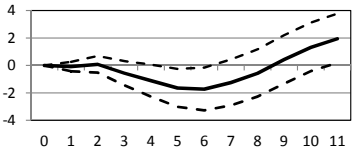
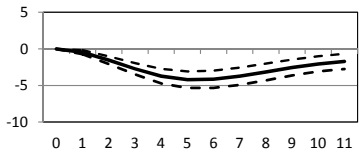
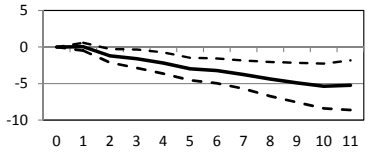
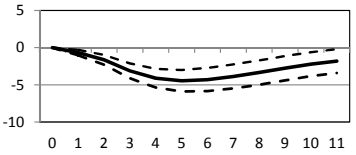
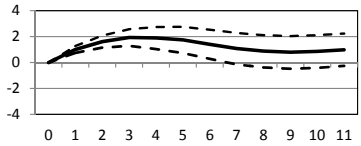
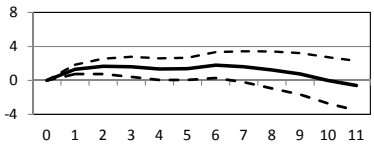
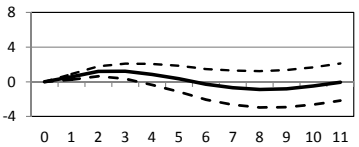
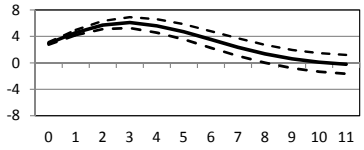
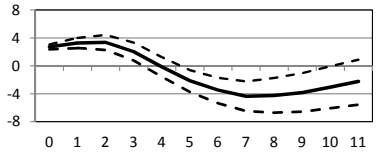
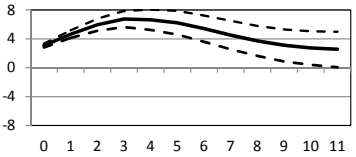
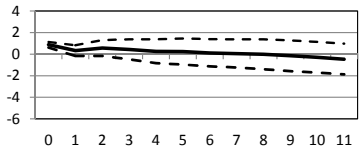
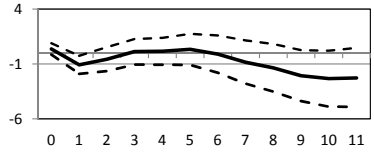
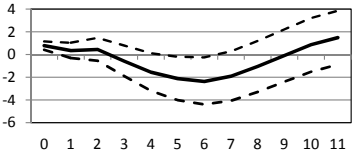
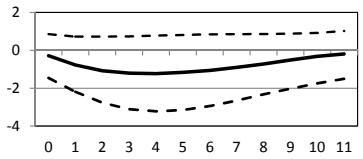
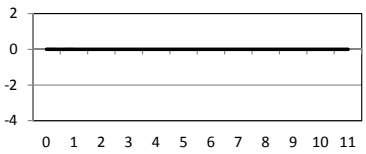
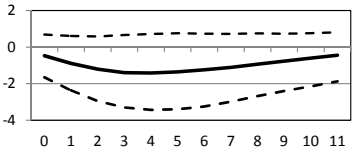
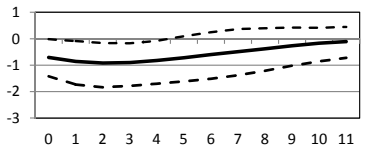
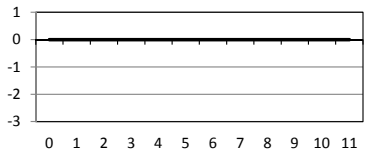
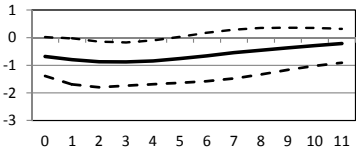
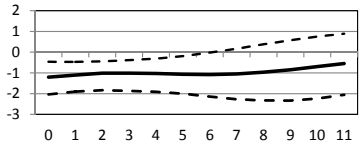
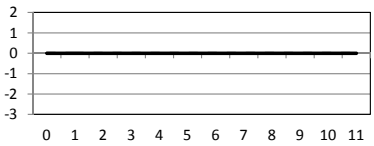
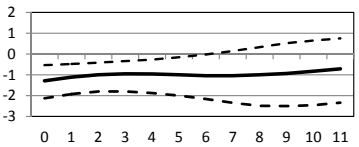
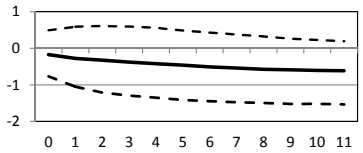
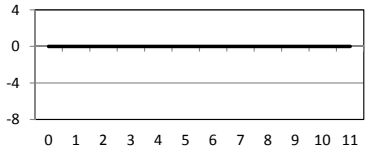
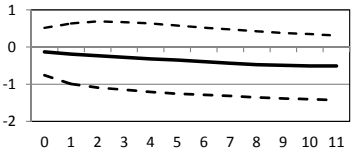
Full Sample	Pre-Globalization	Globalization
Equity Price Shocks		
		
Short-term Interest Rate Shocks		
		
Credit Shocks		
		
House Price Shocks		
		
Output Shocks		
		

Figure 4A. Impulse Responses to Credit Shocks (18 Countries)

Full Sample	Pre-Globalization	Globalization
House Price		
		
Output		
		
Credit		
		
Short-term Interest Rate		
		
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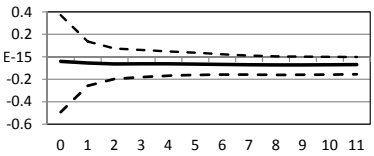
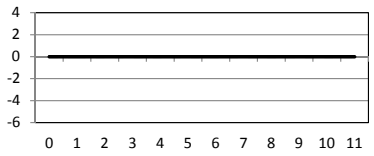
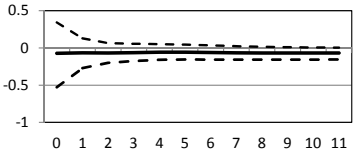
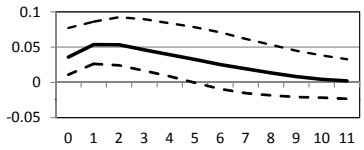
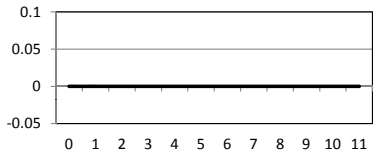
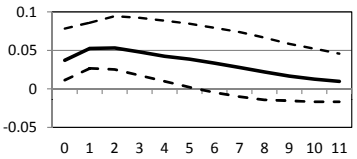
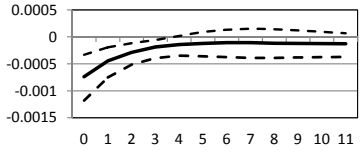
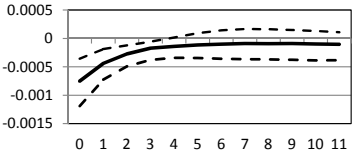
		
Spread		
		
Default		
		

Figure 4B. Impulse Responses to Monetary Policy Shocks (18 Countries)

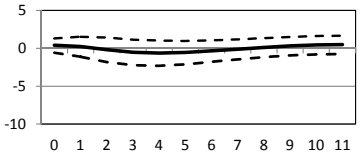
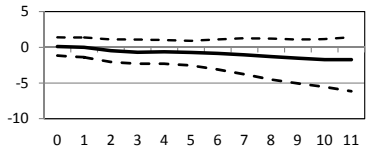
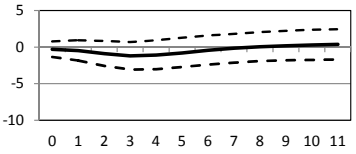
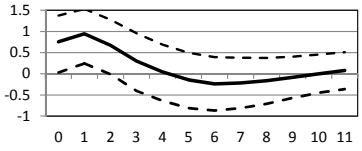
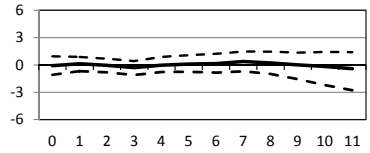
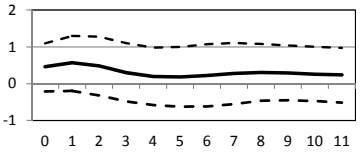
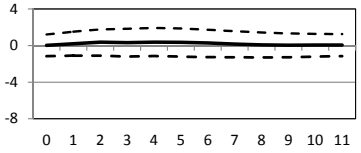
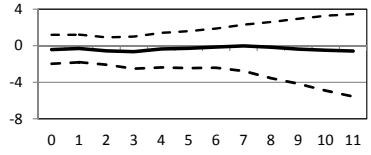
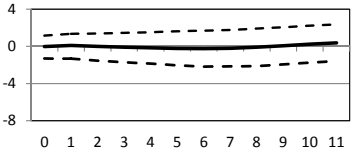
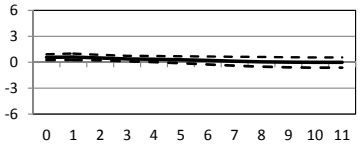
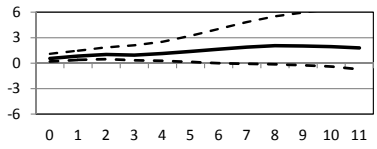
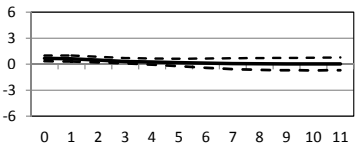
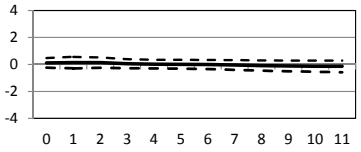
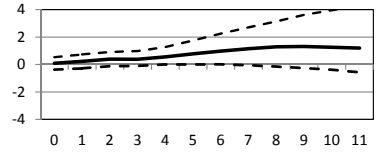
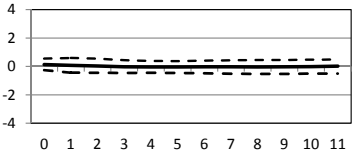
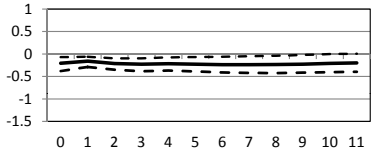
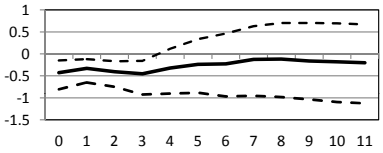
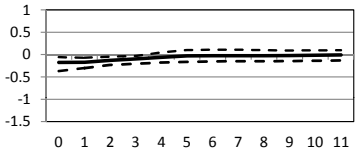
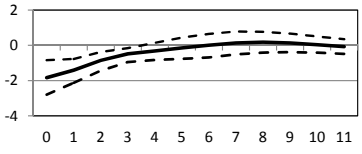
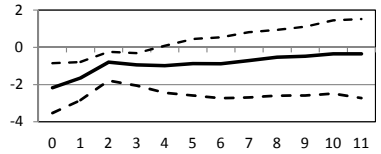
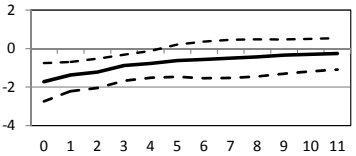
Full Sample	Pre-Globalization	Globalization
House Price		
		
Output		
		
Credit		
		
Short-term Interest Rate		
		
Long-term Interest Rate		
		
Inflation		
		
Reserves		
		

Figure 4C. Impulse Responses to Productivity Shocks (18 Countries)

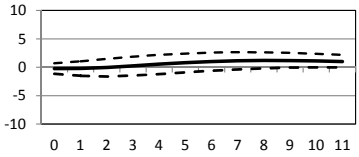
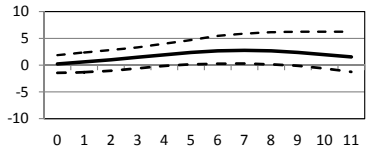
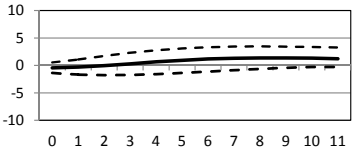
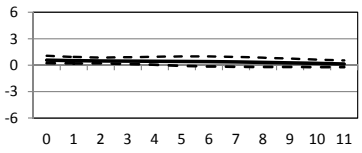
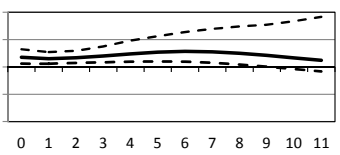
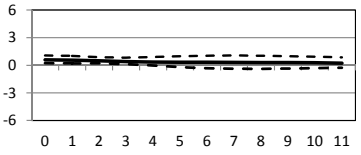
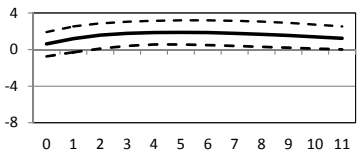
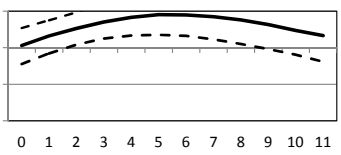
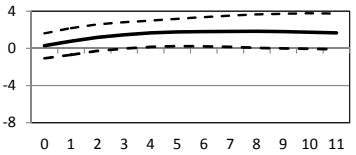
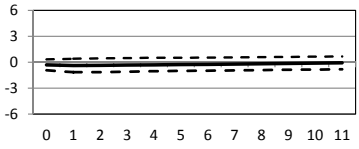
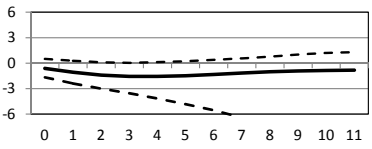
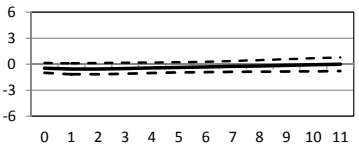
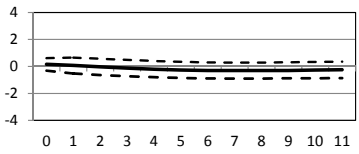
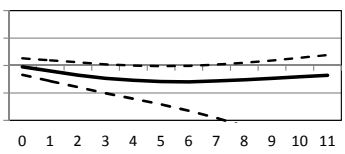
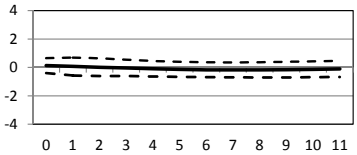
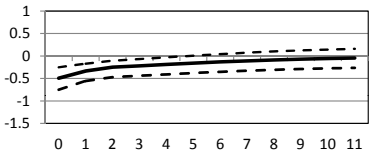
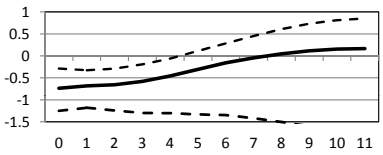
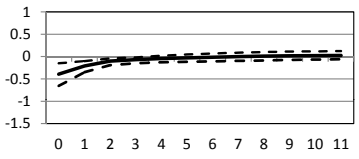
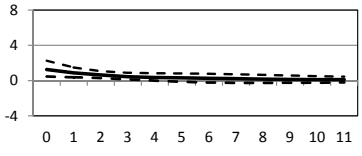
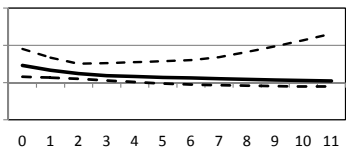
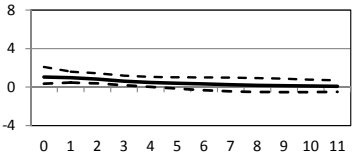
Full Sample	Pre-Globalization	Globalization
House Price		
		
Output		
		
Credit		
		
Short-term Interest Rate		
		
Long-term Interest Rate		
		
Inflation		
		
Reserves		
		

Figure 5A. Impulse Responses to Uncertainty Shocks (18 Countries)

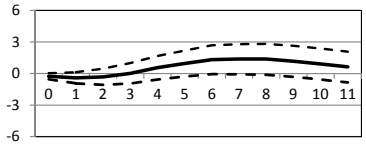
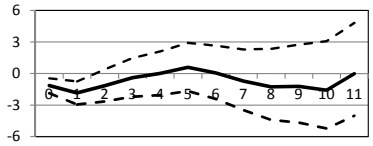
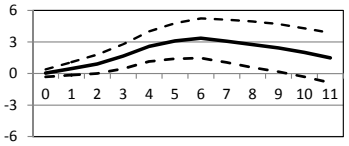
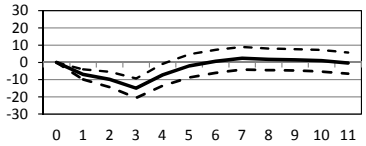
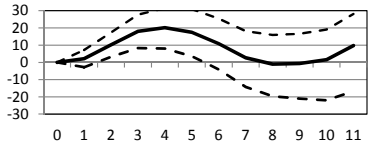
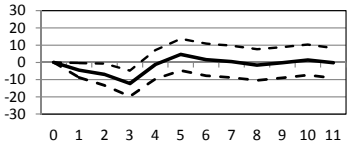
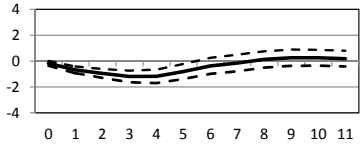
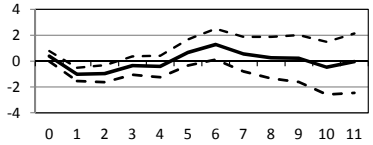
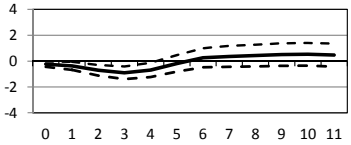
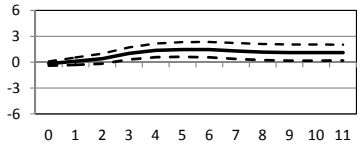
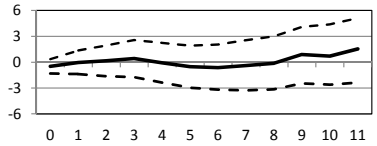
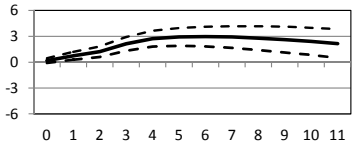
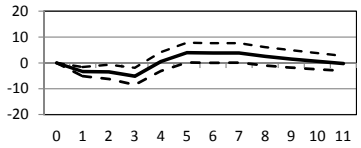
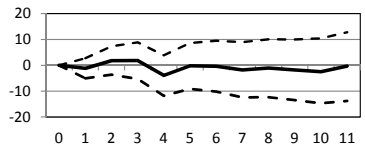
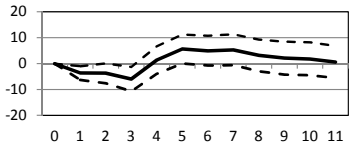
Full Sample	Pre-Globalization	Globalization
House Prices		
		
Equity Prices		
		
Output		
		

Figure 5B. Impulse Responses to Uncertainty Shocks (G7 Countries)

Full Sample	Pre-Globalization	Globalization
House Prices		
		
Equity Prices		
		
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