Global Macro-Financial Cycles and Spillovers

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Abstract: We develop a new dynamic factor model that allows us to jointly characterize global macroeconomic and financial cycles and the spillovers between them. The model decomposes macroeconomic cycles into the part driven by global and country-specific macro factors and the part driven by spillovers from financial variables. We consider cycles in macroeconomic aggregates (output, consumption, and investment) and financial variables (equity and house prices, interest rates, and credit). Our estimations indicate that while the global macro factor plays a major role in explaining G-7 business cycles, there are also sizeable spillovers from shocks to equity and house prices onto macroeconomic aggregates. These spillovers operate mainly through the global macro factor rather than the country-specific macro factors and are stronger in the period leading up to and following the global financial crisis. We find little evidence of spillovers from macroeconomic cycles to financial cycles.

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1. Introduction

Rising cross-border trade and financial flows, coupled with the increasing prominence of financial markets, appear to have intensified spillovers between financial markets and macroeconomic activity, both within and across economies. The 2007-09 global financial crisis dramatically highlighted these linkages as the crisis rapidly spread across financial markets in different countries. However, there was substantial heterogeneity across countries in how their financial markets and economies were affected by the crisis and ensuing global recession. Most advanced countries experienced deep contractions, but the timing and duration of the contractions and subsequent recovery have differed sharply across countries. The notion of a tightly linked global economy in which macroeconomic and financial disturbances are transmitted symmetrically, in terms of both speed and intensity, across countries is clearly not a suitable characterization.

This warrants a more nuanced analysis of business cycle transmission that accounts for various sources and channels of shock propagation across borders. A sharper distinction is also needed between macroeconomic aggregates (output, consumption, investment) and financial market variables (asset prices and credit), both as sources of shocks and as channels of propagation. The existing empirical literature has tended to focus on only one of these channels at a time and often in the context of a single country, ignoring both the potentially large feedback effects between them and cross-border spillovers. Another important issue is whether comovement among macroeconomic and financial variables is the result of spillovers of country-specific or variable-specific shocks, or simply reflects common shocks. Existing econometric models have not been able to make a convincing distinction.

In this paper, we attempt to provide an empirical characterization of macroeconomic and financial cycles in a setting that allows us to analyze the relationships between these two types of cycles, including potential spillovers between them. We begin by examining whether there is a common global cycle in financial variables, similar to the one that has been documented for macroeconomic aggregates. Our empirical analysis focuses on the G-7 economies over the period 1985-2016. This is the period that some earlier studies have identified as representing the recent wave of financial globalization (e.g., Kose, Otrok, and Prasad, 2012). Using a dynamic factor model that comprises

four key financial variables—equity prices, house prices, interest rates, and credit—we find no evidence of a common global cycle among these variables for the G-7 economies. Instead, we find evidence that there are global cycles specific to each financial variable (which are proxies for different asset classes)—there is a global equity price cycle, a separate global interest rate cycle, as well as cycles for credit and house prices. We then ask if there is a common cycle among real and financial variables—that is, do the shocks that drive cycles in macroeconomic aggregates also drive any of the financial cycles? The answer we find is again no.

Do these results imply that global macroeconomic and financial cycles evolve independently of each other? This question brings us to the heart of the model developed in this paper, which is designed to investigate cross-border spillovers across macroeconomic and financial cycles. During the global financial crisis, financial market spillovers appear to have been the main mechanism for transmission of shocks across advanced economies, but there is little formal evidence on this point. The crisis also illustrated extensive feedback between these two types of cycles, making it more imperative to study them in a unified setting. Our objective, therefore, is to study the dynamics of business and financial cycles in a unified model that allows us to characterize potential global macro-financial cycles and spillovers.

We develop a new dynamic factor model to capture spillovers in both directions across the financial sector and macroeconomy.[2] Existing factor models attribute the observed comovement among multiple macroeconomic aggregates to a small set of underlying shocks and help identify the relative importance of different driving forces for national and global business cycles—global shocks, shocks specific to certain groups of countries, and country-specific shocks. However, we are also interested in the global propagation of shocks originating in one sector (macroeconomic or financial) to other sectors. The model we develop explicitly captures spillovers from one type

[2] There is a large empirical literature using dynamic factor models to characterize business and financial cycles within and across countries (see Stock and Watson (2011, 2016)) and Breitung and Eickmeier (2016) for surveys of methods and applications for this class of models). Using a dynamic factor model, Stock and Watson (2005) and Kose, Otrok and Whiteman (2003, 2008) document the roles played by global and/or group-specific factors in driving business cycles. Using a factor model, Miranda-Agrippino and Rey (2015) document that a common factor drives a sizeable portion of variation in equity prices, commodity prices, and bond indices. Hirata et al. (2012) report that common factors play an important role in explaining cycles in certain financial variables, including equity and house prices, and credit.

of factor to another. Specifically, our model allows us to analyze the quantitative importance of cross-border spillovers of shocks hitting different segments of financial markets onto macroeconomic variables through the global and country-specific macroeconomic factors.

We report four major findings. First, while the global macroeconomic (macro) factor plays an important role in explaining business cycle fluctuations, there are sizeable spillovers from shocks to specific financial variables—equity prices and house prices, in particular—to macroeconomic variables. Spillovers from the global interest rate and credit factors also contribute to macroeconomic fluctuations but they are less important as sources of cross-border spillovers. Second, spillovers from the equity and housing markets operate mainly through the global macro factor rather than the country-specific macro factors. This means, for instance, that global equity price shocks influence the global macroeconomic cycle, in turn affecting fluctuations in domestic macroeconomic variables in our sample. Third, common cycles among macroeconomic and financial variables, and also the spillovers from financial to macroeconomic variables, are stronger in the period leading up to and following the financial crisis.

Fourth, we find little evidence of spillovers from macroeconomic cycles to financial cycles. One exception is in the case of interest rates, which seem to experience significant spillovers from the global macro factor. In addition to these new results we also confirm, consistent with the prior literature, that there is evidence of common business cycles, as reflected in the comovement of macroeconomic aggregates, among the G-7 economies. Our finding of common cycles in certain financial variables, especially equity prices and interest rates, is also consistent with the previous literature.

There is a large literature analyzing macro-financial linkages—the two-way interactions between the real economy and the financial sector.[3] Shocks originating in the real economy can be propagated through asset prices and credit markets, thereby amplifying business (macroeconomic) cycles. Imperfections in financial markets can intensify such propagation effects and, consequently, lead to more pronounced macroeconomic fluctuations. Conversely, shocks that hit

[3] Brunnermeier, Eisenbach and Sannikov (2013), Cochrane (2017), and Claessens and Kose (2017a, 2017b) present surveys of different branches of the literature on macro-financial linkages.

financial markets can result in more pronounced asset price movements and macroeconomic fluctuations. Through cross-border linkages, these developments can lead to international spillovers.

Fluctuations in financial markets are shown to have a significant impact on the real economy in a wide range of theoretical models (Bernanke, Gertler, and Gilchrist (1999), Carlstrom and Fuerst (1997), and Kiyotaki and Moore (1997)). In these models, wealth and substitution effects can be amplified by changes in access to external financing, including through the financial accelerator and related mechanisms operating through the balance sheets of firms, households, and countries. These mechanisms imply, for instance, that a decline in asset prices lowers an entity's net worth, reducing its capacity to borrow, invest, and spend (an increase in asset prices has the opposite effect). This process, in turn, can intensify fluctuations in asset prices and amplify macroeconomic fluctuations. A number of recent theoretical studies employ similar mechanisms to analyze the roles of leverage constraints, financial integration, global banks, and different types of financial shocks in explaining international business cycle comovement in the context of multi-country models with financial imperfections.[4]

A sizeable empirical literature studies macro-financial linkages at the country level but the research on global macro-financial cycles and spillovers is in its early stages.[5] Our paper contributes to the nascent literature on global macro-financial cycles and spillovers in multiple dimensions. First, our study is the first to explicitly distinguish between common shocks and cross-border spillovers

[4] Some studies have focused on the role of asset prices in transmitting financial shocks to business cycles (Adrian, Colla, and Shin (2013), Geanakoplos (2010)). For recent theoretical studies of international business cycle comovement in models with financial market imperfections, see Devereux and Sutherland (2011), Dedola and Lombardo (2012), Kollmann (2013), and Perri and Quadrini (forthcoming).

[5] For empirical research on macro-financial cycles and spillovers, see Helbling et al. (2011) and Eickmeier and Ng (2015). These studies document that global credit shocks have been influential in driving macroeconomic fluctuations. Ciccarelli, Ortega, and Valderrama (2016) find that both common and country-specific factors play important roles in explaining cross-border spillovers in real and financial variables. A large literature examines the interactions between business and financial cycles at the country level using a wide range of methodologies: Claessens, Kose, and Terrones (2009, 2012), Borio (2014), Cesa-Bianchi (2013), Mian, Sufi, and Terebbi (2015), and Jordà, Schularick, and Taylor (2017). Some employ time-series methods to analyze the roles played financial markets in driving business cycles in the United States: Meeks (2012) and Prieto, Eickmeier, and Marcellino (2016). Some other studies consider the linkages between the financial sector and macreoconomy during financial crises (Reinhart and Rogoff (2009) and Claessens et al. (2014)).

in a systematic fashion that accounts for global and country-specific factors, along with spillovers. The models used in the previous literature are unable to disentangle spillovers from common shocks. Second, our model is able to analyze linkages between business and financial cycles without requiring a strong *a priori* stand on the nature of spillovers between them. Finally, we consider common cycles and spillovers in an empirical model that encompasses both macroeconomic and financial variables in multiple countries (instead of focusing a single country).

In Section 2, we employ a standard dynamic factor model to assess the evidence for a global financial cycle. In Section 3, we introduce our new dynamic factor model that is used to capture spillovers between the financial sector and macroeconomy. Next, we discuss the results of models that allow for spillovers from the financial sector to the macroeconomy. In Section 5, we describe the results of models that allow for spillovers from the macroeconomy to the financial sector. Section 6 concludes.

2. Modelling Global Financial Cycles

We first briefly analyze the evidence for a global financial cycle by using a standard dynamic factor model. Our concept of the global financial cycle is broad-based in the sense that it captures cyclical fluctuations that are common across multiple financial markets.[6] Specifically, we analyze the existence of a global financial cycle based on four major financial series: equity prices, house prices, short-term interest rates, and credit in the G7 countries over the period 1985-2016.[7]

[6] Our broad-based view of the global financial cycle follows the basic idea of studying business cycles in multiple aggregates, rather than focusing on cycles in a single variable such as output or industrial production (Kose and Terrones, 2015).

[7] We provide details about our database in the Appendix Table A1. Financial series are all seasonally adjusted, in quarterly frequency, and deflated by the CPI for each country. We use growth rates of all variables and, following Stock and Watson (2012), remove low-frequency movements using the Local Mean method.

2.1. A Dynamic Factor Model with Common Financial Cycles

We employ three versions of a standard dynamic factor model. This class of empirical models is useful in identifying a few common factors that drive fluctuations in large multi-dimensional datasets. These factors can capture common fluctuations across the entire dataset (i.e., the world) or across subsets of the data (e.g., country-specific or variable-specific groupings). Our basic model contains: (i) a global financial factor common to all financial variables (and all countries) in the system; (ii) a factor common to each financial variable; (iii) a country factor common to all financial variables in each country; and (iv) an idiosyncratic component for each series.

We start by writing the dynamic factor model in a general matrix form:

$$(1) \qquad Y_t = \beta F_t + \Gamma_t$$

$$(2) \qquad \Gamma_t = \Psi(L)\Gamma_{t-1} + U_t \quad \text{with} \quad E(U_t U_t') = \Omega,$$

$$(3) \qquad F_t = \Phi(L)F_{t-1} + V_t \quad \text{with} \quad E(V_t V_t') = I_k.$$

Y_t is an n-dimensional vector of time series data. Γ_t is an $(n \times 1)$ vector of idiosyncratic components that captures movement in each observable series that are specific to that time series. Each element of Γ_t is assumed to follow an independent AR(q) process as in equation (2). Hence, $\Psi(L)$ is a block diagonal lag polynomial matrix and Ω is a covariance matrix that is restricted to be diagonal. The latent factors are denoted by the vector F_t.[8] This vector contains contemporaneous values of the factors as well as lags. The lags of the factor enter the state equation (3) to allow for dynamics in each factor.

If we let s be the number of factors ($s < n$) and p be the order of the autoregressive process that each factor follows, then we can define $m = sp$ as the dimension of the state vector. F is then an ($m \times 1$) vector of unobservable factors (and its lags) and $\Phi(L)$ is a matrix lag polynomial governing

[8] The set of equations (1)–(3) comprises a state space system where (1) and (2) combined correspond to the measurement equation and (3) corresponds to the state transition equation. This state space structure is exploited in the Gibbs sampling procedure when the model parameters are estimated.

the evolution of these factors. The variance covariance matrix of this equation, $I_{k,}$ is assumed to be an identity matrix for normalization purposes. Typically, the matrix $\Phi(L)$ is restricted to be block diagonal. In Section 3, we will model spillovers by relaxing that restriction in a number of ways. While, in principle, all variables can load on all factors in these models, we want to make a clear distinction in our model between global, country-specific, and financial variable-specific factors in this section. In order to identify such factors, we follow Kose, Otrok, and Whiteman (2003) and impose zero restrictions on some of the β parameters. This implies that, for example, only the equity price variable in each country has a non-zero factor loading on the factor we label "equity prices". The zero restrictions of this sort that we impose on β imply that the model can then be written as:

$$(4) \qquad Y_t^{i,j,k} = \beta_{global}^{i,j,k} f_t^{global} + \beta_{fin\ variable_k}^{i,j,k} f_t^{fin\ variable_k} + \beta_{country_j}^{i,j,k} f_t^{country_j} + \varepsilon_t^{i,j,k}$$

$$(5) \qquad \varepsilon_t^{i,j,k} = \phi^{i,j,k}(L)\varepsilon_{t-1}^{i,j,k} + \nu_t^{i,j,k},$$

$$(6) \qquad f_t^m = \phi^m(L) f_{t-1}^m + \mu_t^m \text{ for } m = 1\ldots(1+K+J).$$

We use this model to investigate common cycles in financial variables.

2.2. Common Factors Driving Financial Cycles

We begin with the most basic one-factor version of this model that allows for only a global factor common to all variables and countries. Panel A in Figure 1 shows the contributions of the global factor to the variance of each series. The variance contributions of the global factor are sizable for equity prices but small for the other variables. We then split the full sample into two overlapping sub-samples: a pre-crisis sample (1985-2007) and a recent sample (1998-2016). The first period excludes the global financial crisis while the second one includes part of the period of the Great Moderation and the subsequent crisis. The variance contributions of the global factor are on average higher in the second period for all four financial variables. For instance, the contribution of the global factor to the variance of equity price fluctuations rises from 52 percent in the first period to 63 percent in the latter period. The corresponding numbers for interest rates rise from 1

percent to 7 percent. For the other variables—housing prices, interest rates, and credit growth—the variance contributions of the global factor remain well under 10 percent in both periods.[9]

The residual variance in the above exercise could in principle be accounted for by other factors that could be common across specific groups of the data. In Table 1, we present results for two other versions of our basic model that, in addition to the global factor, include (i) variable-specific factors that capture common cross-country fluctuations specific to each financial variable, and (ii) variable-specific factors as well as country-specific factors that capture the comovement of all financial variables within a particular country. Since comovement of financial market variables appears to be stronger in the period 1998-2016, we show only the results for the models estimated over that period.

The results indicate that the contribution of the global factor to the variance of equity price fluctuations is smaller in the multi-factor models, accounting on average for 11-19 percent of the variance in the two extended versions of the model (Panel B in Figure 1). In the model with three factors, the variance contributions of the global factor to fluctuations in equity prices range from 8 percent in the case of Germany to 13 percent for the United States. Instead, the bulk of fluctuations in each of the financial variables is explained by the variable-specific financial factors. For fluctuations in equity prices, for example, the common equity price factor is responsible on average for roughly 68 percent of variation across countries in the three-factor model. For house prices, interest rates, and credit, the variable-specific factor accounts on average for one-fifth to one-half of the variance and the global factor for 3-4 percent. Country-specific factors play a minor role in explaining fluctuations in financial variables.

The picture that emerges from these exercises is that there is *not* a global financial cycle that encompasses all four financial market variables. The global financial factor does not play a major role in explaining the variance of fluctuations in any of these variables. This may appear a surprising result in view of the recent literature making a case for global financial cycles.[10]

[9] We also examined the importance of different factors for the period 2008-2016. Relative to the period 1998-2016, the variance shares explained by the global factor increase for almost all financial variables.

[10] For example, Miranda-Agrippino and Rey (2015) find that one global factor explains an important part of the variance of a large cross section of equity prices, commodity prices, and bond indices. Similarly, Rey

However, most of the literature is based on comovement of one financial variable across countries. Our findings are consistent with this view.[11] Indeed, we find that there is strong evidence of cross-country comovement of equity prices and interest rates. For house prices and credit, the variable-specific factor plays a smaller but still sizeable role in explaining cross-country comovement. But our results also highlight that there is no empirical basis for a global financial cycle that encompasses multiple financial markets or asset classes.

We acknowledge that there could be more cross-country financial market synchronization at higher frequencies, especially in response to unanticipated policy shocks, financial disruptions, and news shocks.[12] However, the quarterly frequency that we focus on is more relevant for analyzing the linkages between the financial sector and macroeconomy. The finding highlighted above—the absence of a broad-based global financial cycle that encompasses multiple asset markets—will play an important role in the construction of the empirical model that we use to capture spillovers between the financial sector and macroeconomy in the next section.

3. A Dynamic Factor Model with Macro-Financial Spillovers

We now provide a more general representation of the standard framework used in the previous section and use that as the basis for developing a dynamic factor model.[13] The new model allows us to study spillovers between financial and macroeconomic (macro) variables, and also permits us to disentangle such spillovers from common shocks. For the macro time series, we use quarterly real deseasonalized data on output, consumption, and investment.

(2015) argues that there is a global financial cycle in capital flows, asset prices, and credit. Cerutti, Claessens, and Rose (2017) conclude that there is no significant global financial cycle in capital flows.

[11] Some recent studies document evidence in support of strong cross-country comovement of cycles in individual financial variables. See Claessens, Kose, and Terrones (2011) for highly synchronized cyclical phases of individual financial market segments, including equity and housing markets; Hirata et al. (2012) and Cesa-Bianchi, Cespedes, and Rebucci (2015) for the synchronization of cycles in equity and house prices and credit. Some of these studies also document that the degree of comovement of cycles in financial variables has increased over time (Claessens and Kose, 2017b).

[12] For example, a rich literature on contagion employs higher-frequency data to analyze the extent of comovement of different types of asset prices across countries (Forbes 2012).

[13] Our strategy to model spillovers closely follows Helbling et al. (2017), who study common shocks and cross-border spillovers in macroeconomic fluctuations.

3.1. Modelling Macroeconomic and Financial Cycles

Following Section 2, we use the same zero restrictions to first estimate a series of models where the factors can be identified as common, macro, or financial. We allow all variables to load on the same common factor. This addresses the question of whether or not there is a common cycle between financial and macroeconomic variables. A common cycle between the two types of variables would mean that they are driven in part by common shocks. We estimated such models combining in sequence macro series with (i) equity prices, (ii) house prices, (iii) credit, and (iv) short-term interest rates. In no case did we find a common component. In other words, there is no common shock that jointly drives macroeconomic and financial variables.

This motivated us to treat the macro and financial blocks as separate in the specification of the factor model. Specifically, this means that the macro variables have zero factor loading on the financial factor, and the financial factors have zero factor loadings on the macro variables. A benefit of this approach is that we cleanly label "macro" and "financial" factors by imposing these zero restrictions. This implies that we rewrite equation (1) as:

$$\begin{bmatrix} Y_t^M \\ Y_t^F \end{bmatrix} = \begin{bmatrix} \beta^M & 0 \\ 0 & \beta^F \end{bmatrix} \begin{bmatrix} F_t^M \\ F_t^F \end{bmatrix} + \begin{bmatrix} \Gamma_t^M \\ \Gamma_t^F \end{bmatrix}$$

where the *M* superscript refers to a block of macroeconomic variables, the *F* superscript the block of financial variables, and the zeros represent appropriately sized matrixes of zeros.

Our next step is to impose restrictions on the factor loading matrices within the macro and financial blocks. Based on the results in Section 2, which indicated that there is no common cycle across all financial variables, we estimate a sequence of macro-financial models where the financial block consists of one financial variable for each of the G-7 countries in our sample. This yields a financial block where Y_t^F is a 7x1 vector with the financial data for each country at time *t*, F_t^F is a single factor (but F_t^F is not scalar because the lags of that factor appear in the state equation), and β^F is non-zero for the relevant financial variable loading on the financial factor (note again that β is not

of dimension 1x7 because of the presence of lags of the factor). The financial factor is then interpreted as a global factor for the relevant financial variable.

For the macro block, we partition the data to allow for global and country-specific macro factors. With our dataset comprising output, consumption, and investment for G-7 countries, the block will have one common macro factor and seven country-specific macro factors. Identification of the country factors is obtained by allowing only variables within each country to load on a particular factor, which we then label that country's factor.

We do not have a country-specific financial factor because we did not find a common component across the financial variables within a country in our previous exercise. This is an empirical result, not an assumption. We do find that global and country-specific factors are both relevant for the macro block, which is consistent with the findings in the literature.

3.2. Modeling Spillovers

As noted above, a standard assumption in the factor literature is that the matrix governing the evolution of the factors, $\Phi(L)$, is block diagonal. This assumption imposes a structure on the model that the latent factors evolve independently of each other. We now seek to relax this assumption in some dimensions to allow spillovers across the factors. Since we have found that there are no common shocks across macro and financial variables, their comovement is driven only by spillovers. For example, a global financial shock may affect the global macro factor with a lag. To capture these effects, we relax the assumption that $\Phi(L)$ is strictly block diagonal.[14] As with the β matrix, we could in principle allow the entire matrix to be unrestricted. In practice, this would result in a proliferation of parameters that would add uncertainty to the estimates and make the results harder to interpret. Instead, we turn on spillovers in sequence from one factor to another. We focus on those spillovers that are "statistically" and "economically" interesting.

[14] Since their data exhibit common shocks, Helbling et al. (2017) also make some assumptions in order to disentangle spillovers from common shocks. In our case, since we find no shocks that are common to both macro and financial *cycles*, no auxiliary assumptions are needed.

A spillover from one factor to another is captured by allowing one factor to load on lags of another factor as well as its own lags. For example, to measure spillovers from the world financial factor (F_t^F) to the world macro factor ($F_t^{M,W}$), we would model the factor evolution equation for the world macro factor as:

$$(7) \quad F_t^{M,W} = \phi_t^{M,W}(L)F_t^{M,W} + \phi_t^{M,W,F}(L)F_t^F + u_t^{M,W}$$

Generically speaking, when we say factor 'A' spills over to factor 'B', we are referring to a structure such as this one. Note that the only commonality across these variables comes from the spillovers that occur with a one (or more) period lag. There are no shocks that are common to the two types of factors. If there were a common shock, then the two types of variables would both load on one common factor, which would contain a common contemporaneous shock. However, as noted above, our results show that there is no common factor across the macro and financial blocks—so, empirically, there is no common shock.

A key assumption of the model is that spillovers take place with a one period lag. In the context of macroeconomic variables, the assumption implies that these variables are "sluggish" in their response to financial shocks. That sluggishness can arise from real or nominal rigidities, or, in the international context, from trade frictions.[15] Since data is released in the quarter after the data is realized, financial markets would react with a one quarter lag, justifying our assumption in the context of the model that captures spillovers from the macroeconomy to the financial sector.

We concentrate on spillovers from the macro to the financial block, and vice versa. Shocks from the financial block are interpreted as global in nature because, as documented above there is a distinct global cycle and no country-specific financial cycle in each of the four financial variables we focus on. From the macro block, we have both country-specific and global macro shocks that

[15] Our assumption is equivalent to ordering macroeconomic variables after financial variables in a Cholesky identification of a VAR. Since we are using quarterly data and assume that spillovers take place with a one period lag, our model framework is unable to capture spillovers at higher frequencies than a quarter.

can affect the financial cycles.[16] To highlight the different types of spillovers, we isolate them by allowing for one type of spillover at a time. For example, our first model allows for spillovers from the financial factor (one for each of four financial variables) to the world macro factor as in equation (7). Each of our models can be described as relaxing the zero restriction on the lag polynomial in equation (6) to allow one factor to depend on lags of another. When we write that one factor spills over to another, we mean that we allow for non-zero coefficients in the appropriate rows of $\Phi(L)$.

Our four models can be described as follows: In Model 1, the financial factor spills over to the world macro factor. In Model 2, the financial factor spills over directly to country macro factors. The difference between these two models is that the first imposes proportional responses (scaled by the factor loading) to the financial factor while the second allows for asymmetric responses. Model 3 allows for the world macro factor to spill over to the financial factor. Model 4 allows the U.S. country factor to spill over to the financial factor. In principle, any country can be used here; we choose the United States since, in view of its being the largest economy and having a dominant role in global finance, conventional wisdom is that spillovers from its economy are most likely to affect others.

In addition, we estimate models that are combinations of these. For example, Models 1 and 2 combined would capture both channels through which the financial factor affects macro activity. We have estimated such models and they naturally lead to variance decompositions where the overall spillover effects equal the sum of the variance contributions of the spillover effects from Models 1 and 2. The same is true for Models 3 and 4.

The combination of models such as Models 1 and 2 yields the same result as estimating the two models separately because our spillover model does not deliver 'new' factors compared to a standard factor model.[17] The spillover parameters do not affect the estimates of the factors

[16] We do not argue or show here that there are no cross-block spillovers within countries. Instead, we only focus on spillovers at the global level.

[17] Our model does not provide a new estimate of the global common factor. Our macro factor is in fact the same as in a standard model. Our model decomposes the movements in that common macro factor into

themselves. We have estimated models without spillovers and found factors that are identical to those without spillovers. The value-added here then is in the variance decompositions that break down the common factors into sources that are macro and financial in nature. Specifically, we know there is a global business cycle in macro aggregates (i.e., there is a significant common factor among key macroeconomic variables). We document how much of that global business cycle is due to commonality in financial cycles—or, more precisely, how important are innovations that originate in the financial side of the economy for the macro side. Likewise, we document how much of financial cycles are due to innovations that originate in the real side of the economy (macroeconomy).

3.3. Model Estimation and Identification

The estimation of the model is Bayesian, though we have strong priors only on the stationarity of the model. Since we are interested in the parameters of the model to measure spillovers, approximate solutions to the model are not appropriate. The state space approach to estimating parametric factor models is shown to yield more accurate estimates of variance decompositions than the asymptotically justified principal components methods when the model includes multiple layers of factors (Jackson et al., 2016). The size of the model allows us, with some partitioning of the model into blocks, to evaluate its exact likelihood.

It is not possible to derive analytical solutions for the posterior distribution of the model. Therefore, we use numerical methods to simulate from the posterior distribution of model parameters and factors. We use a state space approach following Kim and Nelson (1998). Their approach is based on using a Gibbs sampler to sequentially sample from the posterior of the parameters conditional on the last draw of the factors and then the factors conditional on the draw of the parameters. The estimation procedure for state-space estimation of dynamic factor models is fairly well known. The specific procedure for drawing factors and parameters is described in Jackson et al. (2016).

shocks that are innovations to the factor itself, and shocks that originate elsewhere, such as the financial sector, and then spillover into the macro sector.

The number of lags that describe the evolution of the idiosyncratic shocks (q) and latent factors (p) are kept at 2 and 3, respectively.[18] Our priors for the model parameters are generally weak, with the exception that we impose stationarity on the dynamic components. The prior for the autoregressive coefficients in the law of motion of each idiosyncratic shock is $(0, \Omega_0)$. The variance terms of the prior Ω_0 are calculated numerically based on a prior over the roots of the polynomial. We specify a prior over each root of the polynominal that is N(0,0.5). We then draw the two roots and translate those roots into polynomial coefficients. If the polynomial is stationary, we retain the draw. These terms are then averaged to get the elements of Ω_0.

The prior for the autoregressive coefficients that govern the evolution of each factor is similarly specified. When Φ(L) is block diagonal, the only variables that enter each factor equation are its own lags. In this case, the prior for the autoregressive coefficients corresponding to these lags is $N(0, \Phi_0)$. As with the idiosyncratic terms, these values come from first specifying a prior over the roots of the polynomial and then translating it into priors for the coefficients. When the block diagonality is relaxed to allow for spillovers, lags of other factors also appear in the law of motion of one or more factors, depending on the exact specification of Φ(L). Accordingly, in these specifications the variance covariance matrix Φ_0 is augmented to include priors for the coefficients of those lags as well.[19] The prior on all factor loading coefficients is $\mathrm{N}(0,1)$. The prior for the innovation variances in the observable equation is Inverted Gamma (0.1*T, 0.25^2). These priors are fairly diffuse and none of the results we report below are sensitive to changes in them.

The model faces standard identification issues that permeate this literature. Following the previous literature, we require that one factor loading for each factor be positive. Second, we normalize the innovation variances of the factors to unity as the scale of the factors is not identified. The additional parameters we estimate in the model cause no new problems for identification. To see this, consider the main blocks that we draw from in the Gibbs sampler. Drawing from the factors

[18] That $q = p-1$ is a matter of convenience as this allows us to perform quasi-differencing of the observables in a straightforward manner. We estimated some of the models with longer lags but the lags beyond 3 were not statistically significant in nearly all cases.

[19] For example, the prior for the autoregressive coefficients in the law of motion of the world factor with spillovers from the financial factor (Model 1) is then given by $N(0, \Phi_{00})$ where $\Phi_{00} = \begin{bmatrix} \Phi_0 & 0 \\ 0 & \Phi_1 \end{bmatrix}$.

conditional on the parameters is a standard use of the Carter-Kohn version of the Kalman filter. The fact that there are fewer zero restrictions than usual has no effect on this step, as the filter itself is derived under the assumption that all elements are non-zero. Conditional on the factors, the parameters are drawn equation by equation. For example, drawing the $\phi^{W,US}$ term just requires that an additional regressor (the U.S. factor) appears in the regression. There is no concern about the factors being misidentified—say, as the world rather than U.S. factor—as the factors are identified through the zero restrictions on the factor loading equations.

3.4. Variance Decompositions

We quantify the relative importance of various factors by calculating how much of the unconditional variance of each observable variable can be attributed to which factor. In the benchmark case, the factors are assumed to be orthogonal so one can simply apply the variance operator to the left and right hand sides of equation (1) and calculate the variance shares. However, in the model presented above, the factors are not orthogonal by assumption of the spillovers. Hence, we need an alternative method for quantifying the relative importance of different factors.

Our approach is to use a forecast error variance decomposition and let the horizon go to infinity. In a stationary system, the unconditional variance is the limit of the forecast error variance as the horizon goes to infinity, so this procedure still yields a decomposition of the unconditional variance of each series. This indicates how much of the variance in each observable variable is attributed to the innovations to each factor and is equivalent to writing out the MA(∞) representation of the model and then applying the variance operator. If a factor is relatively more important for a variable, then its share of the explained variance will be large.

In practice, we apply standard VAR forecasting formulas (with many zeros imposed on the VAR coefficients) to calculate the variance decompositions. These formulas trace the impact of an innovation to factor A on factor B at horizon *h*. The variance decompositions for observable variable Y then rescales the factor decomposition based on the factor loadings of Y on each factor. For example, denote the variance of the world macro factor explained by the financial factor at

horizon H as $Var_H(F^W|F^F)$. Then the variance of U.S. output at horizon H due to the financial factor is given by

$$Var_H(Y_{US}|F^F) = \frac{[b^W_{US,Y}]^2 Var_H(F^W|F^F)}{var_H(Y_{US})}$$

U.S output in this case does not load on the financial factor. Yet, the formula reveals that U.S. output does depend on the financial factor, due to the impact of the financial factor on the world macro factor. This is the spillover we attempt to measure.

We examine the variance decompositions at a horizon of 30 periods (quarters) in order to abstract from short-term fluctuations. In practice, the variance decompositions generally settle down after about 8 quarters, so our approach essentially focuses on a medium- to long-term forecasting horizon. The relative share of each factor's contribution to the forecasting error of each variable does not change substantially from short- to long-term forecasting horizons. The spillover effects, however, do increase over the first few quarters since these effects are generated from lags of the macro or financial factor.

An interesting ancillary question is whether the contributions of different factors have changed over time. In particular, a question is whether the financial crisis that hit the world economy in 2008-09 has a major bearing on the results. To address this issue, we consider two exercises. First, we estimate the models over the full sample (1985-2016) and then separately over two partially overlapping periods: 1985-2007 and 1998-2016. The first period excludes the financial crisis while the second one includes part of the period of the Great Moderation and the subsequent crisis. Second, we consider an exercise that involves the estimation of our combined Models 1 and 2 over 15 year rolling sub-periods with one year increments. This provides a better characterization of the evolution of the importance of common factors and spillovers in explaining variation in macroeconomic and financial variables, especially during the global financial crisis.

To avoid cluttering the tables in the main text, we mostly report variance decomposition results averaged across the G-7 economies. We do not report posterior coverage intervals for the variance

decompositions (which, in turn, are posterior medians of the variance decompositions based on 10,000 draws). In the main text, we emphasize those results where the one standard deviation bands of the coverage intervals around the estimated medians do not include zero.

3.5. Global and Country-Specific Factors

Before getting into the details of results from variance decompositions, we briefly discuss the estimated factors and their properties. Figure 2 plots the global macro factor, the U.S. country factor, and global factors of four financial variables. It presents the posterior mean for each factor, along with the 16 and 84 percent posterior quantile bands. The factors are estimated reasonably precisely as the quantile bands are often quite tight.

The estimated global factor tracks global output growth well and picks up the major peaks and troughs: the recession of the early 1990s; the 2001 recession and the subsequent recovery; and the global financial crisis. The U.S. country factor also picks up the main cyclical episodes. The correlation between the U.S. country factor and global factor is about 0.17. We also check the cross-correlations among the country factors. These correlations are often quite low, implying that most of the business cycle comovement among G-7 countries is captured by the global macro factor, with little residual correlation among the country-specific cycles.

The estimated financial factors are also generally consistent with major developments in financial markets. The equity price factor is substantially more volatile than the common factors for each of the other financial variables. The posterior quantile bands for the house price and credit factors are larger than the other two, suggesting that there is more variability across G-7 countries in the time series behavior of these two variables. The volatility of the house price factor is high in the late 1980s-early 1990s and mid to late 2000s, reflecting boom-bust cycles in G-7 housing markets during these period. Between these two periods, the house price factor has substantially lower volatility.

4. Spillovers from the Financial Sector to Macroeconomy

4.1. Global Spillovers

In this section, we explore the importance of spillovers from the financial sector in explaining fluctuations in macroeconomic aggregates of the G-7 countries. We estimate Models 1 and 2 for this purpose. In the former model, the global financial factor spills over to the global macro factor whereas, in the latter one, it spills over directly to country-specific macro factors. We also estimate the combination of these two models in which financial market spillovers operate through both the global and country-specific macro factors. Table 2 reports the averages of variance decompositions based on these three models for each financial variable.

Equity Prices. We first consider equity prices as the main measure of global financial market activity. The comparison of results from Models 1 and 2 indicate that spillovers from the equity markets to output and investment take place mostly through the global macro factor (rather than country-specific factors). For instance, the spillovers from the global equity price factor through the global (country-specific) macro factor in Model 1 (Model 2) account for 6 (1.4) percent of output fluctuations for the full sample (see Table 2, Panel A, third column marked SF). The global equity price factor is responsible for a slightly larger than 4 percent of the variation in investment in Model 1 while its importance is much smaller in explaining consumption fluctuations. The results from the combination of Models 1 and 2 indicate that the spillovers through the global macro factor and country-specific factors are together responsible for 14 percent of output fluctuations, 6 percent of consumption fluctuations, and roughly 10 percent of investment fluctuations in 1998-2016 (Figure 3). These results collectively suggest that spillovers originating in equity markets play a sizeable role in explaining macroeconomic fluctuations.

The potency of spillovers from some segments of the financial sector has increased over time for all macroeconomic variables (Figure 3). For example, the average variance of output due to spillovers from the global equity price factor in Model 1 increases from 4 percent in 1985-2007 to

12 percent in 1998-2016.[20] The increase in the importance of spillovers in 1998-2016 is mainly driven by the larger role of spillovers from the global macro factor as the importance of spillovers through the country-specific macro factors has not changed much over time. Contributions of spillovers from the financial sector to fluctuations in output and investment have become much larger in 1998-2016 than those in the case of consumption. Interestingly, the comovement of equity prices, captured by the fraction of variance of equity prices accounted for by the global equity price factor, increases only slightly in 1998-2016 relative to 1985-2007 (from 51 to 58 percent in the combined model). Thus, it is not the greater integration of equity markets across the G7 countries but the size of their spillover effects on to macro cycles that distinguishes the latter period from the former one.

How important are financial market spillovers relative to the global macro factor in driving fluctuations in macroeconomic fluctuations? Among the G-7 countries, the role of spillovers from the global equity markets is on average smaller but, relative to that of the global macro factors, it remains sizeable (Figures 4 and 5). Specifically, the global macro factor (spillovers from the global equity price factors) on average accounts for about 36 (14) percent of output fluctuations, 8 (6) percent of consumption fluctuations, and 24 (10) percent of investment fluctuations over the period 1998-2016. While the average variance of output and investment explained by the global macro factor has risen in the second period, the relative importance of spillovers from the global equity price factor has increased slightly more.

The global macro factor explains a much larger fraction of output variance than it does for consumption. The results about the importance of the global macro factor are consistent with other evidence that, contrary to the predictions of standard international risk sharing models, output fluctuations are more correlated across countries than consumption fluctuations (Backus, Kehoe, and Kydland 1992). Country-specific factors account for about one-quarter to one-third of fluctuations in output and investment, and an even higher share of consumption fluctuations, in the 1998-2016 period.

[20] We check the robustness of these findings by studying the posterior coverage intervals around the posterior means of the estimated variance contributions for each country. Nonoverlapping posterior coverage intervals indicate "statistically significant" changes between the two periods. Our results indicate that the averages presented here are representative of patterns at the country level.

Given that the combined model captures both the global and country-specific channels of spillovers and the degree of comovement is higher in the period 1998-2016, in the rest of this sub-section we focus our discussion on the results from the combined model over the second period—the table does include results for the full sample and the earlier period.

House Prices. In Panel B of Table 2, we present results using house prices as the financial market variable. This is of particular interest as developments in housing markets in the United States and some other G-7 countries seem to have played a significant role in precipitating the 2009 global recession and deepening its macroeconomic implications. The cross-country comovement of house prices, as captured by the share of fluctuations in this variable accounted for by the estimated global house price factor, is much smaller than that of equity prices. For the combined model, this share is only about 9 percent for the full sample and 12 percent for 1998-2016.

Although it is smaller than that of the global equity price factor, the role of the global house price factor in driving macroeconomic fluctuations is significant and increases over time. The results from the combined model for the latter period indicate that the global house price factor on average accounts for about 11 percent of output fluctuations, 8 percent of investment fluctuations, and 5 percent of consumption fluctuations. Similar to the results with equity prices, the spillover effects on to the macroeconomy operate mainly through the global macro factor rather than the country-specific factor—with variance contributions of 7 percent and 2 percent, respectively, in the case of output.

The global macro factor plays an increasingly more important role in explaining fluctuations in output and investment (Table 2 and Figure 5). Similar to the results with equity prices, although the role of the global macro factor has become more pronounced in the second period, the relative importance of spillovers from the global house price factor has increased by a greater proportion (the absolute increase in the variance contribution of the global macro factor is greater). Over the period 1998-2016, the average variance of output explained by the global macro factor is about four times larger than that of spillovers from the global house price factor (42 percent versus 11 percent), compared from a ratio of roughly six for the full-sample period (34 percent versus 6 percent)

Interest rates. Panel C of Table 2 shows the results when we use short-term interest rates as the financial market variable. During 1998-2016, the variance contributions of the global interest-rate factor through the spillover effects on the global macro factor amount to 7 percent for output, 3 percent for consumption, and 5 percent for investment fluctuations (see bottom row of the panel). As in the case of the equity and house prices, a substantial portion of these spillovers takes place through the global macro factor. The average variance explained by spillovers through the country-specific factors are in the range of only about 2-4 percent. Although the importance of the global macro factor increases by roughly twofold in the second period (42 percent versus 23 percent), the change in the variance of output due to the spillovers from the global interest rate factor registers a marginal increase. The average variance of interest rates due to the global interest rate factor rose from 28 percent in 1985-2007 to 40 percent in 1998-2016. The degree of comovement of interest rates across G-7 countries is much higher than that of house prices (and credit, as discussed below), although lower than that of equity prices, especially in the aftermath of the global financial crisis. Our headline results did not change when we used long-term interest rates (10-year bond yields).

Credit. In Panel D of Table 2, we present results using credit growth as the main financial market variable. The magnitude of spillovers originating from the global credit factor is relatively smaller than that of other financial variables: the global credit factor is responsible for about 5 percent of output variation, 4 percent of consumption, and 4 percent of investment in the latter period in the combined model (see last row of the panel). The global credit factor accounts for only about one-fourth of fluctuations in credit even during 1998-2016, indicating relatively modest comovement of credit across countries.

Evolution of Spillovers. We now briefly discuss results from the estimation of our combined Models 1 and 2 over 15 year rolling sub-periods with one year increments. In Figure 6, we present the average variance of output explained by the global macro factor and spillovers stemming from the financial sector over the rolling sub-periods. The results indicate a sharp increase in the importance of the global macro factor especially after the 2007-08 global financial crisis. Specifically, the average variance due to the global macro factor (over the 15-year rolling sub-periods) increased from about 22-25 percent from the early 2000s to roughly 35-50 percent after

2007.[21]

While spillovers from the global equity and house price factors to output fluctuations have become larger after the global financial crisis, those associated with the global interest rate and credit factors have not changed much. For example, prior to the 2007-08 crisis, spillovers from the global equity (house) factor on average account for 8 (6) percent of output variation over the 15 year rolling sub-periods. With the unfolding of the crisis, spillovers from the global equity (house) factor explained on average 15 (15) percent of output variance. These results are broadly consistent with our findings from the two specific sub-samples (1985-2007 and 1998-2016) documented above. However, the results with the rolling windows also highlight the significant change in the nature of cross-border spillovers and the extent of comovement between the financial sector and the macroeconomy during periods of financial stress. There was naturally a steep increase in the importance of the global macro factor because of the global financial crisis. In addition, spillovers from some financial market segments onto the macroeconomy have become more pronounced after the onset of the crisis.

Summary. The main results to this point can be summarized as follows. First, among the G-7 countries, there are sizeable spillovers from the global equity and house price factors onto macroeconomic fluctuations. These spillovers are responsible for a larger share of variation of output and investment than of consumption. There are also some spillovers from the global interest rate and credit factors but their contributions to macroeconomic fluctuations are relatively modest compared with those of equity and house prices.

Second, the global macro factor plays a more important role than the financial factor in explaining macroeconomic fluctuations but the relative importance of spillovers stemming from the financial sector is quite sizeable especially in the case of equity and housing markets. Third, spillovers from the global equity and house price factors operate mainly through the global macro factor rather than the country-specific macro factors.

[21] These findings are consistent with others in the literature that also report an increase in the extent of business cycle synchronization during periods of financial stress (Helbling et al. (2011, 2017), Imbs (2010), and Kalemli-Ozcan, Papaioannou, and Peydro (2013)).

Fourth, the importance of spillovers from the equity price and house price global factors has risen over time. Specifically, it increased by more than twofold in the case of equity prices and by more than threefold in the case of house prices in 1998-2016. The importance of spillovers from equity and housing markets has increased over time, especially after the global financial crisis. Given the global nature of the crisis, there has also been a substantial increase in the importance of the global macro factor in explaining macroeconomic fluctuations after 2007.

Finally, both equity prices and interest rates display a higher degree of cross-country comovement. The degree of cross-country comovement of equity prices and interest rates has intensified in the period 1998-2016 relative to 1985-2007. Comovement of house prices and credit is modest, even during the latter period.

These results emphasize the importance of spillovers from the financial sector to the macroeconomy.[22] We document that spillovers from cross-country comovements in global equity and housing markets play a substantial role in driving national business cycle fluctuations even after accounting for the roles played by the global and country-specific macro factors. These results lend support to the findings in theoretical studies linking developments in equity and housing markets to macroeconomic fluctuations. For example, some studies examine how fluctuations in equity prices can be associated with leverage cycles that can then translate into fluctuations in the real economy (Adrian, Colla, and Shin, 2013; Geanakoplos, 2010; Mendoza, 2010; Jermann and Quadrini, 2012). Some others analyze how shocks originating in housing markets can be a source of macroeconomic fluctuations in the context of general equilibrium models (Iacoviello, 2005; Liu, Wang and Zha, 2015).

Our results indicate that spillovers from the global credit and interest rate factors also contribute to macroeconomic fluctuations but their roles tend to be smaller than those of the global equity

[22] The variance decompositions we discuss here are a product of the factor loadings and the variances of the factors. We present some of the key parameter estimates—the factor loadings and the vector-autoregressive coefficients on the factors—in Appendix Tables A2 and A3. In most cases, the loadings of the macroeconomic factors on the global macro factor are larger than the loadings on the country macro factors. The loadings of equity prices on the global financial factor are much greater than the loadings of other financial variables on their corresponding financial factors, confirming the evidence we presented earlier in the paper on the substantial comovement of equity prices among G-7 countries.

and house price factors. The small role of the interest rate factor in driving macroeconomic fluctuations in the period 1998-2016 may reflect the weak role of monetary policy in influencing economic activity once policy rates in the G-7 economies approached the zero lower bound. In the case of credit, our findings are broadly consistent with those in Helbling et al. (2011), who also document that shocks originating in credit markets appear to play a smaller role during "normal" business cycles and a larger one during periods of financial stress. Perri and Quadrini (forthcoming) also report that credit shocks play an important role in explaining the global dimension of the Great Recession. A number of studies document strong linkages between credit markets and the macroeconomy at the country level (e.g., Gilchrist and Zakrajsek, 2012).[23]

4.2. Country-Specific Spillovers

In the discussion above, we have focused on averages for the G-7 countries. We now present results at the level of individual countries. The composite spillovers from financial variables to output growth fluctuations, operating through both the global factor and the country-specific factors (combination of Models 1 and 2), are shown for each country and macroeconomic variable in Tables 3-4 and Figure 7. Table 3 shows the combined spillovers over different periods. For all financial variables except credit, these spillovers are usually much higher—or at least as high—during the period 1998-2016 relative to estimates based on the period 1985-2007 or the full sample, 1985-2016. Hence, to conserve space, in the discussion below we mainly emphasize the results for 1998-2016.[24] Table 4 shows the breakdown of the variance contributions of different factors over the period 1998-2016.

Table 3 shows that there are significant spillovers from the global equity price factor to output in all G-7 countries. The average variance of output due to spillovers associated with the global equity price factor is about 14 percent ranging from 9 percent in the United States to 19 percent in France and Germany. The spillover effects from the global house price factor are also quite large: it on

[23] Our measure of credit market activity is the volume of credit. Other research claims that indicators of credit standards applied by lenders and credit spreads could be better indicators to assess the strength of linkages between credit markets and the macroeconomy (Lown and Morgan, 2006; Meeks, 2012; Gilchrist and Zakrajsek, 2012; Faust et al., 2013).

[24] We present detailed country-level results from the combined models in Appendix Table A4.

average accounts for 11 percent of output fluctuations (ranging from 8 percent in Japan to 13 percent in France, Germany, and Italy). The comparison of the contributions of spillovers from the global equity and house price factors with that of the global macro factor indicate that spillovers from the financial sector play a relatively important role in driving macroeconomic fluctuations in some countries. For example, in the United Kingdom, the share of variance due to spillovers from the global equity (house) price factor is roughly one-half (one-third) of the variation that is explained by the global macro factor. The importance of spillovers from the global interest rate and credit factors is on average relatively smaller than that of other financial variables but still sizeable in some countries (France, Germany and Italy).

For the United States, the global equity and house price factors play significant roles in driving output, consumption, and investment fluctuations. While the global interest rate and credit factors are also important, they appear to play smaller roles in driving business cycles in the United States. Table 4 shows that the global macro factor accounts for 18 percent of the variance of output while the country factor accounts for about 40 percent. The results are roughly similar for U.S. investment fluctuations while the variance contribution of the global factor is much smaller for U.S. consumption fluctuations. The results are qualitatively similar independent of which financial indicator we use. In the case of output, the share of variance due to the spillovers from the global equity price factor is about half that of the global macro factor (9.1 percent versus 18.1 percent), confirming that financial market spillovers are important but less so than the global macro factor. In the case of the house price factor, this ratio is about one-third (8.5 percent versus 23.7 percent).

We turn next to a relatively smaller but more open economy, Canada, where one would *a priori* expect financial market spillovers to be larger than in the case of the United States. We find slightly larger spillover effects from the financial cycle in Canada, especially when we use equity prices as the financial indicator. The global equity price factor accounts for the following variance shares: 12 percent of output fluctuations, 9 percent of consumption fluctuations, and 16 percent of investment fluctuations. The variance contributions are a few percentage points lower for each of the variables when we use house prices as the financial indicator, and even more modest in the case of global interest rate and credit factors. When we look at the breakdown of variance

contributions, it appears that the global macro factor accounts for more of the fluctuations in all three macroeconomic aggregates than in the case of the United States.

We also find sizeable spillovers from the financial market for other G-7 countries. For instance, in the case of France, over the period 1998-2016, about 19 percent of output fluctuations, 7 percent of consumption fluctuations, and 12 percent of investment fluctuations are accounted for by the spillovers onto the global macro factor from the global equity price factor. The corresponding numbers based on the house price variable are 13 percent, 5 percent, and 9 percent, respectively. For Italy and Japan, the contributions to the variance of output fluctuations from spillovers of the global equity and house prices are around 12-17 percent and 8-13 percent, respectively.

These country-level results largely confirm the major conclusions that we summarized at the end of the previous sub-section.

5. Spillovers from the Macroeconomy to Financial Sector

5.1. Global Spillovers

We now explore a different channel for spillovers—from the global macro factor and the U.S. country-specific macro factor to the financial sector. That is, we seek to understand the role of macroeconomic cycles in driving fluctuations in G-7 countries' financial markets. And it is clearly of interest to examine if the U.S. business cycle affects global activity through its effects on world financial markets. As noted in Section 3, we estimate Models 3 and 4 to study spillovers from the macroeconomy to the financial sector. Model 3 captures spillovers from the global macro factor to the global financial factor while model 4 captures spillovers from the U.S. country-specific macro factor. In addition, we estimate a combination of these two models in which spillovers from the macroeconomy transmit through both the global and U.S. country-specific macro factors. Table 5 presents the averages of variance decompositions based on these three models for each financial variable.

Our main finding is that there is little evidence of spillovers from macroeconomic cycles to financial cycles as spillovers from the macro factors to financial variables are smaller than those from the financial sector to the macroeconomy. Specifically, the spillovers from the macroeconomy account for around 1-3 percent of the variance of equity prices, house prices, and credit even if one takes into account spillovers from both the global and U.S. country-specific macro factors (the relevant results are under the column heading SR). By contrast, the spillovers from the global and U.S. country-specific macro factors to interest rates are greater, amounting to 7 percent of the variance contribution to fluctuations in interest rates during the period 1998-2016 (Figure 8). Assuming that short-term interest rates are largely reflective of policy interest rates, this result implies that any commonality in the policy actions of G-7 central banks is influenced to a significant extent by common fluctuations in key macroeconomic variables in these countries. The contribution of the U.S. country-specific macro factor to the variance of fluctuations in interest rates is slightly larger than that of the global macro factor in the second sub-sample. This is consistent with the observation that the Great Recession that initially hit the U.S. rapidly incited monetary policy responses from other G-7 economies.

The relative roles of spillovers from the macroeconomy to the financial sector across the two models and over time are quite different than those of spillovers from the financial sector to the macroeconomy (Figure 8). For example, the comparison of results from Models 3 and 4 suggest that spillovers from either the global macro factor or the U.S. factor on to global financial factors are quite muted. Moreover, the variance of financial variables due to spillovers from the macro factors does not change much over time except in the case of interest rates. In light of these observations, we again focus on the results from the combined model in the 1998-2016 period.

Comparing Tables 2 and 5 reveals the importance of separating out the spillover effects of financial factors from global business cycles that reflect macroeconomic phenomena. For the period 1998-2016, the variance contribution of the global and U.S. country-specific macro factors to output fluctuations in each country on average about 46 percent when we allow for spillovers from the macroeconomy to equity prices (Table 5, Panel A, last row). When we allow for spillovers from equity prices to the global macro and country-specific factors, the variance contributions of the macro factors drop to an average of 36 percent (Table 2, Panel A, last row). The difference is

accounted for by the spillovers from the global financial factor on to the global and country-specific macro factors.

Returning to the results in Table 5, over the second sub-sample the global macro factor accounts for about 42-47 percent of output, 9-11 percent of consumption, and 31-32 percent of investment fluctuations. The global financial factor, which essentially measures the extent of cross-country comovement of the relevant financial variable, on average accounts for about 50 percent of equity price, 27 percent of interest rate, and 20 percent of credit fluctuations (see column marked F). All of these shares are higher when the model is estimated over the period 1998-2016 compared to the period 1985-2007. The global financial factor plays a less important role in explaining house price comovement.

We also examine the results from the estimation of our combined Models 3 and 4 over 15 year rolling sub-periods with one year increments. In Figure 9, we present the average variance of each financial variable explained by the global financial factor and spillovers from the global and U.S. country macro factors over the rolling sub-periods. Similar to the findings in the previous section, there is an increase in the importance of the global financial factor spillovers from the macroeconomy in all financial variables (except house prices) especially after the 2007-08 global financial crisis. Specifically, over the 15-year rolling sub-periods, the average variance of equity prices in G7 countries due to the global financial factor increased from about 39 percent from the early 2000s to roughly 50 percent after 2007 in the case of equity prices.

Spillovers from the macroeconomy to interest rates and credit have also become larger after the global financial crisis. Prior to the 2007-08 crisis, spillovers from the macro factors on average account for 4 (1) percent of interest rates (credit) variation over the 15 year rolling sub-periods. With the onset of the crisis, spillovers explained on average 6 (3) percent of fluctuations in interest rates (credit). These results are broadly consistent with our findings from the two sub-samples (1985-2007 and 1998-2016) documented above. Spillovers from the macro factors on to global equity and house price factors have not changed much over time.

The conclusion from this set of results is that the global and the U.S. macro factors have a relatively modest impact on global financial cycles. One exception is that of short-term interest rates, which seem to experience significant spillovers from the global and U.S. country-specific macro factors. As we summarize in the next sub-section, there are also differences across countries in terms of the strength of macro spillovers since spillovers from the macroeconomy to the financial sector tend to be more pronounced in some countries.

These results are generally supportive of some of the earlier findings in the literature. Some of these studies consider the predictive ability of macroeconomic variables for financial aggregates while others consider the explanatory power of the second moments of macro variables for the second moments of financial aggregates. In the context of interest rates, both theory and evidence point to the presence of an interest rate channel through which movements in policy interest rates have implications for macroeconomic outcomes (Woodford 2003). Some empirical studies document that interest rates react to changes in macroeconomic variables (Gurkaynak and Wright 2012; Bauer and Hamilton 2017). However, the existing literature presents a mixed verdict about the role of macroeconomic fluctuations in explaining cycles in asset prices, including equity prices.[25] Some of these studies consider macro-financial interactions at lower frequencies (rather than quarterly data we employ here) and examine the impact of surprise macroeconomic announcements (rather than realized data as we do here).

5.2. Country-Specific Spillovers

Next, we briefly examine country-level results on the importance of spillovers from macroeconomic aggregates to financial variables. The composite spillovers to financial variables from macroeconomic fluctuations, operating through both the global and U.S. country-specific macro factors (combination of Models 3 and 4), are shown for each country and each macroeconomic variable in Tables 6 and 7 and Figure 10. We again focus on the results for 1998-2016 to conserve space.

[25] For the importance of macroeconomic variables for financial markets, see Stock and Watson 2003; Christiansen, Schmeling and Schrimpf 2012; Diebold and Yilmaz 2010 and 2015; and Engle, Ghysels and Sohn 2013.

Table 6 shows that the spillovers from the global and U.S. country-specific macro factors to financial variables are smaller than those from the financial sector to the macroeconomy across countries. The largest spillover effects of macroeconomic cycles are on interest rates, with the spillovers being largest in the cases of the United States, Canada, and France. The average variance of credit due to spillovers from the global and U.S. country-specific macro factors is about 2.5 percent. But the importance of spillovers from the macroeconomy to the global credit factor is sizeable for some countries: it is about 8 percent for credit cycles in Canada and 5 percent for the United States.

Among the financial variables that we consider, global comovement is clearly most pronounced for equity prices. The contribution of the estimated global factor for equity prices accounts for at least one-third of the fluctuations in domestic equity prices for all countries. The global comovement in interest rates is also pronounced, with the global factor accounting for nearly half of the total variance in interest rates in the United States, and around one-third in Canada, France, and the United Kingdom. The global credit factor on average accounts for 20 percent of credit variation but this result is mostly driven by the importance of the global credit factor for Canada and the United States. For the other two financial variables, the contribution of the global financial factor is typically smaller. These results are consistent with those in section 2.2 (those results were based on single or multiple factor models estimated on financial variables alone) and the literature discussed in that section.

The importance of spillovers from the global and U.S. country-specific macro factors to the global interest rate factor rises over time (Table 7). The average variance of short-term interest rates ascribed to spillovers from the macro factors increases from 3.2 percent in 1985-2007 to 6.7 percent in 1998-2016. For all countries except Canada, the share of variance due to the macro spillovers registers a substantial increase. For the other three financial variables, the spillovers from macro factors are quite muted for all countries, even in the second sub-sample (although in most cases the variance contributions do increase marginally relative to those for the first sub-sample).

6. Conclusions

Our objective in this paper was to provide a joint empirical characterization of macroeconomic and financial cycles, and the linkages between these cycles. We developed a new dynamic factor model that allows us to study business cycle comovement, evaluate the magnitude of financial market spillovers onto real macroeconomic aggregates, and differentiate between global shocks and spillovers. We applied the model to quarterly macroeconomic and financial market data for the G-7 economies over the period 1985-2016.

The major novelty of our factor model is that, unlike existing models, it enables us to distinguish between common shocks and spillovers from one sector to another. For instance, we are able to capture the extent to which spillovers from financial markets affect global business cycles. This provides an economically valuable decomposition of why there is comovement of some key macroeconomic and financial variables across the world. The model is general enough that we can also model spillovers from one country to others. This adds a second layer to our understanding of the nature of comovement. The model allows us to analyze if it is the transmission of country-specific shocks that drives global business cycle comovement or the existence of common shocks.

Our main findings are as follows. Over the period 1985-2016, there is evidence of common business cycles, as reflected in the comovement of macroeconomic aggregates, among the G-7 economies. There are also common cycles in certain financial variables, especially equity prices and interest rates. However, there is no common global financial cycle among different financial variables (which proxy for different asset classes) and also no evidence of a common macro-financial cycle.

Our analysis documents that the global macro factor plays an important role in explaining fluctuations in macroeconomic variables but there are also quantitatively significant spillovers from shocks to specific financial variables—equity prices and house prices, in particular—on to macroeconomic variables. Interest rates and credit do matter as well but they are quantitatively less important as sources of such spillover effects. Common cycles among real and financial

variables, respectively, and also the spillovers from financial to real variables are stronger in the period leading up to and following the financial crisis.

While the financial crisis is a special case, a broader understanding of the nature and sources of comovement of business and financial cycles and the propagation mechanisms for global, country or variable-specific shocks is important for designing effective stabilization policies at the national level and for coordination of policies at the global level. It is also an essential step to guide the development of theoretical models that could help explain changes in global business and financial cycles and transmission mechanisms between them. A better understanding of global macro-financial cycles and spillovers is an important building block for the design of dynamic models that can replicate the changing nature of these linkages. Such models could be helpful in analyzing alternative policy responses to different shocks.

There are a number of directions in which this work could be extended. The first would be to integrate a broader group of countries, including emerging markets, into the analysis to examine the shifting dynamics of macro-financial cycles across advanced and emerging market economies. Second, it would be useful to investigate how business cycle dynamics play out at the sectoral level and, in turn, how aggregate business and financial cycles are affected by sectoral dynamics. Third, in light of our findings, it would be beneficial to explore the two-way spillovers between domestic macro-financial cycles in the context of specific asset prices after controlling for the roles played by spillovers between global macro-financial cycles. Finally, it would be worth considering how policy responses, including monetary, fiscal, and financial sector policies, shape the transmission channels and feedback effects between different groups of countries. This may require a different class of models, however.

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Table 1. Variance Decompositions
(Models with Only Financial Variables; 1998-2016)

A. Equity Prices

	One Factor Model		Two Factor Model			Three Factor Model			
	Global	Idiosyncratic	Global	Variable	Idiosyncratic	Global	Variable	Country	Idiosyncratic
Canada	70.6	29.4	35.0	37.7	27.3	10.5	56.9	16.5	16.1
France	53.9	46.1	0.7	92.1	7.2	11.7	83.0	0.2	5.1
Germany	51.2	48.8	0.7	85.2	14.1	7.8	77.2	1.3	13.8
Italy	46.7	53.3	0.6	78.1	21.3	9.2	70.8	0.7	19.3
Japan	49.6	50.4	31.0	20.2	48.8	12.5	35.2	27.2	25.0
United Kingdom	81.4	18.6	29.7	53.4	16.8	11.8	74.6	5.0	8.7
United States	85.8	14.2	33.2	51.6	15.3	13.2	74.6	2.8	9.4
Average	62.7	37.3	18.7	59.7	21.5	11.0	67.5	7.7	13.9

B. House Prices

	One Factor Model		Two Factor Model			Three Factor Model			
	Global	Idiosyncratic	Global	Variable	Idiosyncratic	Global	Variable	Country	Idiosyncratic
Canada	5.3	94.7	4.0	10.5	85.5	3.0	8.6	0.6	87.8
France	6.6	93.4	4.2	35.4	60.5	1.9	32.3	3.6	62.2
Germany	20.9	79.1	15.7	0.5	83.8	6.3	0.2	1.8	91.7
Italy	0.1	99.9	0.1	59.9	40.0	0.1	53.9	8.0	38.0
Japan	6.6	93.4	7.8	5.0	87.3	5.3	4.4	0.6	89.7
United Kingdom	5.2	94.8	6.4	13.9	79.7	3.3	11.2	5.7	79.8
United States	2.4	97.6	0.3	16.8	82.9	0.1	18.0	1.0	80.9
Average	6.7	93.3	5.5	20.3	74.2	2.9	18.4	3.0	75.7

C. Interest Rates

	One Factor Model		Two Factor Model			Three Factor Model			
	Global	Idiosyncratic	Global	Variable	Idiosyncratic	Global	Variable	Country	Idiosyncratic
Canada	7.4	92.6	12.4	25.6	62.0	10.3	29.6	0.3	3.7
France	11.8	88.2	12.9	72.4	14.7	5.7	75.7	0.8	0.5
Germany	3.0	97.0	0.7	77.1	22.2	0.2	76.1	0.4	0.5
Italy	1.3	98.7	3.2	35.9	60.9	1.4	36.9	1.5	0.6
Japan	2.7	97.3	0.6	30.9	68.5	0.1	31.9	0.2	0.2
United Kingdom	19.8	80.2	20.4	40.4	39.2	9.2	45.6	0.3	8.0
United States	1.1	98.9	1.3	33.7	65.0	0.5	34.0	0.3	0.4
Average	6.7	93.3	7.4	45.1	47.5	3.9	47.1	0.6	2.0

D. Credit

	One Factor Model		Two Factor Model			Three Factor Model			
	Global	Idiosyncratic	Global	Variable	Idiosyncratic	Global	Variable	Country	Idiosyncratic
Canada	0.1	99.9	5.8	78.1	16.1	4.7	65.3	0.6	29.4
France	0.0	100.0	0.3	23.6	76.1	0.3	22.6	3.6	73.5
Germany	3.5	96.5	2.9	2.0	95.0	1.1	2.3	1.8	94.9
Italy	0.2	99.8	0.1	9.0	90.9	0.6	8.4	8.0	82.9
Japan	1.4	98.6	0.3	11.7	88.0	0.2	10.7	0.6	88.4
United Kingdom	6.5	93.5	5.1	13.6	81.3	2.8	16.6	5.7	74.9
United States	6.6	93.4	13.8	23.8	62.3	11.1	26.0	1.0	61.9
Average	2.6	97.4	4.1	23.1	72.8	3.0	21.7	3.0	72.3

Notes: In each cell, the variance share attributable to the relevant factor is reported. The variance contributions are attributed to: Global (global factor), Variable (variable-specific factor), Country (country-specific factor), and Idiosyncratic (idiosyncratic factor). One factor model refers to the dynamic factor model that includes only a global factor common to all variables and countries. Two factor model includes: (i) a global factor common to all variables and countries; and (ii) variable-specific factors that capture common cross-country fluctuations specific to each financial variable. Three factor model includes (i) a global factor common to all variables and countries; (ii) variable-specific factors that capture common cross-country fluctuations specific to each financial variable; and (iii) country-specific factors that capture the comovement of all financial variables within a particular country.

Table 2. Variance Decompositions: From Financial Sector to Macroeconomy (Models 1, 2 and 1&2; G-7 Averages)

A. Model with Equity Prices

	Output				Consumption				Investment				Equity prices	
	W	C	SF	I	W	C	SF	I	W	C	SF	I	F	I
	Model 1													
1985-2016	31.5	37.6	6.0	25.0	7.6	42.7	1.4	48.2	23.3	25.5	4.4	46.8	49.8	50.2
1985-2007	20.9	42.9	3.8	32.5	9.5	38.7	1.8	50.0	19.4	28.6	3.5	48.5	45.7	54.3
1998-2016	35.6	27.9	11.6	24.9	7.3	42.7	2.4	47.7	24.7	20.9	8.1	46.4	51.4	48.6
	Model 2													
1985-2016	37.9	35.8	1.4	24.8	9.6	39.9	1.6	48.9	28.1	24.4	1.0	46.5	54.7	45.3
1985-2007	23.5	42.4	2.3	31.8	10.9	37.5	2.0	49.6	22.4	27.3	1.5	48.8	51.0	49.0
1998-2016	50.7	22.0	1.7	25.7	11.6	36.6	2.7	49.0	34.9	17.4	1.3	46.4	53.9	46.1
	Model 1&2													
1985-2016	30.7	36.8	7.9	24.5	7.5	41.9	3.2	47.3	22.8	24.8	5.8	46.6	54.9	45.1
1985-2007	20.6	41.7	6.2	31.4	9.7	37.3	3.9	49.1	19.4	27.4	5.3	47.9	50.6	49.4
1998-2016	35.5	25.5	14.0	25.0	7.5	39.8	5.6	47.0	24.3	19.4	9.8	46.5	57.6	42.4

B. Model with House Prices

	Output				Consumption				Investment				House prices	
	W	C	SF	I	W	C	SF	I	W	C	SF	I	F	I
	Model 1													
1985-2016	33.6	36.5	4.5	25.4	8.1	42.1	1.1	48.7	24.6	25.0	3.3	47.1	10.0	90.0
1985-2007	21.9	44.0	1.9	32.2	10.0	38.5	0.9	50.5	20.5	29.0	1.8	48.7	9.2	90.8
1998-2016	39.5	28.3	6.7	25.5	8.4	42.0	1.5	48.1	27.5	20.9	4.7	46.9	8.6	91.4
	Model 2													
1985-2016	37.2	35.9	2.1	24.8	9.6	40.5	2.4	47.5	27.7	24.9	1.4	45.9	10.9	89.1
1985-2007	23.3	42.0	2.3	32.3	10.9	37.0	2.1	50.0	22.3	28.1	1.5	48.1	7.2	92.8
1998-2016	47.8	23.9	2.2	26.1	11.2	36.3	3.2	49.3	32.3	19.1	1.7	46.9	13.6	86.4
	Model 1&2													
1985-2016	34.0	35.0	6.2	24.8	8.7	39.9	3.2	48.2	25.0	24.4	4.5	46.1	9.2	90.8
1985-2007	22.1	41.1	5.4	31.5	10.3	36.5	3.7	49.4	20.7	27.1	4.3	48.0	8.5	91.5
1998-2016	42.1	23.0	10.8	24.2	10.3	36.5	5.3	47.9	29.0	17.8	7.6	45.6	12.3	87.7

C. Model with Interest Rates

	Output				Consumption				Investment				Interest rates	
	W	C	SF	I	W	C	SF	I	W	C	SF	I	F	I
	Model 1													
1985-2016	33.7	38.5	2.3	25.6	7.9	42.4	0.5	49.2	25.0	26.1	1.7	47.2	20.0	80.0
1985-2007	22.3	43.6	1.4	32.7	10.2	38.2	0.6	51.0	20.9	28.9	1.3	48.8	19.3	80.7
1998-2016	38.7	29.4	4.8	27.2	7.7	42.9	0.9	48.5	26.7	21.0	3.3	48.9	34.3	65.7
	Model 2													
1985-2016	38.5	35.0	1.9	24.6	10.0	40.1	2.2	47.7	28.6	23.9	1.3	46.1	30.0	70.0
1985-2007	23.3	41.7	3.9	31.1	10.8	36.7	3.3	49.2	22.3	26.5	2.8	48.4	28.7	71.3
1998-2016	46.3	26.2	1.7	25.8	10.4	39.4	2.3	47.9	31.6	20.1	1.4	47.0	44.5	55.5
	Model 1&2													
1985-2016	35.8	36.3	4.2	23.8	9.2	40.9	2.9	47.0	26.7	24.7	2.9	45.6	28.3	71.7
1985-2007	22.8	40.8	5.0	31.4	10.5	36.9	3.8	48.8	21.4	26.1	4.0	48.5	27.6	72.4
1998-2016	41.5	26.3	6.7	25.4	8.8	40.4	3.4	47.4	28.3	20.7	4.9	46.1	40.0	60.0

D. Model with Credit

	Output				Consumption				Investment				Credit	
	W	C	SF	I	W	C	SF	I	W	C	SF	I	F	I
	Model 1													
1985-2016	36.9	36.4	2.3	24.4	9.5	41.1	0.6	48.8	27.5	25.3	1.7	45.5	19.3	80.7
1985-2007	20.2	43.6	3.8	32.3	8.8	39.0	1.7	50.5	18.5	28.6	3.4	49.5	12.1	87.9
1998-2016	45.6	26.6	3.4	24.4	10.7	40.8	0.8	47.6	31.8	20.9	2.4	44.9	22.0	78.0
	Model 2													
1985-2016	37.9	34.6	2.5	25.1	10.3	38.7	2.7	48.3	27.9	24.4	2.0	45.7	22.8	77.2
1985-2007	23.0	41.5	4.0	31.5	10.5	36.9	3.3	49.3	22.0	26.5	3.1	48.3	16.5	83.5
1998-2016	46.5	25.5	1.9	26.1	10.5	38.3	2.7	48.5	31.7	19.7	1.5	47.1	23.9	76.1
	Model 1&2													
1985-2016	37.1	33.7	5.1	24.1	10.5	37.9	3.5	48.2	27.5	24.2	3.9	44.4	22.8	77.2
1985-2007	19.7	41.2	7.8	31.3	8.6	37.3	5.1	49.0	18.0	26.1	6.6	49.3	16.9	83.1
1998-2016	46.4	24.1	5.4	24.0	11.1	38.6	3.6	46.7	32.7	19.0	4.1	44.3	23.8	76.2

Notes: In each cell, the variance share attributable to the relevant factor is reported. The share is averaged across the G-7 countries at a horizon of 30th quarter. The variance contributions are attributed to: W (global macro factor), C (country-specific macro factor), F (global financial factor), SF (spillovers from financial to macro factors), and I (idiosyncratic factor). In Model 1, the financial factor spills over to the global macro factor. In Model 2, the financial factor spills over directly to country-specific macro factor. Model 1 and 2 combined captures both channels through which the financial factor affects macro activity.

Table 3. Variance Decompositions: Spillovers from Financial Sector to Macroeconomy (Model 1&2)

		Equity prices			House prices			Interest rates			Credit		
		Y	C	I	Y	C	I	Y	C	I	Y	C	I
Canada	**1985-2016**	6.5	4.4	7.2	5.4	3.6	5.0	4.3	2.8	3.0	4.6	2.9	3.5
	1985-2007	4.5	3.2	3.0	5.4	3.5	2.9	6.3	3.9	3.0	7.7	5.0	4.1
	1998-2016	11.5	9.3	15.9	8.3	6.8	10.8	5.0	4.1	7.0	4.0	3.4	5.4
France	**1985-2016**	12.2	3.8	10.0	8.5	3.4	7.0	5.1	3.9	3.4	5.9	4.1	4.4
	1985-2007	12.4	5.6	13.4	8.1	4.2	8.7	5.4	3.9	5.3	12.0	5.4	12.1
	1998-2016	19.0	7.0	12.4	13.0	4.7	9.2	8.1	3.2	5.5	6.1	3.3	4.1
Germany	**1985-2016**	8.2	1.3	5.4	5.7	1.2	4.0	3.0	0.8	2.2	4.6	1.7	3.6
	1985-2007	5.0	2.0	4.3	4.4	2.1	3.5	2.7	1.3	2.2	5.5	2.5	4.6
	1998-2016	18.9	1.8	10.8	12.6	1.2	7.4	8.5	1.3	5.3	6.3	1.5	4.5
Italy	**1985-2016**	10.2	3.4	4.8	7.5	3.6	4.8	3.8	2.3	2.9	5.2	3.7	5.0
	1985-2007	6.9	5.3	5.7	5.2	3.9	4.6	3.4	2.6	3.4	7.0	5.1	5.9
	1998-2016	17.4	6.4	8.1	12.9	7.5	7.5	8.1	4.2	4.4	6.2	5.4	4.3
Japan	**1985-2016**	6.1	2.3	4.1	4.7	2.3	2.9	2.6	1.4	1.5	3.8	2.3	2.0
	1985-2007	5.0	3.3	3.7	4.0	2.6	2.8	3.1	2.2	1.9	4.5	2.9	3.4
	1998-2016	11.8	4.8	6.7	8.1	3.3	4.8	5.4	2.5	3.1	4.6	3.4	2.6
United	**1985-2016**	5.4	2.6	2.6	6.0	4.2	2.3	5.4	4.9	1.9	5.4	4.5	1.8
Kingdom	**1985-2007**	3.5	2.9	1.5	5.2	5.0	1.5	5.8	6.1	1.5	5.9	5.4	1.9
	1998-2016	10.5	4.2	4.7	11.6	6.6	4.0	5.9	3.1	2.2	5.8	4.0	1.9
United	**1985-2016**	7.0	4.8	6.4	5.7	4.2	5.6	5.1	4.2	5.7	6.2	5.1	7.2
States	**1985-2007**	6.4	4.9	5.9	5.6	4.3	5.7	8.5	6.4	10.4	12.3	9.2	14.2
	1998-2016	9.1	6.1	9.8	8.8	6.8	9.4	6.2	5.2	6.9	5.0	4.3	5.6
Average	**1985-2016**	7.9	3.2	5.8	6.2	3.2	4.5	4.2	2.9	2.9	5.1	3.5	3.9
	1985-2007	6.2	3.9	5.3	5.4	3.7	4.3	5.0	3.8	4.0	7.8	5.1	6.6
	1998-2016	14.0	5.6	9.8	10.8	5.3	7.6	6.7	3.4	4.9	5.4	3.6	4.1

Notes: In each cell, the variance share attributable to the relevant factor is reported. Spillovers from financial sector to macroeconomy capture spillovers from the global financial factors (equity prices, house prices, interest rates, and credit) to fluctuations in macro variables through the global macro factor and the country-specific macro factor. The results are based on the combined Model 1 and 2, which captures spillovers to the global macro factor (Model 1) and to country-specific macro factor (Model 2) through which the financial factor affects macro activity. Y, C, and I refer to output, consumption, and investment, respectively.

Table 4. Variance Decompositions: From Financial Sector to Macroeconomy (Model 1&2; 1998-2016)

		Equity prices			House prices			Interest rates			Credit		
		Y	C	I	Y	C	I	Y	C	I	Y	C	I
Canada	**Global Macro Factor**	31.6	25.4	44.7	36.8	29.6	49.9	36.4	30.3	51.7	42.0	34.2	57.6
	Country-Specific Factor	8.8	7.7	6.8	8.3	7.9	6.5	8.9	5.8	9.9	7.2	6.8	7.2
	Idiosyncratic Factor	48.0	57.6	32.6	46.7	55.7	32.8	49.6	59.8	31.5	46.8	55.6	29.8
	Financial Spillovers	11.5	9.3	15.9	8.3	6.8	10.8	5.0	4.1	7.0	4.0	3.4	5.4
France	**Global Macro Factor**	48.2	4.9	33.9	56.6	7.1	41.9	54.7	4.9	40.1	59.0	6.3	44.9
	Country-Specific Factor	17.6	40.7	5.3	16.2	39.3	4.8	21.9	45.3	7.4	21.6	42.6	8.1
	Idiosyncratic Factor	15.3	47.4	48.3	14.1	48.9	44.2	15.3	46.6	47.0	13.2	47.8	42.9
	Financial Spillovers	19.0	7.0	12.4	13.0	4.7	9.2	8.1	3.2	5.5	6.1	3.3	4.1
Germany	**Global Macro Factor**	52.6	0.8	26.2	57.3	0.9	28.1	61.4	0.9	30.0	64.0	1.2	31.6
	Country-Specific Factor	14.7	22.5	26.3	15.8	19.4	28.2	15.4	20.7	26.3	16.1	20.9	28.4
	Idiosyncratic Factor	13.8	74.9	36.7	14.2	78.4	36.3	14.8	77.1	38.4	13.6	76.4	35.5
	Financial Spillovers	18.9	1.8	10.8	12.6	1.2	7.4	8.5	1.3	5.3	6.3	1.5	4.5
Italy	**Global Macro Factor**	46.9	4.3	16.5	54.5	6.7	21.1	56.1	5.6	20.2	60.3	7.4	23.2
	Country-Specific Factor	18.4	61.4	31.4	14.9	57.4	27.4	18.4	61.8	31.1	16.7	58.0	29.3
	Idiosyncratic Factor	17.2	27.9	44.0	17.7	28.3	44.0	17.4	28.4	44.4	16.8	29.2	43.1
	Financial Spillovers	17.4	6.4	8.1	12.9	7.5	7.5	8.1	4.2	4.4	6.2	5.4	4.3
Japan	**Global Macro Factor**	28.8	4.2	17.5	32.1	4.9	20.3	34.7	5.4	21.4	37.5	6.0	23.7
	Country-Specific Factor	35.5	61.3	13.8	35.7	62.2	13.8	36.3	63.7	13.8	34.3	61.5	13.6
	Idiosyncratic Factor	23.9	29.6	62.0	24.2	29.6	61.1	23.6	28.4	61.7	23.6	29.1	60.2
	Financial Spillovers	11.8	4.8	6.7	8.1	3.3	4.8	5.4	2.5	3.1	4.6	3.4	2.6
United Kingdom	**Global Macro Factor**	22.0	3.3	12.7	32.9	8.0	16.3	27.2	4.4	14.9	34.2	6.7	18.8
	Country-Specific Factor	43.1	43.7	5.1	33.4	34.2	3.5	42.0	42.3	4.9	36.6	41.1	4.0
	Idiosyncratic Factor	24.4	48.8	77.5	22.1	51.3	76.2	24.8	50.2	77.9	23.5	48.2	75.4
	Financial Spillovers	10.5	4.2	4.7	11.6	6.6	4.0	5.9	3.1	2.2	5.8	4.0	1.9
United States	**Global Macro Factor**	18.1	9.4	19.0	24.4	15.2	25.8	20.1	10.4	19.7	28.0	16.3	29.2
	Country-Specific Factor	40.3	41.5	46.9	36.4	34.7	40.4	41.3	43.5	51.3	36.3	38.8	42.2
	Idiosyncratic Factor	32.5	43.0	24.3	30.4	43.4	24.3	32.4	40.9	22.0	30.7	40.6	23.0
	Financial Spillovers	9.1	6.1	9.8	8.8	6.8	9.4	6.2	5.2	6.9	5.0	4.3	5.6
Average	**Global Macro Factor**	35.5	7.5	24.3	42.1	10.3	29.0	41.5	8.8	28.3	46.4	11.1	32.7
	Country-Specific Factor	25.5	39.8	19.4	23.0	36.5	17.8	26.3	40.4	20.7	24.1	38.6	19.0
	Idiosyncratic Factor	25.0	47.0	46.5	24.2	47.9	45.6	25.4	47.4	46.1	24.0	46.7	44.3
	Financial Spillovers	14.0	5.6	9.8	10.8	5.3	7.6	6.7	3.4	4.9	5.4	3.6	4.1

Notes: In each cell, the variance share attributable to the relevant factor is reported. The results are based on the combined Model 1 and 2, which captures spillovers to the global macro factor (Model 1) and to country-specific macro factor (Model 2) through which the financial factor affects macro activity. Y, C, and I refer to output, consumption, and investment, respectively.

Table 5. Variance Decompositions: From Macroeconomy to Financial Sector (Models 3, 4 and 3&4; G-7 Averages)

A. Model with Equity Prices

	Output			Consumption			Investment			Equity prices		
	W	C	I	W	C	I	W	C	I	SR	F	I
	Model 3											
1985-2016	37.7	36.8	25.5	9.4	40.9	49.6	27.8	25.4	46.8	0.7	48.8	50.5
1985-2007	23.6	43.2	33.2	10.8	38.1	51.1	22.3	28.7	49.0	0.7	45.2	54.2
1998-2016	45.5	28.2	26.3	10.0	41.5	48.5	31.0	21.9	47.1	1.0	50.4	48.5
	Model 4											
1985-2016	37.9	36.5	25.6	9.6	40.6	49.8	27.9	25.4	46.7	0.6	48.9	50.5
1985-2007	24.0	43.3	32.7	11.0	38.1	50.8	22.6	28.5	48.9	0.6	45.2	54.2
1998-2016	45.9	27.9	26.3	10.1	41.6	48.4	31.3	21.3	47.4	0.9	50.0	49.1
	Model 3&4											
1985-2016	37.0	37.4	25.6	9.1	40.7	50.2	27.2	25.6	47.2	1.2	48.1	50.7
1985-2007	23.6	43.7	32.7	11.0	38.0	51.1	22.4	28.6	49.0	1.2	45.0	53.8
1998-2016	45.8	28.0	26.2	9.9	42.1	48.0	31.5	21.4	47.1	1.9	49.2	48.9

B. Model with House Prices

	Output			Consumption			Investment			House prices		
	W	C	I	W	C	I	W	C	I	SR	F	I
	Model 3											
1985-2016	37.7	37.0	25.2	9.5	41.4	49.1	27.9	25.6	46.6	1.4	11.6	87.0
1985-2007	23.4	47.1	29.6	10.2	43.4	46.4	22.1	31.9	45.9	0.9	7.6	91.5
1998-2016	42.0	33.2	24.8	9.5	47.0	43.5	30.5	25.0	44.5	0.7	5.6	93.7
	Model 4											
1985-2016	37.3	37.9	24.9	9.5	41.7	48.8	27.9	26.2	46.0	0.5	10.2	89.2
1985-2007	23.4	44.4	32.2	10.8	38.5	50.6	22.4	28.3	49.3	0.4	7.9	91.7
1998-2016	46.3	27.8	25.9	10.3	41.4	48.4	31.5	21.2	47.3	0.7	7.8	91.5
	Model 3&4											
1985-2016	37.4	37.3	25.3	9.4	41.0	49.6	27.5	25.9	46.6	1.9	9.5	88.6
1985-2007	23.9	43.3	32.8	11.2	37.8	51.0	22.7	28.5	48.8	1.0	7.2	91.8
1998-2016	42.9	32.5	24.6	9.6	46.2	48.0	31.1	24.5	44.5	1.1	4.6	94.3

C. Model with Interest Rates

	Output			Consumption			Investment			Interest rates		
	W	C	I	W	C	I	W	C	I	SR	F	I
	Model 3											
1985-2016	37.6	36.9	25.5	9.5	40.3	50.2	27.6	25.6	46.9	1.7	15.8	82.5
1985-2007	23.7	43.7	32.6	11.3	37.6	51.1	22.6	29.0	48.4	1.7	13.9	84.4
1998-2016	46.3	27.8	25.9	10.0	42.0	48.1	32.1	21.1	46.8	2.9	27.9	69.2
	Model 4											
1985-2016	37.3	36.9	25.8	9.3	40.8	49.8	27.3	25.5	47.2	1.2	15.6	83.3
1985-2007	23.4	44.2	32.5	10.6	38.5	50.9	22.2	28.8	49.0	1.4	15.0	83.7
1998-2016	46.2	27.7	26.1	10.1	41.3	48.6	31.7	20.7	47.6	4.8	24.4	70.8
	Model 3&4											
1985-2016	37.4	37.6	25.0	9.4	41.0	49.6	27.6	25.9	46.4	2.6	16.6	80.9
1985-2007	23.5	43.6	32.9	10.8	38.2	51.0	22.0	28.8	49.1	3.2	15.6	81.3
1998-2016	46.5	27.3	26.3	10.1	42.0	47.9	32.1	21.3	46.6	6.7	27.3	65.9

D. Model with Credit

	Output			Consumption			Investment			Credit		
	W	C	I	W	C	I	W	C	I	SR	F	I
	Model 3											
1985-2016	37.8	36.7	25.5	9.6	40.7	49.7	27.8	25.7	46.5	1.6	16.7	81.7
1985-2007	23.8	43.3	32.9	10.9	37.9	51.2	22.3	28.8	48.9	0.3	5.7	94.0
1998-2016	46.2	27.7	26.2	10.1	41.6	48.2	31.7	21.3	47.0	1.2	21.1	77.7
	Model 4											
1985-2016	37.3	37.0	25.7	9.3	40.7	50.0	27.4	25.5	47.1	1.8	17.7	80.5
1985-2007	23.8	43.6	32.6	10.9	38.0	51.0	22.4	28.7	48.9	0.9	9.1	90.0
1998-2016	45.8	28.2	26.0	10.0	42.0	48.0	31.6	21.3	47.0	1.5	20.8	77.8
	Model 3&4											
1985-2016	38.1	36.2	25.7	9.7	40.7	49.6	27.9	25.3	46.8	2.5	15.7	81.7
1985-2007	27.1	42.6	30.2	13.7	38.5	47.8	24.8	29.2	46.0	0.9	7.3	91.7
1998-2016	46.7	27.3	26.0	10.5	41.0	48.5	32.2	20.9	46.9	2.5	20.2	77.2

Notes: In each cell, the variance share attributable to the relevant factor is reported. The share is averaged across the G-7 countries at a horizon of 30th quarter. The variance contributions are attributed to: W (global macro factor), C (country-specific macro factor), F (global financial factor), SR (spillovers from macro to financial factor), and I (idiosyncratic factor). In Model 3, the global macro factor spills over to the financial factor. In Model 4, the U.S. country factor spills over to the financial factor. Model 3 and 4 combined captures both channels through which the macro factors affect financial sector.

Table 6. Variance Decompositions: From Macroeconomy to Financial Sector (Model 3&4; 1998-2016)

		Equity prices	House prices	Interest rates	Credit
Canada	**Global Financial Factor**	63.4	14.5	37.6	65.7
	Idiosyncratic Factor	34.1	82.0	53.2	26.2
	Macroeconomic Spillovers	2.5	3.5	9.2	8.0
France	**Global Financial Factor**	41.8	4.0	35.7	13.8
	Idiosyncratic Factor	56.6	94.9	55.6	84.4
	Macroeconomic Spillovers	1.7	1.1	8.8	1.8
Germany	**Global Financial Factor**	40.8	2.2	13.8	5.0
	Idiosyncratic Factor	57.6	97.5	82.7	94.4
	Macroeconomic Spillovers	1.6	0.4	3.5	0.6
Italy	**Global Financial Factor**	33.9	2.1	16.9	3.2
	Idiosyncratic Factor	64.8	97.3	78.9	96.3
	Macroeconomic Spillovers	1.4	0.6	4.2	0.4
Japan	**Global Financial Factor**	31.1	3.4	12.8	8.1
	Idiosyncratic Factor	67.6	95.8	84.0	90.9
	Macroeconomic Spillovers	1.3	0.8	3.2	1.0
United Kingdom	**Global Financial Factor**	61.7	1.1	29.1	8.4
	Idiosyncratic Factor	35.9	98.7	63.8	90.5
	Macroeconomic Spillovers	2.4	0.3	7.2	1.1
United States	**Global Financial Factor**	71.7	4.8	45.7	37.3
	Idiosyncratic Factor	25.5	94.0	43.2	57.9
	Macroeconomic Spillovers	2.8	1.2	11.1	4.7
Average	**Global Financial Factor**	49.2	4.6	27.3	20.2
	Idiosyncratic Factor	48.9	94.3	65.9	77.2
	Macroeconomic Spillovers	1.9	1.1	6.7	2.5

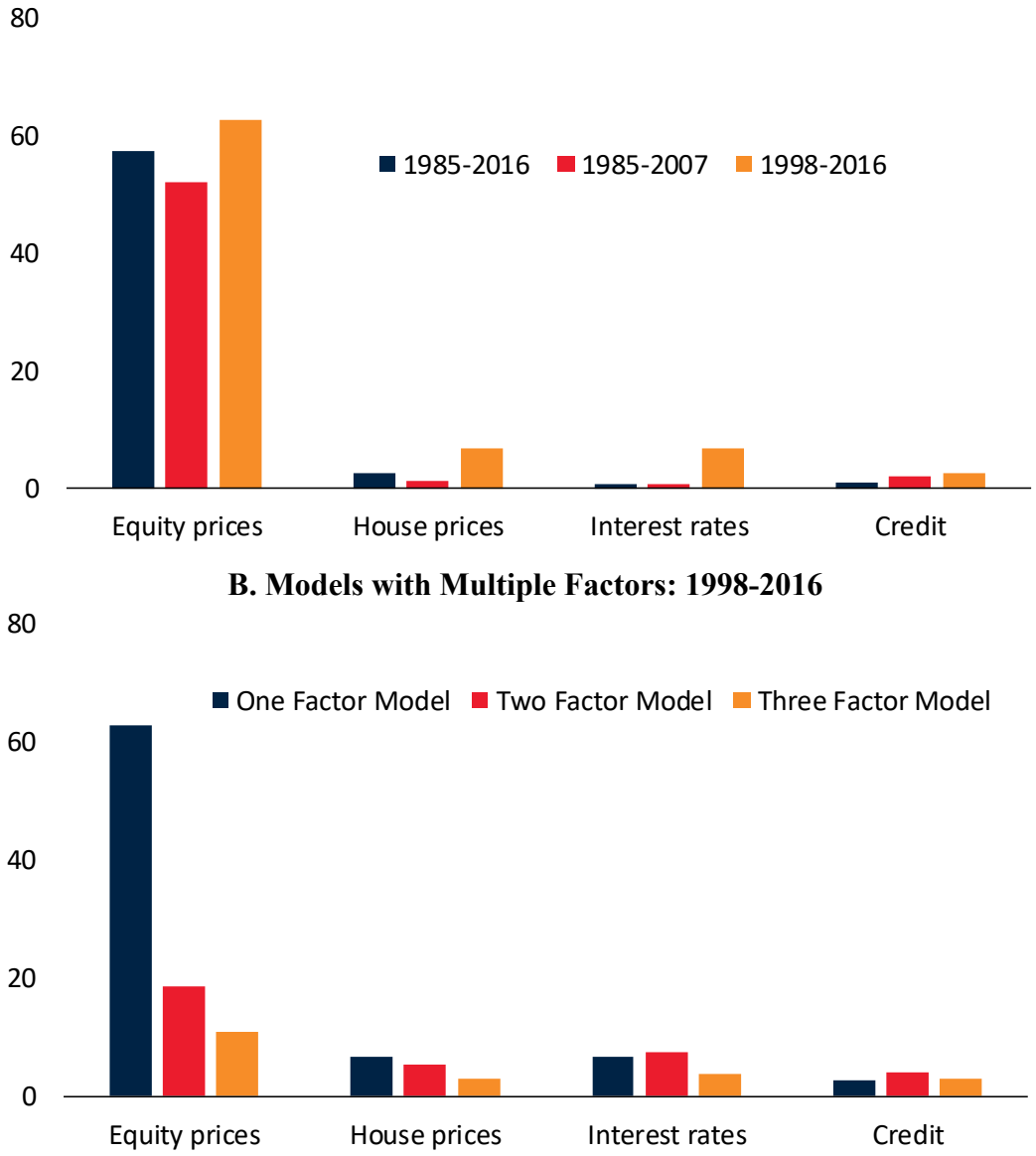
Notes: In each cell, the variance share attributable to the relevant factor is reported. The results are based on the combined Model 3 and 4, which captures spillovers from the global macro factor (Model 3) and from the U.S. country factor (Model 4) to the financial sector.

Table 7. Variance Decompositions: Spillovers from Macroeconomy to Financial Sector (Model 3&4)

		Equity prices	House prices	Interest rates	Credit
Canada	**1985-2016**	1.7	3.3	7.9	7.9
	1985-2007	1.7	3.1	9.7	2.3
	1998-2016	2.5	3.5	9.2	8.0
France	**1985-2016**	1.0	1.1	2.1	1.9
	1985-2007	1.1	0.4	2.6	1.0
	1998-2016	1.7	1.1	8.8	1.8
Germany	**1985-2016**	0.8	0.3	0.5	0.5
	1985-2007	0.8	0.3	0.6	0.2
	1998-2016	1.6	0.4	3.5	0.6
Italy	**1985-2016**	0.7	0.3	1.0	0.3
	1985-2007	0.7	0.1	1.2	0.2
	1998-2016	1.4	0.6	4.2	0.4
Japan	**1985-2016**	0.5	0.3	1.6	1.0
	1985-2007	0.3	0.1	2.2	0.3
	1998-2016	1.3	0.8	3.2	1.0
United Kingdom	**1985-2016**	1.6	0.4	1.5	1.0
	1985-2007	1.6	0.1	1.7	0.3
	1998-2016	2.4	0.3	7.2	1.1
United States	**1985-2016**	2.1	7.2	3.4	5.2
	1985-2007	2.2	2.6	4.0	2.1
	1998-2016	2.8	1.2	11.1	4.7
Average	**1985-2016**	1.2	1.9	2.6	2.5
	1985-2007	1.2	1.0	3.2	0.9
	1998-2016	1.9	1.1	6.7	2.5

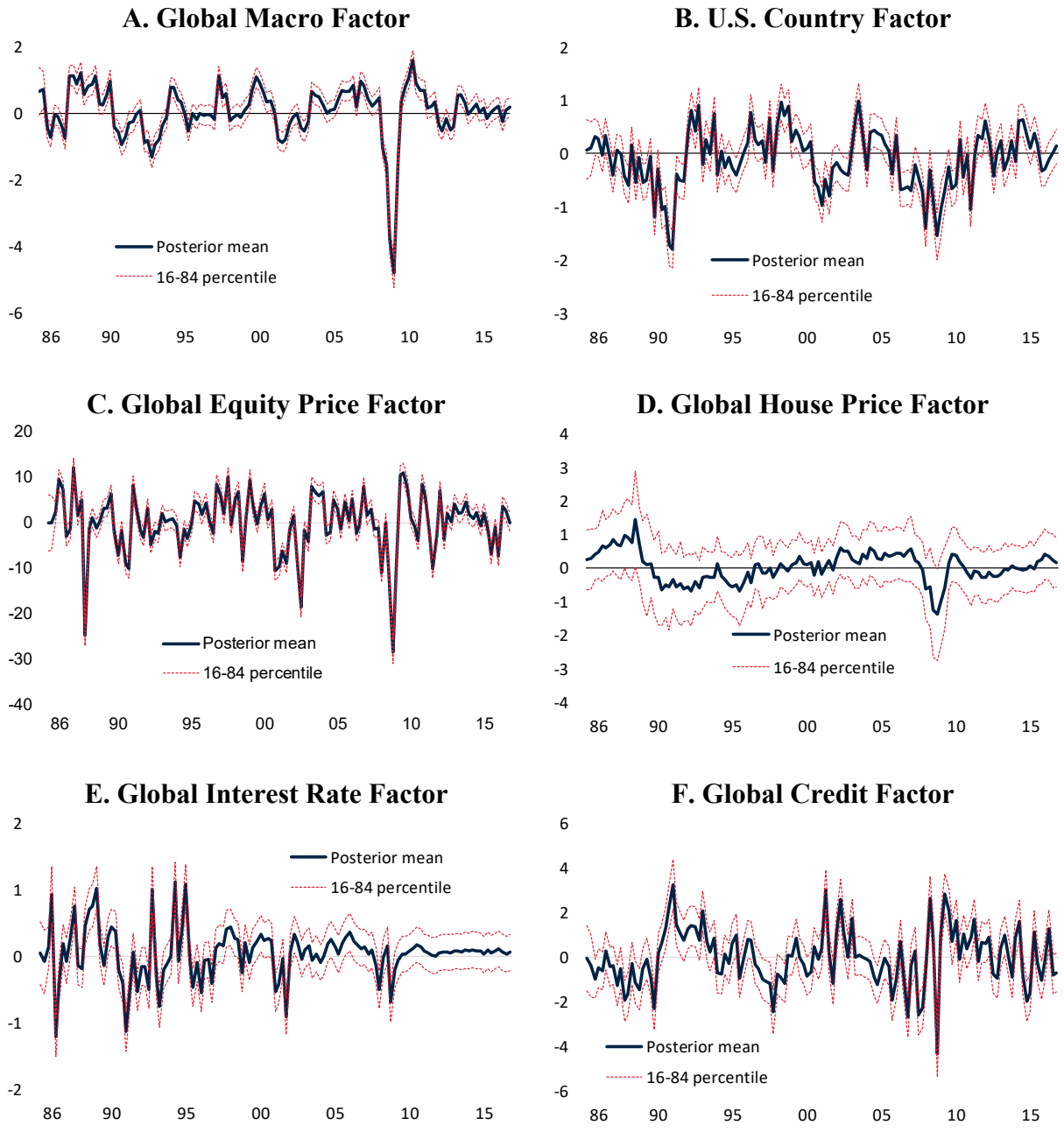
Notes: In each cell, the variance share attributable to the relevant factor is reported. Spillovers from macroeconomy to financial sector capture spillovers from macroeconomic aggregates to financial factors (equity prices, house prices, interest rates, and credit) through the global macro factor and U.S. country factor. The results are based on the combined Model 3 and 4, which captures spillovers from the global macro factor (Model 3) and from the U.S. country factor (Model 4) to the financial sector.

Figure 1. Variance Decompositions: Models with Only Financial Variables



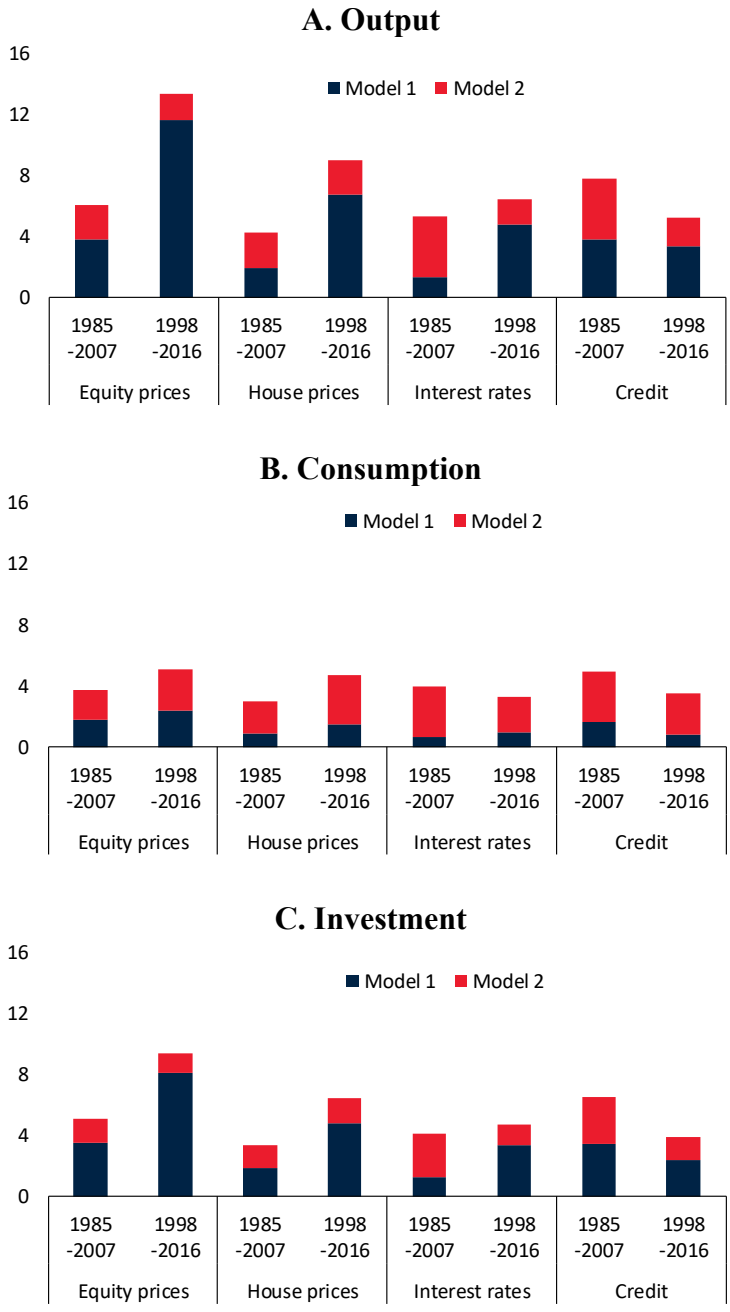
Notes: These figures show variance decompositions from standard dynamic factor models with the four financial variables (equity prices, house prices, interest rates, and credit). One factor model refers to the dynamic factor model that includes only a global factor common to all variables and countries. Two factor model includes: (i) a global factor common to all variables and countries; and (ii) variable-specific factors that capture common cross-country fluctuations specific to each financial variable. Three factor model includes (i) a global factor common to all variables and countries; (ii) variable-specific factors that capture common cross-country fluctuations specific to each financial variable; and (iii) country-specific factors that capture the comovement of all financial variables within a particular country.

Figure 2. Estimates of Macroeconomic and Financial Factors (1985-2016)



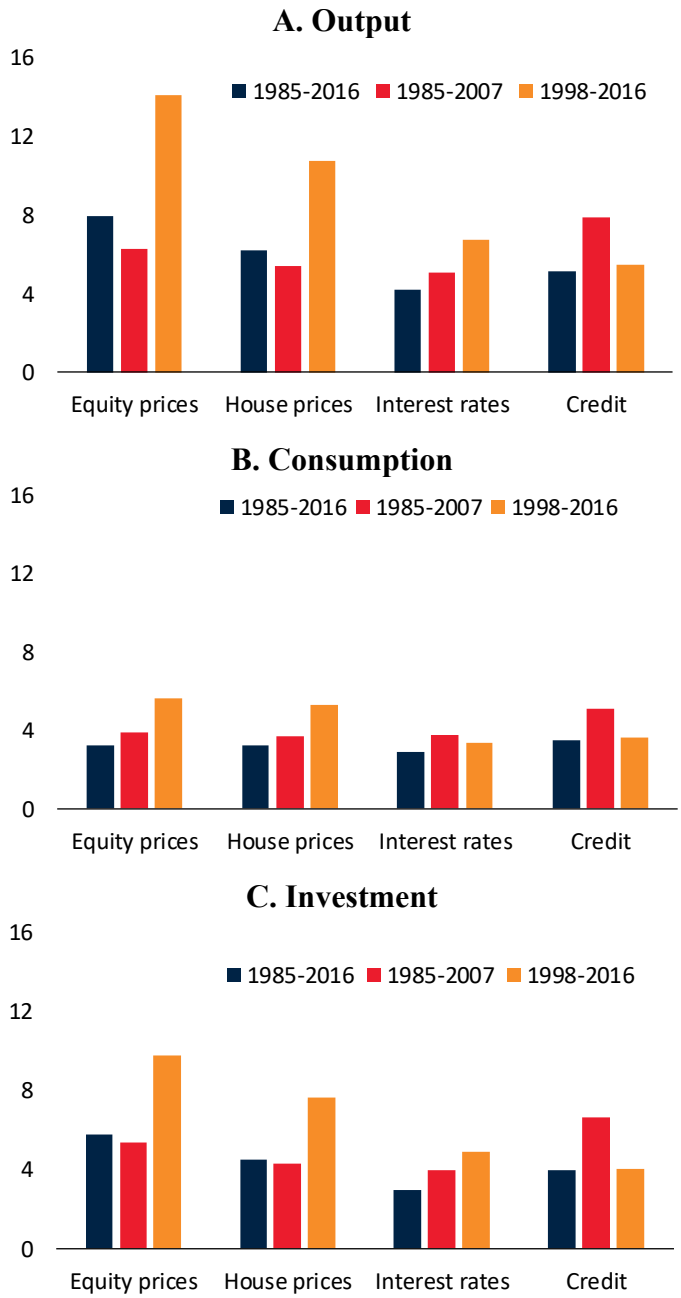
Notes: The factors shown as solid lines are posterior means. Panels A and B are based on the combined Model 1&2 and Panels C to F are based on the combined Model 3&4 estimated over the full sample (1985-2016). In Model 1, the financial factor spills over to the global macro factor. In Model 2, the financial factor spills over directly to country-specific macro factor. Model 1 and 2 combined captures both channels through which the financial factor affects macro activity. In Model 3, the global macro factor spills over to the financial factor. In Model 4, the U.S. country factor spills over to the financial factor. Model 3 and 4 combined captures both channels through which the macro factors affect the financial sector.

Figure 3. Variance Decompositions: Spillovers from Financial Sector to Macroeconomy (Models 1 and 2; G-7 Averages)



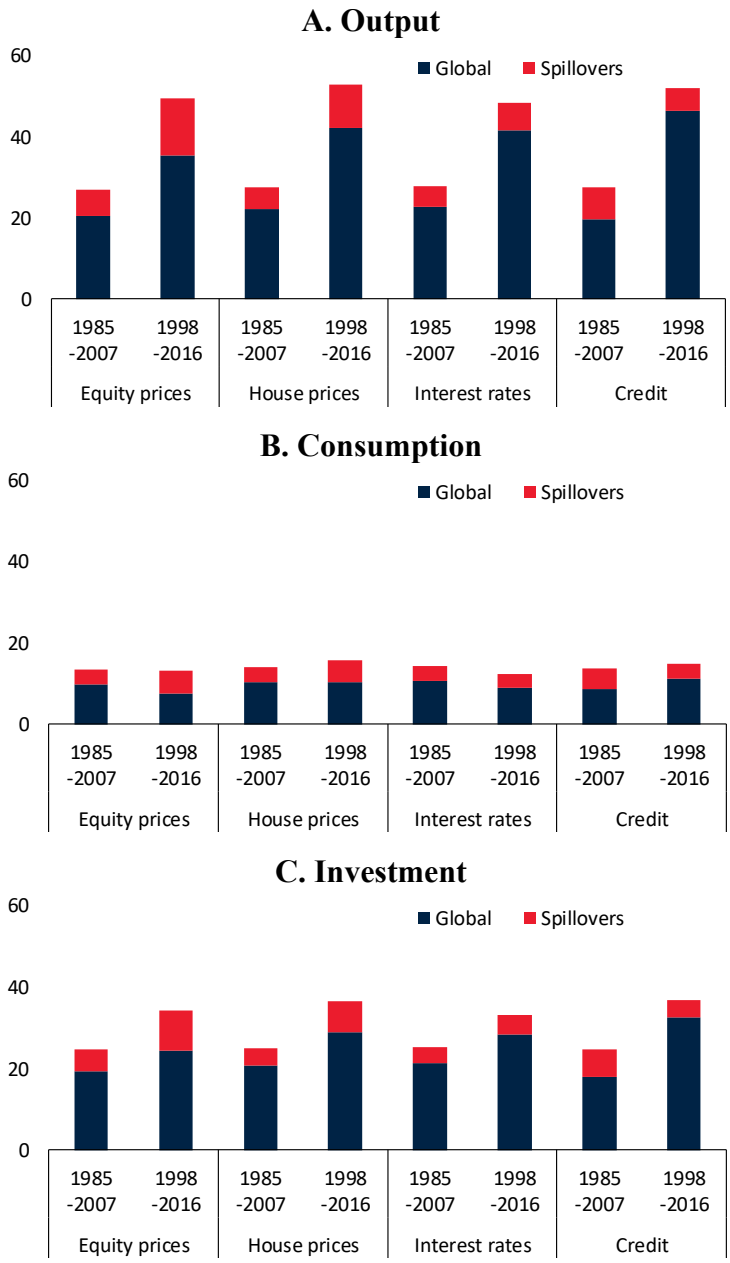
Notes: These figures show spillovers from the global financial factors (equity prices, house prices, interest rates, and credit) to fluctuations in macro variables through the global macro factor and the country-specific macro factor. In Model 1, the financial factor spills over to the global macro factor. In Model 2, the financial factor spills over directly to country-specific macro factor.

Figure 4. Variance Decompositions: Spillovers from Financial Sector to Macroeconomy (Model 1&2; G-7 Averages)



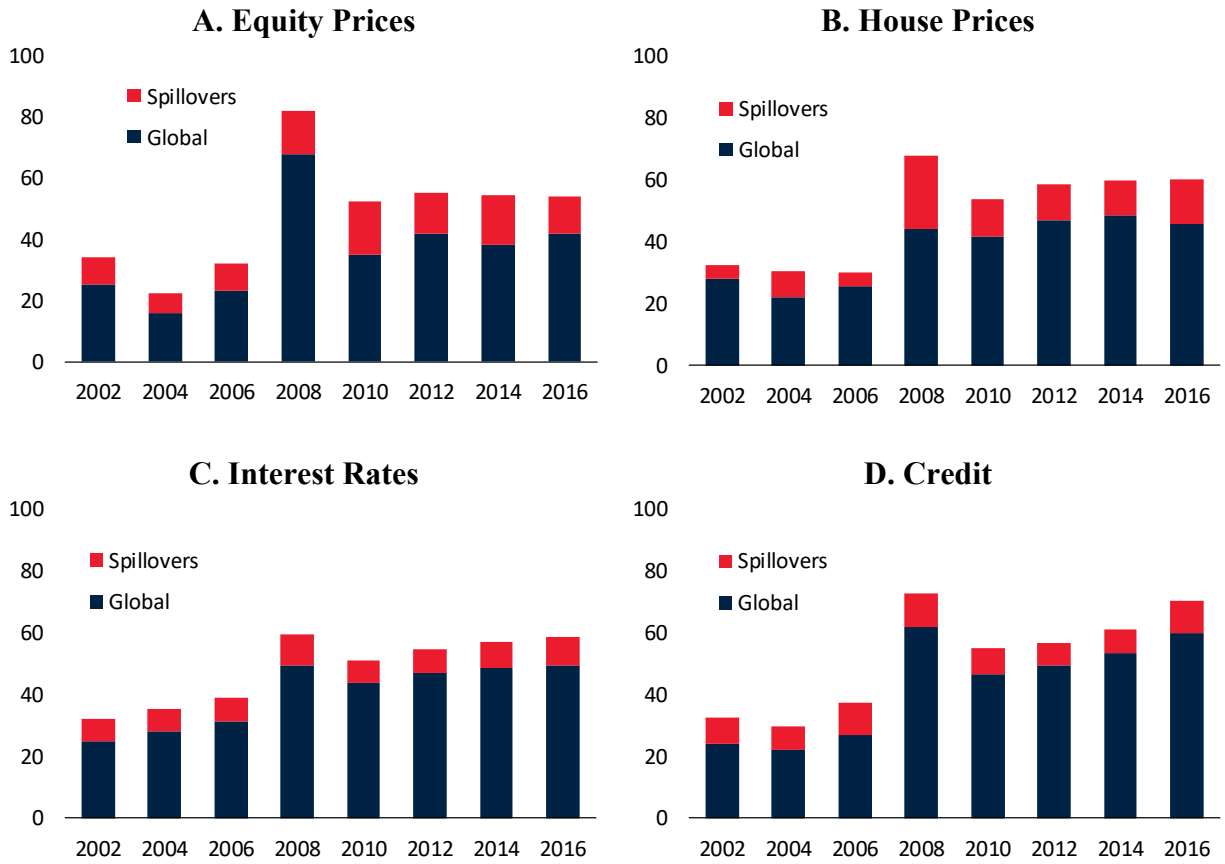
Notes: These figures show spillovers from the global financial factors (equity prices, house prices, interest rates, and credit) to fluctuations in macro variables, based on the combined Model 1 and 2, which captures spillovers to the global macro factor (Model 1) and to country-specific macro factor (Model 2) through which the financial factor affects macro activity.

Figure 5. Variance Decompositions: From Financial Sector to Macroeconomy (Model 1&2; G-7 Averages)



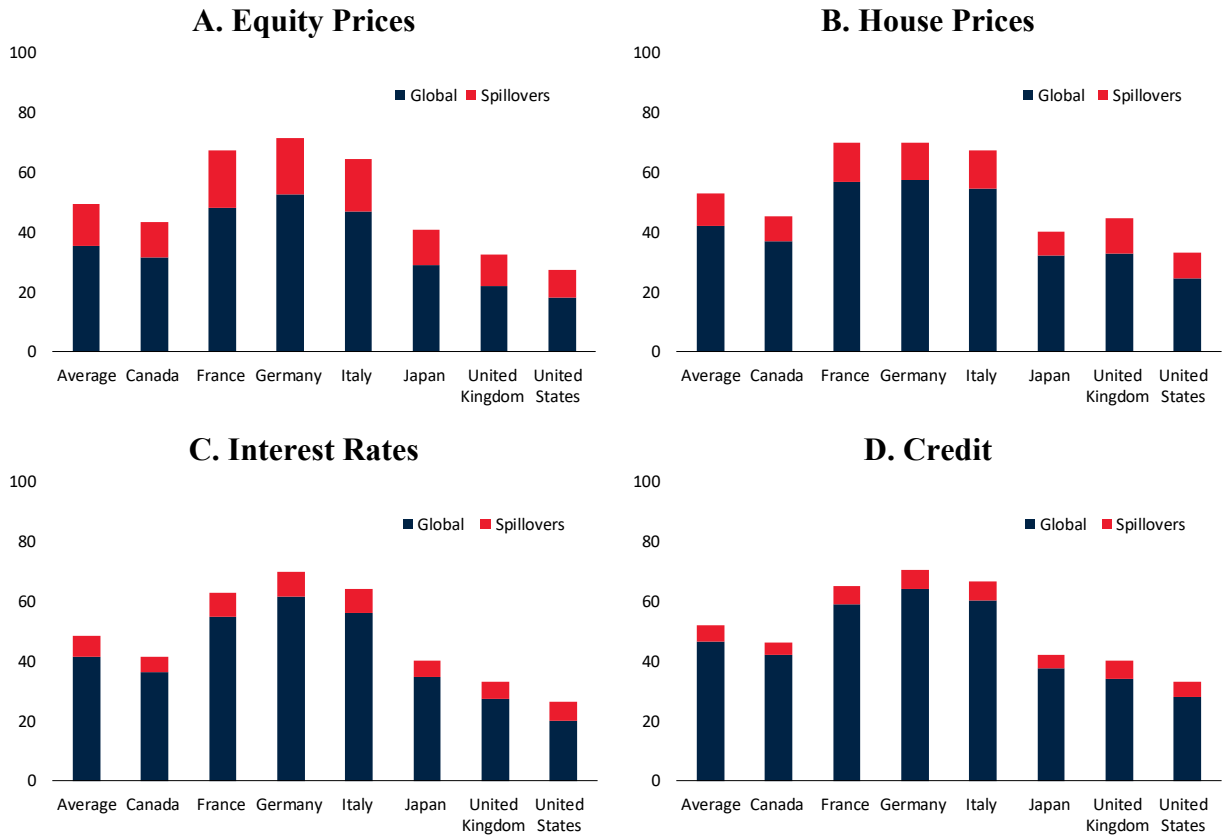
Notes: These figures show the variance decompositions for the global macro factor ("global") and spillovers from financial factors (equity prices, house prices, interest rates, and credit) to fluctuations in macro variables ("spillovers"). The results are based on the combined Model 1 and 2, which captures spillovers to the global macro factor (Model 1) and to country-specific macro factor (Model 2) through which the financial factor affects macro activity.

Figure 6. Variance Decompositions: From Financial Sector to Macroeconomy (Rolling Estimation; Model 1&2; Output; G-7 Averages; 1985-2016)



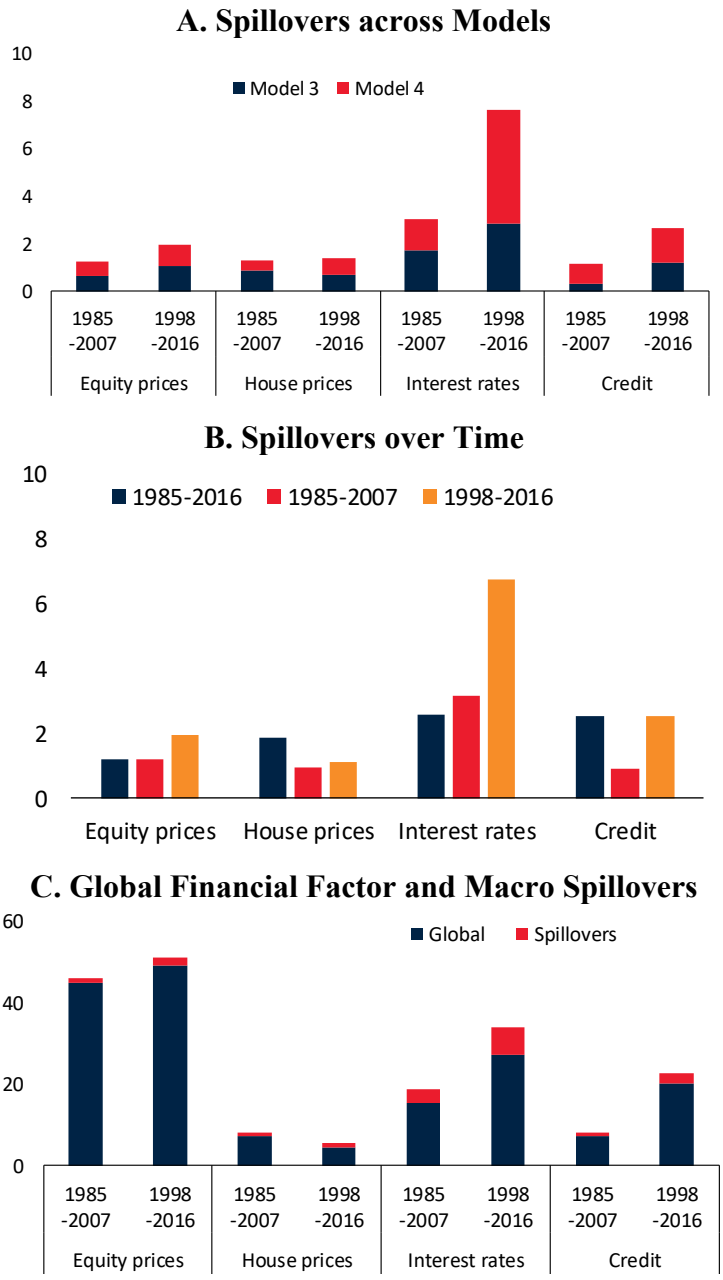
Notes: These figures show 15-year rolling estimations of variance decompositions for the global macro factor ("global") and spillovers from financial factors (equity prices, house prices, interest rates, and credit) to fluctuations in macro variables ("spillovers"). The results are based on the combined Model 1 and 2, which captures spillovers to the global macro factor (Model 1) and to country-specific macro factor (Model 2) through which the financial factor affects macro activity. Year refers to the end of rolling windows (e.g., for 2002, data over 1988-2002 are used).

Figure 7. Variance Decompositions: From Financial Sector to Macroeconomy (Model 1&2; Output; Country-Specific; 1998-2016)



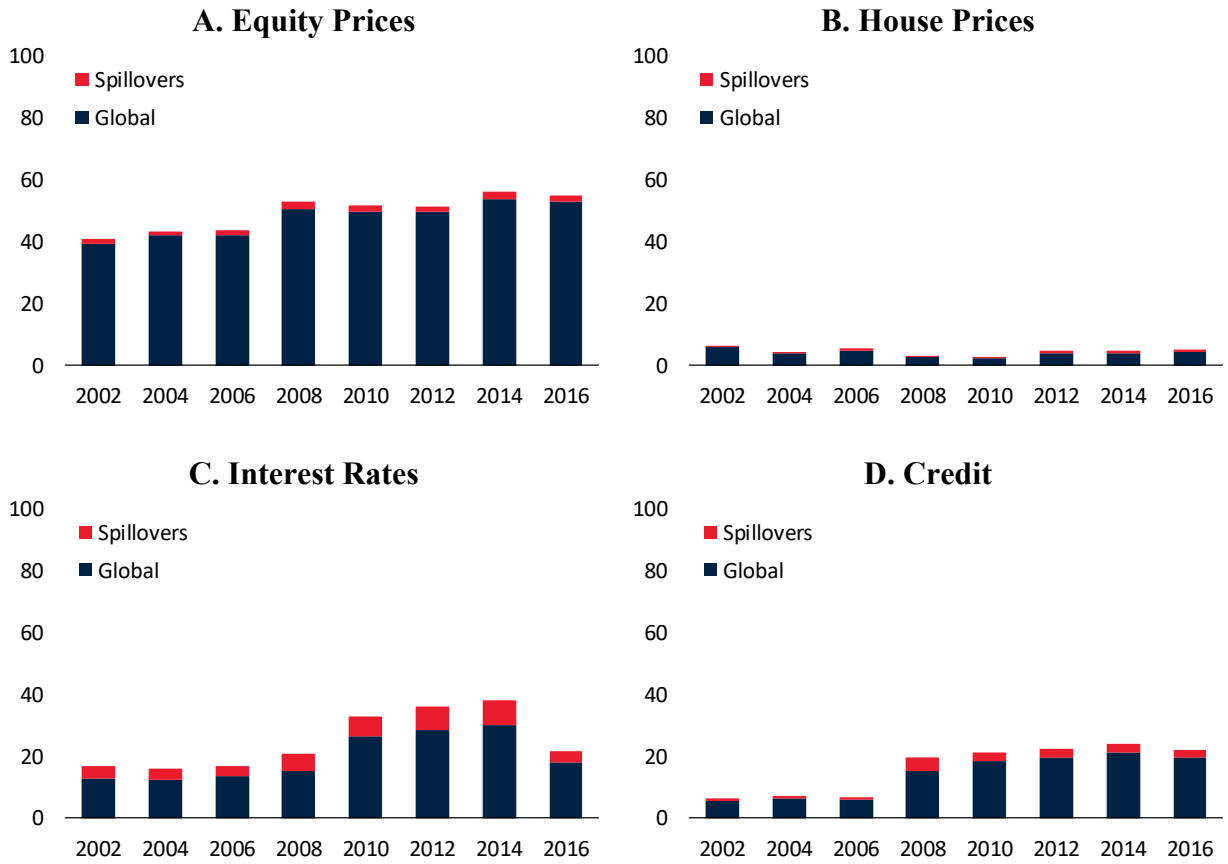
Notes: These figures show the variance decompositions for the global macro factor ("global") and spillovers from financial factors (equity prices, house prices, interest rates, and credit) to fluctuations in macro variables ("spillovers"). The results are based on the combined Model 1 and 2, which captures spillovers to the global macro factor (Model 1) and to country-specific macro factor (Model 2) through which the financial factor affects macro activity.

Figure 8. Variance Decompositions: From Macroeconomy to Financial Sector (Model 3 and 4; G-7 Averages)



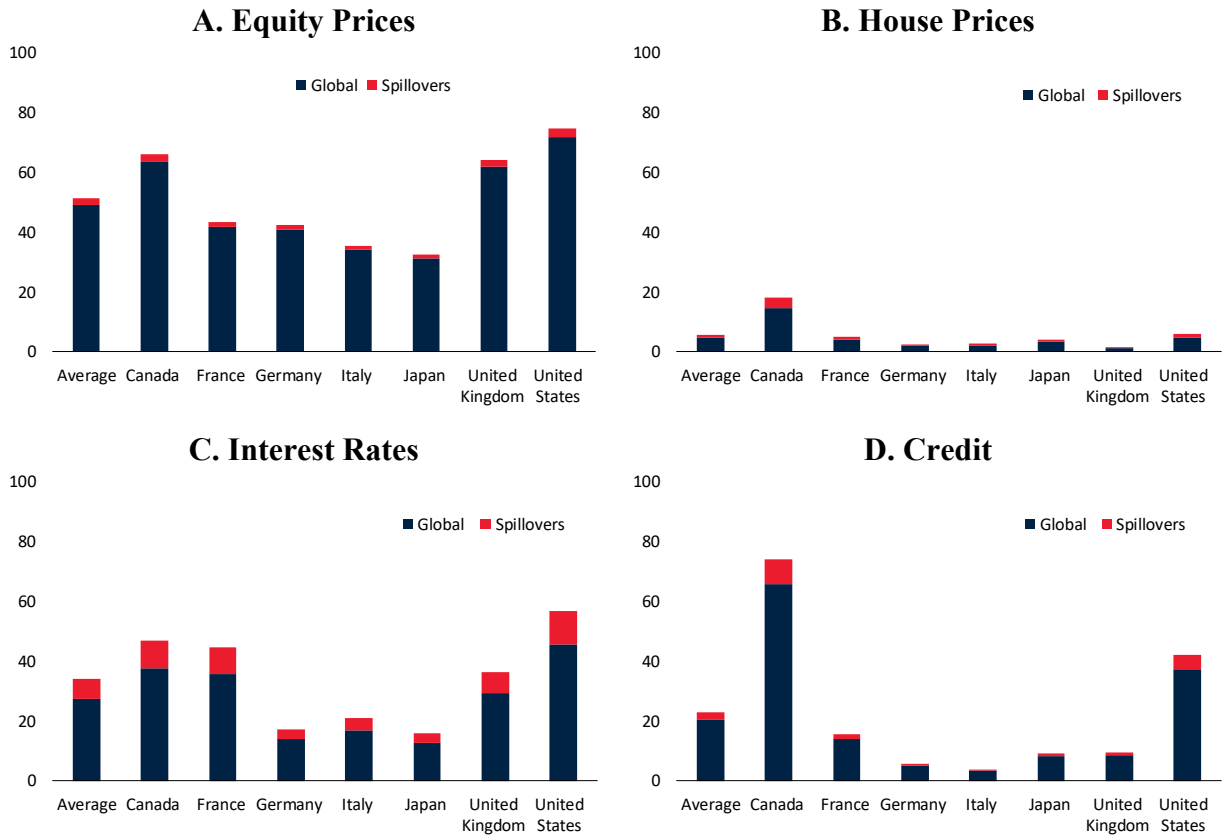
Notes: Panel A shows spillovers from macroeconomic aggregates to financial factors through the global macro factor and U.S. country factor. In Model 3, the global macro factor spills over to the financial factor. In Model 4, the U.S. country factor spills over to the financial factor. Panel B shows spillovers from macroeconomic aggregates to financial factors, based on the combined Model 3 and 4, which captures spillovers from the global macro factor (Model 3) and and from the U.S. country factor (Model 4) through which the financial sector is affected. Panel C shows the variance decompositions for the global financial factor ("global") and spillovers from macro to financial factors ("spillovers") based on the combined Model 3 and 4.

Figure 9. Variance Decompositions: From Macroeconomy to Financial Sector (Rolling Estimation; Model 3&4; G-7 Averages; 1985-2016)



Notes: These figures show 15-year rolling estimations of variance decompositions for the global financial factor ("global") and spillovers from macroeconomic aggregates to financial factors (equity prices, house prices, interest rates, and credit). The results are based on the combined Model 3 and 4, which captures spillovers from the global macro factor (Model 3) and and from the U.S. country factor (Model 4) through which the financial sector is affected. Year refers to the end of rolling windows (e.g., for 2002, data over 1988-2002 are used).

Figure 10. Variance Decompositions: From Macroeconomy to Financial Sector (Model 3& 4; Country-Specific; 1998-2016)



Notes: These figures show the variance decompositions for the global financial factor ("global") and spillovers from macro to financial factors ("spillovers"). The results are based on the combined Model 3 and 4, which captures spillovers from the global macro factor (Model 3) and from the U.S. country factor (Model 4) through which the financial sector is affected.

APPENDIX

Global Macro-Financial Cycles and Spillovers

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October 2017

This appendix contains:

Table A1. Database

Variable	Definition	Source	Transformation
Output	Real GDP	Haver Analytics	Growth (in percent)
Consumption	Real private consumption	Haver Analytics	Growth (in percent)
Investment	Real gross fixed capital formation	Haver Analytics	Growth (in percent)
Equity Prices	Equity price index	Haver Analytics	Growth (in percent)
Housing Prices	Real housing price index	OECD	Growth (in percent)
Interest Rates	3-month treasury bill yields	Federal Reserve Economic Data, OECD	Difference (in percentage points)
Credit	Domestic credit	Federal Reserve Economic Data, Haver Analytics	Growth (in percent)

Notes: Data series cover the 1985-2016 period. Macroeconomic aggregates and financial variables are all seasonally adjusted. Financial variables are deflated by the CPI of each country. We use growth rates of all variables (except interest rates) and, following Stock and Watson (2012), remove low-frequency movements using the Local Mean method.

Table A2. Factor Loadings
(Model 1&2; 1998-2016)

	Factor	Output	Consumption	Investment	Equity Prices	House Prices	Interest Rates	Credit
Canada	**Global Macro Factor**	0.44	0.29	1.63				
	Country-Specific Factor	0.21	0.08	0.35				
	Financial Factor				0.84	0.18	0.37	0.40
	Constant	-0.03	-0.02	-0.15	0.63	0.04	0.04	0.08
France	**Global Macro Factor**	0.40	0.11	0.73				
	Country-Specific Factor	0.32	0.51	0.32				
	Financial Factor				1.24	0.27	0.56	0.27
	Constant	0.01	0.04	0.02	1.26	0.09	0.01	0.07
Germany	**Global Macro Factor**	0.77	-0.01	1.26				
	Country-Specific Factor	0.34	0.22	1.07				
	Financial Factor				1.44	0.02	0.30	0.13
	Constant	-0.04	0.00	-0.08	1.33	0.01	0.00	0.07
Italy	**Global Macro Factor**	0.58	0.11	0.76				
	Country-Specific Factor	0.33	0.50	1.01				
	Financial Factor				1.19	0.56	0.54	0.11
	Constant	-0.09	-0.08	-0.22	1.15	0.07	0.01	0.05
Japan	**Global Macro Factor**	0.73	0.22	0.85				
	Country-Specific Factor	0.58	0.66	0.54				
	Financial Factor				0.79	-0.18	0.06	0.14
	Constant	-0.12	-0.09	-0.17	0.34	0.01	0.00	0.04
United Kingdom	**Global Macro Factor**	0.33	0.12	1.25				
	Country-Specific Factor	0.33	0.42	0.50				
	Financial Factor				0.78	0.21	0.60	0.41
	Constant	0.02	0.04	-0.06	0.87	0.17	0.01	0.24
United States	**Global Macro Factor**	0.31	0.16	0.78				
	Country-Specific Factor	0.57	0.44	1.54				
	Financial Factor				0.78	0.59	0.26	0.73
	Constant	0.03	0.04	0.08	0.69	0.13	0.02	0.15

Notes: This table shows posterior medians of factor loadings based on the combined Model 1 and 2, which captures spillovers to the global macro factor (Model 1) and to country-specific macro factor (Model 2) through which the financial factor affects macro activity.

Table A3. Factor Vector-autoregressive Coefficients (1998-2016)

A. Global Macro and Country-Specific Factors (Model 1&2)

			Financial Factor			
	Lags	Own Factor	Equity Prices	House Prices	Interest Rates	Credit
Global Macro Factor	**1**	0.65	0.05	0.15	0.38	-0.09
	2	-0.21	-0.01	0.12	-0.39	0.16
	3	-0.01	0.02	-0.05	0.04	-0.06
Country-Specific Factor						
Canada	**1**	0.17	0.01	-0.02	0.06	-0.03
	2	-0.08	0.00	0.03	-0.07	0.01
	3	-0.01	0.00	0.00	-0.01	0.00
France	**1**	0.01	0.02	0.10	0.08	0.03
	2	0.05	-0.01	0.00	-0.06	0.01
	3	0.01	0.02	-0.02	0.00	-0.01
Germany	**1**	-0.05	0.00	-0.10	0.26	-0.06
	2	0.11	0.01	-0.03	-0.03	0.05
	3	0.04	0.01	0.04	0.01	0.05
Italy	**1**	0.65	0.00	0.08	0.04	0.01
	2	0.02	0.02	-0.06	-0.02	0.01
	3	0.04	-0.01	0.04	-0.03	0.04
Japan	**1**	-0.12	0.00	0.07	-0.01	-0.01
	2	-0.13	-0.01	-0.06	-0.17	0.03
	3	-0.01	-0.01	0.00	0.01	-0.05
United Kingdom	**1**	0.98	0.00	0.16	-0.08	-0.01
	2	-0.23	0.01	-0.03	0.10	-0.02
	3	-0.03	0.00	-0.01	0.01	-0.03
United States	**1**	0.43	0.01	0.03	-0.02	-0.02
	2	0.14	0.00	0.07	-0.07	0.01
	3	0.04	-0.01	-0.04	-0.01	-0.03

B. Financial Factors (Model 3&4)

	Lags	Own Factor	Global Macro Factor	U.S. Country Factor
Financial Factor				
Equity Prices	**1**	0.42	0.03	0.64
	2	-0.09	-0.14	0.11
	3	-0.01	-0.02	0.01
House Prices	**1**	0.58	0.04	0.01
	2	0.07	-0.03	-0.02
	3	0.04	-0.01	0.00
Interest Rates	**1**	0.65	0.03	0.17
	2	-0.12	0.05	-0.07
	3	0.04	-0.06	0.04
Credit	**1**	0.41	-0.10	0.25
	2	-0.22	0.16	0.12
	3	0.10	0.03	0.00

Notes: This table shows factor VAR coefficients (posterior medians) for the global macro factor and country-specific factors, based on the results of the combined Models 1 and 2 (in Panel A). The corresponding coefficients for financial factors are based on the results of the combined Model 3 and 4 (in Panel B). Combined Model 1 and 2 captures spillovers to the global macro factor (Model 1) and to country-specific macro factor (Model 2) through which the financial factor affects macro activity. Combined Model 3 and 4, which captures spillovers from the global macro factor (Model 3) and from the U.S. country factor (Model 4) through which the financial sector is affected.

Table A4. Variance Decompositions for G-7 Countries
(Model 1&2 and Model 3&4; Country-Specific; 1998-2016)

A. Canada

	Output				Consumption				Investment				Financial		
	W	C	SF	I	W	C	SF	I	W	C	SF	I	SR	F	I
	Model 1&2														
Equity prices	31.6	8.8	11.5	48.0	25.4	7.7	9.3	57.6	44.7	6.8	15.9	32.6		59.8	40.2
House prices	36.8	8.3	8.3	46.7	29.6	7.9	6.8	55.7	49.9	6.5	10.8	32.8		4.6	95.4
Interest rates	36.4	8.9	5.0	49.6	30.3	5.8	4.1	59.8	51.7	9.9	7.0	31.5		33.7	66.3
Credit	42.0	7.2	4.0	46.8	34.2	6.8	3.4	55.6	57.6	7.2	5.4	29.8		72.0	28.0
	Model 3&4														
Equity prices	40.8	8.9		50.3	32.6	6.9		60.4	58.5	9.3		32.2	2.5	63.4	34.1
House prices	41.6	8.4		50.0	33.5	7.8		58.7	59.2	8.1		32.7	3.5	14.5	82.0
Interest rates	41.4	7.6		51.0	33.3	7.8		58.9	59.5	8.1		32.4	9.2	37.6	53.2
Credit	41.1	9.3		49.6	33.1	7.3		59.6	58.3	9.3		32.3	8.0	65.7	26.2

B. France

	Output				Consumption				Investment				Financial		
	W	C	SF	I	W	C	SF	I	W	C	SF	I	SR	F	I
	Model 1&2														
Equity prices	48.2	17.6	19.0	15.3	4.9	40.7	7.0	47.4	33.9	5.3	12.4	48.3		54.4	45.6
House prices	56.6	16.2	13.0	14.1	7.1	39.3	4.7	48.9	41.9	4.8	9.2	44.2		6.6	93.4
Interest rates	54.7	21.9	8.1	15.3	4.9	45.3	3.2	46.6	40.1	7.4	5.5	47.0		73.3	26.7
Credit	59.0	21.6	6.1	13.2	6.3	42.6	3.3	47.8	44.9	8.1	4.1	42.9		17.8	82.2
	Model 3&4														
Equity prices	57.9	28.3		13.8	4.8	48.8		46.4	43.4	11.2		45.4	1.7	41.8	56.6
House prices	38.3	53.7		8.0	3.2	68.2		28.5	37.6	28.4		34.0	1.1	4.0	94.9
Interest rates	59.2	27.1		13.7	5.1	48.3		46.6	44.5	10.5		45.0	8.8	35.7	55.6
Credit	60.4	25.7		13.9	5.6	46.5		47.9	44.5	10.1		45.4	1.8	13.8	84.4

C. Germany

	Output				Consumption				Investment				Financial		
	W	C	SF	I	W	C	SF	I	W	C	SF	I	SR	F	I
	Model 1&2														
Equity prices	52.6	14.7	18.9	13.8	0.8	22.5	1.8	74.9	26.2	26.3	10.8	36.7		55.3	44.7
House prices	57.3	15.8	12.6	14.2	0.9	19.4	1.2	78.4	28.1	28.2	7.4	36.3		1.9	98.1
Interest rates	61.4	15.4	8.5	14.8	0.9	20.7	1.3	77.1	30.0	26.3	5.3	38.4		24.4	75.6
Credit	64.0	16.1	6.3	13.6	1.2	20.9	1.5	76.4	31.6	28.4	4.5	35.5		6.6	93.4
	Model 3&4														
Equity prices	66.8	17.6		15.6	1.1	22.3		76.6	31.3	29.4		39.4	1.6	40.8	57.6
House prices	67.1	17.5		15.4	1.0	19.4		79.5	31.5	29.9		38.6	0.4	2.2	97.5
Interest rates	67.6	16.8		15.6	1.1	21.9		77.0	31.9	29.5		38.6	3.5	13.8	82.7
Credit	67.0	17.3		15.7	1.1	20.9		78.0	31.5	30.1		38.4	0.6	5.0	94.4

D. Italy

	Output				Consumption				Investment				Financial		
	W	C	SF	I	W	C	SF	I	W	C	SF	I	SR	F	I
	Model 1&2														
Equity prices	46.9	18.4	17.4	17.2	4.3	61.4	6.4	27.9	16.5	31.4	8.1	44.0		43.7	56.3
House prices	54.5	14.9	12.9	17.7	6.7	57.4	7.5	28.3	21.1	27.4	7.5	44.0		40.6	59.4
Interest rates	56.1	18.4	8.1	17.4	5.6	61.8	4.2	28.4	20.2	31.1	4.4	44.4		26.6	73.4
Credit	60.3	16.7	6.2	16.8	7.4	58.0	5.4	29.2	23.2	29.3	4.3	43.1		4.3	95.7
	Model 3&4														
Equity prices	61.8	19.7		18.5	6.8	63.1		30.1	22.2	31.9		45.9	1.4	33.9	64.8
House prices	60.1	22.2		17.7	6.3	65.1		43.1	21.7	35.6		42.7	0.6	2.1	97.3
Interest rates	61.8	20.1		18.1	6.5	63.8		29.7	22.0	33.3		44.7	4.2	16.9	78.9
Credit	62.0	19.2		18.7	6.8	62.8		30.3	22.4	31.7		45.9	0.4	3.2	96.3

E. Japan

	Output				Consumption				Investment				Financial		
	W	C	SF	I	W	C	SF	I	W	C	SF	I	SR	F	I
	Model 1&2														
Equity prices	28.8	35.5	11.8	23.9	4.2	61.3	4.8	29.6	17.5	13.8	6.7	62.0		34.8	65.2
House prices	32.1	35.7	8.1	24.2	4.9	62.2	3.3	29.6	20.3	13.8	4.8	61.1		6.2	93.8
Interest rates	34.7	36.3	5.4	23.6	5.4	63.7	2.5	28.4	21.4	13.8	3.1	61.7		16.8	83.2
Credit	37.5	34.3	4.6	23.6	6.0	61.5	3.4	29.1	23.7	13.6	2.6	60.2		12.4	87.6
	Model 3&4														
Equity prices	37.5	37.5		25.1	5.6	65.1		29.3	22.8	13.9		63.4	1.3	31.1	67.6
House prices	39.0	36.4		24.6	6.0	64.4		43.1	24.1	13.7		62.2	0.8	3.4	95.8
Interest rates	38.6	36.8		24.6	6.2	63.1		30.7	23.8	13.7		62.5	3.2	12.8	84.0
Credit	37.6	37.7		24.8	5.8	63.9		30.4	23.1	14.0		62.9	1.0	8.1	90.9

F. United Kingdom

	Output				Consumption				Investment				Financial		
	W	C	SF	I	W	C	SF	I	W	C	SF	I	SR	F	I
	Model 1&2														
Equity prices	22.0	43.1	10.5	24.4	3.3	43.7	4.2	48.8	12.7	5.1	4.7	77.5		77.2	22.8
House prices	32.9	33.4	11.6	22.1	8.0	34.2	6.6	51.3	16.3	3.5	4.0	76.2		2.8	97.2
Interest rates	27.2	42.0	5.9	24.8	4.4	42.3	3.1	50.2	14.9	4.9	2.2	77.9		59.6	40.4
Credit	34.2	36.6	5.8	23.5	6.7	41.1	4.0	48.2	18.8	4.0	1.9	75.4		13.5	86.5
	Model 3&4														
Equity prices	31.1	42.9		26.0	4.9	45.1		50.0	16.9	4.6		78.5	2.4	61.7	35.9
House prices	29.7	47.4		22.9	4.8	50.8		43.1	17.8	5.3		77.0	0.3	1.1	98.7
Interest rates	31.0	42.5		26.5	4.6	45.6		49.8	16.9	4.7		78.5	7.2	29.1	63.8
Credit	32.0	42.1		25.9	5.7	43.7		50.7	17.4	4.5		78.1	1.1	8.4	90.5

G. United States

	Output				Consumption				Investment				Financial		
	W	C	SF	I	W	C	SF	I	W	C	SF	I	SR	F	I
	Model 1&2														
Equity prices	18.1	40.3	9.1	32.5	9.4	41.5	6.1	43.0	19.0	46.9	9.8	24.3		78.3	21.7
House prices	24.4	36.4	8.8	30.4	15.2	34.7	6.8	43.4	25.8	40.4	9.4	24.3		23.1	76.9
Interest rates	20.1	41.3	6.2	32.4	10.4	43.5	5.2	40.9	19.7	51.3	6.9	22.0		45.5	54.5
Credit	28.0	36.3	5.0	30.7	16.3	38.8	4.3	40.6	29.2	42.2	5.6	23.0		40.0	60.0
	Model 3&4														
Equity prices	24.6	41.4		34.0	13.1	43.9		43.0	25.4	49.4		25.2	2.8	71.7	25.5
House prices	24.7	41.6		33.6	12.6	47.8		39.6	25.5	50.2		24.3	1.2	4.8	94.0
Interest rates	25.5	40.0		34.5	13.8	43.5		42.6	26.3	49.4		24.3	11.1	45.7	43.2
Credit	26.6	40.0		33.4	15.2	42.2		42.6	28.1	46.8		25.1	4.7	37.3	57.9

Notes: In each cell, the variance share attributable to the relevant factor at a horizon of 30th quarter is reported. The variance contributions are attributed to: W (global macro factor), C (country-specific macro factor), SF (spillovers from financial to macro factors), SR (spillover from global financial factor), F (global financial factor), and I (idiosyncratic factor). Combined Model 1 and 2 captures spillovers to the global macro factor (Model 1) and to country-specific macro factor (Model 2) through which the financial factor affects macro activity. Combined Model 3 and 4, which captures spillovers from the global macro factor (Model 3) and from the U.S. country factor (Model 4) through which the financial sector is affected.