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Asset Price Shocks, Real Expenditures, and Financial Structure: A Multi-Country Analysis

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Abstract

This paper examines the responses of private consumption, residential investment, and business investment in 11 EU countries, Japan, and the United States to shocks in housing and equity prices. The effects are assessed with a Structural Vector Auto Regressive (SVAR) model, and four key findings emerge. First, the impacts of asset price shocks are heterogeneous across countries. Second, these heterogeneous responses are systematically related to cross-country variation in financial structure. We are thus able to document the importance of a wealth/balance sheet channel for private consumption and residential investment and an equity finance channel for business investment. Third, for a given country, housing shocks have a much greater impact than equity shocks. Fourth, variance decompositions indicate that monetary policy reacts to equity price shocks but not to housing price shocks. These results highlight the important role played by asset prices on real activity and fuel the debate about the inclusion of asset prices in the formulation of monetary policy.

JEL Code: E44, E52, E2.

Keywords: monetary policy, asset prices, structural VAR.

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Thus, understanding how monetary policy affects the broader economy necessarily entails understanding both how policy actions affect key financial markets, as well as how changes in asset prices and returns in these markets in turn affect the behavior of households, firms, and other decision makers.

Ben Bernanke (2003)

As societies accumulate wealth, asset prices will have a growing influence on economic developments. The problem of how to design monetary policy under such circumstances is probably the biggest challenge for central banks in our times.

Otmar Issing (2004)

1. Introduction

Popular accounts suggest that asset prices have played a prominent role in recent macroeconomic fluctuations. According to some commentators, the run-up in equity prices in Japan, Sweden, the United Kingdom, and the United States fuelled rapid growth. The subsequent sharp declines in equity prices in Japan and the United States have been linked by *The Economist* (1994 and 2004, respectively) to the subsequent recessions, though this view has some prominent dissenters (Malkiel, 1996; Porter, 1992). The so-called sub-prime mortgage loans crisis in the United States is the most recent example: "[t]he housing market is going into a deeper chill, and consumers are starting to shiver" (*Wall Street Journal*, 2007).

While these casual observations are provocative, economic theory indicates that asset prices impact real activity through several channels that, on balance, have ambiguous effects. In this study, we confine ourselves to considering housing and equity prices and their impacts on household-related real expenditures -- private consumption and residential investment -- and on business non-residential investment. Three channels are examined. Asset prices are directly linked to household expenditures by a *wealth channel* according to the life-cycle/permanent income model. However, there are a number of reasons why the response of household expenditures to variations in wealth may differ by asset.[1] Given the volatility of asset prices, households may have difficulty separating temporary from permanent changes. If asset price movements are viewed as largely temporary, then the impact on household expenditures will be minimal. The degree of recognition of wealth

[1] This list of factors is drawn from Case, Quigley and Shiller (2005, Section II).

changes may differ by asset because financial portfolios are priced daily while housing assets are traded and hence valued infrequently. Moreover, some assets such as housing provide both wealth and a service flow. Tax laws impact the ultimately realizable change in wealth and may differ by asset and across countries. If wealth directly enters the utility function and is a sufficiently strong substitute for household expenditures, then increases in wealth may lead rational consumers to lower consumption and raise leisure. The assumption of a rationally calculating consumer may not be appropriate with regard to asset prices and the emotions that are created by price movements. With behavioral heuristics such as "mental accounts," certain assets are viewed as vehicles for retirement saving or other long-term goals, and changes in their value may have little effect on current household expenditures. In sum, the wealth channel may be small, perhaps negative, and likely differs between housing and equity assets.

Recent work on finance constraints faced by households and firms links asset prices to spending patterns via a *balance sheet channel*.[2] This literature highlights the critical role played by asymmetric information in capital markets that disrupts the financial flows supporting expenditures by households and investment by firms. A key element is that a wedge exists between the costs of external and internal finance that is sensitive to the ability of lenders to recover funds in the case of bankruptcy. Hence, a critical role exists for collateral in particular and financial structure in general. Increases in the value of collateral due to increases in housing and equity values may lower the financing wedge and stimulate consumption, residential investment, and business investment spending.[3]

Rising equity prices that lower the cost of equity to firms may create an *equity finance channel*. Whether managers truly believe that the cost of equity has fallen depends on the relation between the current stock price and the fundamental stock price that managers presumably are in a better position to evaluate than outside investors. A misvaluation perceived by managers is the basis for this third channel.

[2] Regarding the voluminous finance constraints literature, see Carroll (2001) on private consumption and Hubbard (1998) on business investment.

[3] This version of the balance sheet channel is likely to be more important for households, though it will also affect firms insofar as they hold equity assets of other companies. Such cross-shareholdings are important in Japan and several Western European countries (see Barca and Becht, 2001).

However, as noted by Blanchard, Rhee and Summers (1993) and Stein (1996), the existence of cheap equity does not necessarily imply that firms will increase investment in physical capital. Rather, managers may sell overvalued equity and invest the proceeds in financial capital such as cash and marketable securities. Thus an equity finance channel may be operative but may have no effect on business investment spending.

The wealth, balance sheet, and equity finance channels suggest that the impact of asset prices on real activity are ambiguous. This ambiguity is also found in structural macroeconometric models, such as the "EUROMON" model developed at the De Nederlandsche Bank (2000). Simulation experiments show that business investment in fixed assets can be negatively affected by asset price increases. The shock to aggregate demand and inflation triggers monetary tightening following a Taylor rule. Consequently, after a permanent house or equity price increase, business investment tends to drop below the baseline. Private consumption, on the other hand, generally seems to benefit from asset price booms. This different pattern for investment and consumption naturally is related to modeling assumptions: an equity channel is absent in the investment equation, while a wealth channel is present in the consumption equation. Whether policymakers should be concerned about asset prices thus remains uncertain. An additional complication is that the strength of several of these channels may depend on country specific financial structure variables such as homeownership and stock market participation.

This paper examines the response of 13 highly industrialized economies to shocks to housing and equity prices. The examination of asset price effects is still at a relatively early stage in the literature, and hence there is little consensus on a detailed structural model.[4] Consequently, we estimate vector autoregressive (VAR) models that allow us to impose a relatively limited amount of structure in order to characterize the responses in the aggregate data and relate them to cross-country variation in financial structure.

Section 2 begins with a discussion of our dataset and the variables in the VAR. We use quarterly data for 13 countries -- Austria, Belgium, Denmark, Finland, France, Germany, Italy, Japan, the Netherlands, Spain, Sweden, the United Kingdom,

[4] Examples of non-structural approaches are Ludvigson, Steindel, and Lettau (2002) on the wealth effects in the United States, Iacoviello (2000) on housing price effects in Europe, and Giuliodori (2005) and Otrok and Terrones (2006) on housing price effects in industrialized countries.

and the United States -- for the period, 1979:4 to 1998:4. This period covers the two decades of the European Exchange Rate Mechanism (ERM), and thus allows us to avoid major structural breaks due to changes in the exchange rate system. The panel database includes several variables describing country-specific economic and financial characteristics. We include four variables used frequently to describe open economies -- real domestic expenditure, an aggregate price index, an exchange rate, and the three-month money market rate, the latter an indicator of monetary policy.[5] Bank credit captures credit channel effects, and the roles of asset prices are captured by the nominal asset values for houses and equities. In addition to these seven endogenous variables, we include (selectively among countries) several exogenous variables.

Section 3 reexamines the role of asset price shocks in a structural vector autoregression (SVAR) model. In order to isolate the effects of hypothetical shocks, we need to impose some structure on the contemporaneous relations among the shocks. A Choleski decomposition is not appropriate because we wish to allow monetary policy to affect and be affected by asset prices. The assumptions that underlie our identification of the contemporaneous structural shocks are discussed in this section.

Section 4 examines the effects of asset prices on real expenditures -- consumption, residential investment, and business investment. Based on cumulative impulse responses over 12 quarters (CIR_3's), we find that the response to asset price shocks is heterogeneous across countries and that housing price shocks have larger effects on real variables than equity price shocks.

Section 5 exploits this heterogeneity to obtain a better understanding of the wealth, balance sheet, and equity finance channels by studying the relation between the cumulative impulse responses of the three components of real expenditures and institutional characteristics that vary very little in the time dimension and measure a country's exposure to asset price movements. We document that the house price sensitivity of consumption (though not residential investment) is stronger in countries where home ownership is high, that the equity price sensitivity of consumption and residential investment is stronger in countries where the stock market is important,

[5] At its inception, the VAR literature followed the basic IS-LM modeling framework, and hence included the above mentioned four endogenous variables (for an overview, see Christiano, Eichenbaum and Evans, 1999).

and that the equity price sensitivity of business investment is stronger in countries where firms are more dependent on equity finance.

Section 6 uses the structural VAR to determine the extent to which policymakers are concerned about asset prices. We find little evidence that housing prices affect monetary policy. However, in about half of the countries, monetary policymakers appear to have responded to equity prices.

Section 7 summarizes and concludes.

2. Model Variables and Pre-testing

2.1. Model Variables

The empirical results in this paper are based on a SVAR analysis (to be discussed in Section 3) of 13 highly industrialized countries: Austria (AT), Belgium (BE), Denmark (DK), Finland (FI), France (FR), Germany (GE), Italy (IT), Japan (JP), Netherlands (NL), Spain (SP), Sweden (SW), the United Kingdom (UK), and the United States (US). Data definitions and sources are discussed in the Data Appendix. The quarterly data are for the period 1979:4 to 1998:4, which covers the two decades of the European Exchange Rate Mechanism (ERM) and thus allows us to avoid major structural breaks due to the introduction of the Euro.

Our SVAR contains seven endogenous and four exogenous variables. Five of the endogenous variables are used frequently in VAR studies to represent the aggregate economy. We include one particular component of domestic expenditure that is likely to be sensitive to asset prices -- private consumption (CONS), residential investment (INVT-R), or business investment (INVT-B). Prices are measured by the aggregate price index for consumption (PC). All of the economies in this study (save the United States) are heavily influenced by foreign trade, and we include a nominal effective exchange rate (EX) based on trade weights. Since the work of Bernanke and Blinder (1992), a short-term interest rate variable has been used frequently as an indicator of monetary policy and, in the present cross-country study, a three-month money market rate (RS) is available for all countries. Bank credit (CREDIT) is included to capture credit channel effects, possibly amplified by asset price movements (Borio and Lowe, 2004).

The role of asset prices is represented by two endogenous variables. The nominal values of privately owned houses (HOUSE) and equity (EQUITY) are

computed as the product of a price index and a stock variable. Stock variables are included to capture the trend behavior (though they have little effect in our differenced specification). Since the vast majority of the movements in the house and equity value series are determined by the price components, we refer to these asset value variables as asset prices.[6]

Four exogenous variables enter the VAR. A real world trade index (WT), a nominal commodity price index (PCOM), and the interest rate for the United States (RSUS) capture global influences on economic activity in the individual countries. The interest rate for Germany (RSGE) has a prominent effect on four countries in our sample. Owing to their substantial trade with Germany, four countries -- Austria, Belgium, Denmark, and the Netherlands -- pegged their exchange rates to that of Germany, and hence the German interest rate loomed large. For this group of four countries, we include both RSGE and RSUS as exogenous variables.[7]

2.2. Pre-testing

We begin by examining the order of integration and cointegration in our seven endogenous variables. All variables are in logs except for RS. As evaluated by ADF tests, most of these level series are I(1), although the first difference of the log of the price level is sometimes a borderline case. Based on these results, we then test for the number of cointegrating vectors. If we find that the rank is close to full, we could follow Sims, Stock, and Watson (1990) and estimate the model in log levels. However, both the trace and maximum eigenvalue tests indicate that the null hypothesis of a full rank is rejected at the 1% level.[8] These results lead us to enter the quarterly variables in the VAR in difference form. The vast majority of the difference series are I(0).

[6] We are assuming that the valuation of listed firms is a good proxy for the valuation of unlisted firms, as is confirmed by, for example, Kaplan and Ruback (1996).

[7] Kakes (2000) adopts a similar approach to modeling the effect of German interest rates.

[8] The results of Cheung and Lai (1993) indicate that, given our short sample, co-integration tests should be evaluated at the 1% level. The results of the ADF and cointegration tests are available upon request from the authors.

3. Model Specification

The primary goal of our study is to quantify the impacts of asset price shocks on real variables at a horizon of three years. We are interested in characterizing the response of real variables to asset price shocks rather than estimating structural parameters of preferences and technology, and thus a VAR modeling approach is appealing. Moreover, since we wish to allow asset prices to affect and be affected by monetary policy contemporaneously, the structural shocks can not be identified by a Choleski decomposition. These considerations lead us to adopt a Structural VAR (SVAR) modeling strategy.

The SVAR is estimated in an efficient maximum likelihood procedure that effectively depends on two steps. First, we estimate the following reduced form,

$$y_t = C(L)\, y_{t-1} + D(L)\, x_t + \varepsilon_t, \qquad (1)$$

where y_t is a k-vector of endogenous variables (k=7 in our model), x_t is an m-vector of exogenous variables (m=4), and C(L) and D(L) are polynomials in the lag operator, L. (Regarding the lag length, the likelihood function is very flat over different lag lengths, and hence selection statistics are not very useful. We choose a lag length of two as a compromise between the need to conserve degrees of freedom and the need to allow for rich dynamics.) The vector ε_t contains the reduced-form residuals or innovations and has a variance-covariance matrix $\Sigma = E[\varepsilon_t \varepsilon_t']$. To identify asset price shocks, we begin by assuming that the economy can be described by the following general structural model,

$$G(L)\, y_t = D(L)\, x_t + u_t, \qquad (2)$$

where u_t are the structural shocks that are serially uncorrelated and have an orthonormal variance-covariance matrix. These unobservable structural shocks are related to the observable reduced-form residuals by the following relation,

$$u_t, = G_0\, \varepsilon_{t.} \qquad (3)$$

where G_0 is the $(k \times k)$-matrix of coefficients multiplying y_t in (2) and this matrix is related to Σ as follows,

$$\Sigma = G_0^{-1} (G_0^{-1})'. \tag{4}$$

Estimation of G_0 with equation (4) and the coefficients in C(L) and D(L) in (1) allows us to relate structural shocks in asset prices (u_{HOUSE} and u_{EQUITY}) to real GDP and other endogenous variables.

In order to identify the shocks, we need to impose (k(k-1)/2) restrictions on the G_0 matrix of coefficients. These restrictions can be based on long-run considerations or contemporaneous effects. Since our primary interest is in medium-run impacts of asset price variables, we do not impose long-run restrictions in order to avoid potentially serious misspecification problems (Faust and Leeper, 1997). Instead, we specify the G_0 matrix based on the contemporaneous restrictions following from theoretical priors. We assume that the G_0 matrix takes the following form,

$$\begin{bmatrix} u_{EXP} \\ u_{PC} \\ u_{CREDIT} \\ u_{HOUSE} \\ u_{EQUITY} \\ u_{EX} \\ u_{RS} \end{bmatrix} = \begin{bmatrix} 1 & 0 & \alpha_{13} & 0 & 0 & 0 & 0 \\ 0 & 1 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 1 & \alpha_{34} & \alpha_{35} & 0 & \alpha_{37} \\ \alpha_{41} & 0 & \alpha_{43} & 1 & \alpha_{45} & 0 & \alpha_{47} \\ \alpha_{51} & 0 & \alpha_{53} & \alpha_{54} & 1 & \alpha_{56} & \alpha_{57} \\ 0 & 0 & 0 & 0 & \alpha_{65} & 1 & \alpha_{67} \\ \alpha_{71} & \alpha_{72} & \alpha_{73} & \alpha_{74} & \alpha_{75} & \alpha_{76} & 1 \end{bmatrix} \begin{bmatrix} \varepsilon_{EXP} \\ \varepsilon_{PC} \\ \varepsilon_{CREDIT} \\ \varepsilon_{HOUSE} \\ \varepsilon_{EQUITY} \\ \varepsilon_{EX} \\ \varepsilon_{RS} \end{bmatrix} \tag{5}$$

based on the following considerations. In this model, we assume that a component of expenditure (EXP) is largely predetermined and is affected contemporaneously only by the EXP innovation and, in light of the substantial evidence concerning finance constraints (Hubbard, 1998), by credit innovations,

$$u_{EXP} = \varepsilon_{EXP} + \alpha_{13} \varepsilon_{CREDIT}. \tag{5a}$$

Prices are assumed to respond sluggishly to all model variables and hence are only affected by the price shock,

$$u_{PC} = \varepsilon_{PC}. \tag{5b}$$

Regarding credit and asset prices, we allow for a full set of interactions among these three variables. Housing and equity assets serve as collateral that may allow households and firms to overcome asymmetric information problems and to obtain credit. Moreover, the availability of credit may serve to stimulate asset prices. We thus assume that asset prices and credit are affected by monetary policy. These considerations lead to the following specification of the credit shock,

$$u_{CREDIT} = \varepsilon_{CREDIT} + \alpha_{34}\,\varepsilon_{HOUSE} + \alpha_{35}\,\varepsilon_{EQUITY} + \alpha_{37}\,\varepsilon_{RS.} \quad (5c)$$

For the housing and equity shocks, we assume that each are affected by several shocks: EXP, credit, housing, equity, and monetary policy. In addition, exchange rates affect equity through short-term capital flows, while housing assets are assumed unaffected,

$$u_{HOUSE} = \alpha_{41}\,\varepsilon_{EXP} + \alpha_{43}\,\varepsilon_{CREDIT} + \varepsilon_{HOUSE} + \alpha_{45}\,\varepsilon_{EQUITY} + \alpha_{47}\,\varepsilon_{RS.} \quad (5d)$$

$$u_{EQUITY} = \alpha_{51}\,\varepsilon_{EXP} + \alpha_{53}\,\varepsilon_{CREDIT} + \alpha_{54}\,\varepsilon_{HOUSE} + \varepsilon_{EQUITY} + \alpha_{56}\,\varepsilon_{EX} + \alpha_{57}\,\varepsilon_{RS}. \quad (5e)$$

The exchange rate is determined by contemporaneous equity and interest rate innovations, as well as the exchange rate innovation. We assume that the effect of price shocks is transmitted to exchange rates through the interest rate, and hence there is no independent effect of price innovations,

$$u_{EX} = \alpha_{65}\,\varepsilon_{EQUITY} + \varepsilon_{EX} + \alpha_{67}\,\varepsilon_{RS}. \quad (5f)$$

The monetary authorities are in a position to respond quickly to all current information, and the interest rate shock responds to innovations in all endogenous model variables,

$$u_{RS} = \alpha_{71}\,\varepsilon_{EXP} + \alpha_{72}\,\varepsilon_{PC} + \alpha_{73}\,\varepsilon_{CREDIT} + \alpha_{74}\,\varepsilon_{HOUSE} + \alpha_{75}\,\varepsilon_{EQUITY} + \alpha_{76}\,\varepsilon_{EX} + \varepsilon_{RS}\,. \quad (5g)$$

For each country, we estimate the above specification with some adaptations to increase the quality of the model. The adaptations imply slight differences from

the G_0-matrix as presented in model (5): imposing more zero-restrictions on especially the parameters α_{13}, α_{37}, α_{41} and α_{47}. For evaluating the overall quality of the model we use the following criteria:

- convergence of the impulse responses to 0;
- well-behaved confidence bands (i.e., no increasing forecasting variance, 'fractals' or bubbles);
- plausibility of the signs of the Impulse-Response Functions;
- insignificance of the overidentification test (in those cases where the model uses more restrictions than the just-identified model above).

If these criteria can not be met easily, we re-estimate the model using another sample period. For instance, for the Netherlands, we only use the post-1982 data representing consistent exchange rate and wage moderation policies; for Finland, we omit the period affected by the banking crisis of 1990-1992.

4. Asset Price Shocks and Cumulative Responses

The standard approach to computing impulse responses (IRs) is to perturb the SVAR with a one standard deviation shock computed from the VAR innovations. However, this procedure precludes meaningful cross-country comparisons because the size of the shocks will differ across countries. Countries whose asset markets have been relatively turbulent will have larger one standard deviation shocks and, ceteris paribus, larger impulse responses. To avoid this historical happenstance, we replace the one standard deviation shocks with unit shocks that are equal across countries.[9]

Figures 1 and 2 present the cumulative quarterly impulse responses for a horizon of three years (CIR_3) of real consumption expenditure to unit shocks in housing and equity prices, respectively. We focus on CIR_3 because we need a summary measure of the impulse response function for our cross-country analysis in Section 5 and three years seems a reasonable measure of the medium run horizon of interest to policymakers (e.g., the inflation "fan charts" generated by the Bank of England). Consumption responds positively to housing price shocks in eight out of

[9] It is not possible though to transform the unit responses to elasticities.

FIGURE 1

Cumulative Impulse-Response of real consumption expenditure to standardized shock in house prices after 3 years

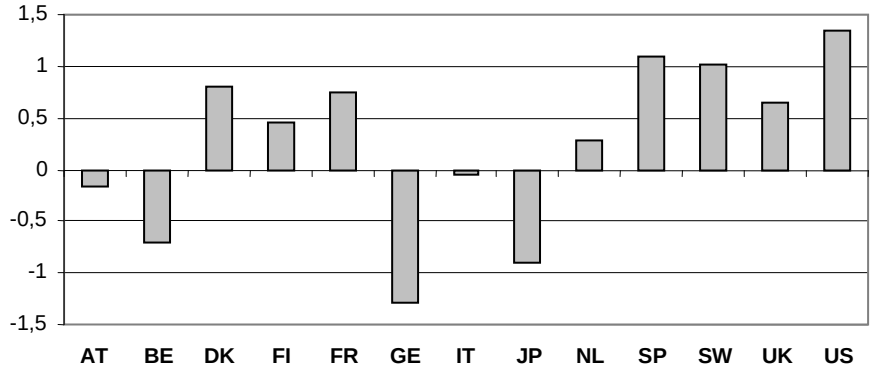
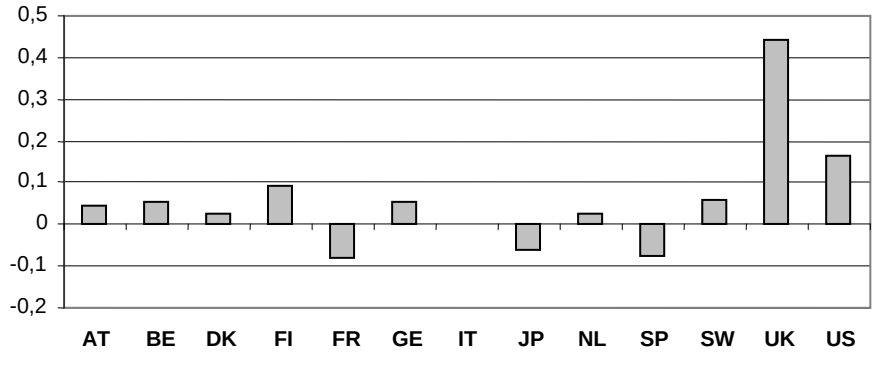


FIGURE 2

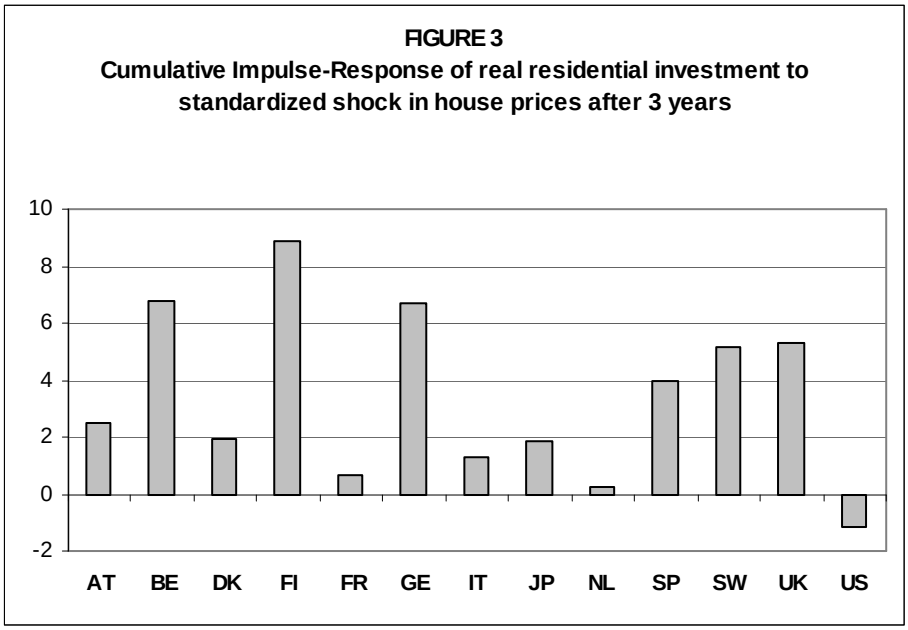
Cumulative Impulse-response of real consumption expenditure to standardized shock in equity prices after 3 years



thirteen countries (Figure 1) and positively to equity price shocks in nine out of thirteen countries (Figure 2, with the responses being most substantial for the UK and the US). Six countries are in both groups. The positive responses of consumption suggest the presence of wealth or balance sheet channels, a point that will be explored further in the cross-country analysis in Section 5. Moreover, as indicated by the scale of the vertical axes in Figures 1 and 2, consumption is much more sensitive to housing shocks than equity shocks. These results document heterogeneous responses across countries and across shocks.

Figure 3 presents the impact of a housing price shock on residential investment. Positive wealth effects for existing homeowners or the anticipation of future gains on both new and existing residential housing assets may raise residential investment. However, rising prices on the housing market may induce substitution away from residential investment. The net effect is ambiguous. We find that a housing price shock increases residential investment after three years in twelve out of the thirteen countries. The exception is the US, whose response is negative, though relatively small.

FIGURE 3
Cumulative Impulse-Response of real residential investment to standardized shock in house prices after 3 years



Figures 4 and 5 plot the CIR_3's for business investment with respect to housing and equity price shocks, respectively, and confirm the cross-country and cross-shock heterogeneity. Interestingly, house price shocks have a positive effect on investment in nine countries, presumably reflecting the effect of temporary demand stimulus. If equity cost or balance sheet channels are active, then we would expect equity shocks to stimulate investment spending. Figure 5 reports positive CIR_3's for eight of the 13 countries.

FIGURE 4
Cumulative Impulse-Response of real business investment to standardized shock in house prices

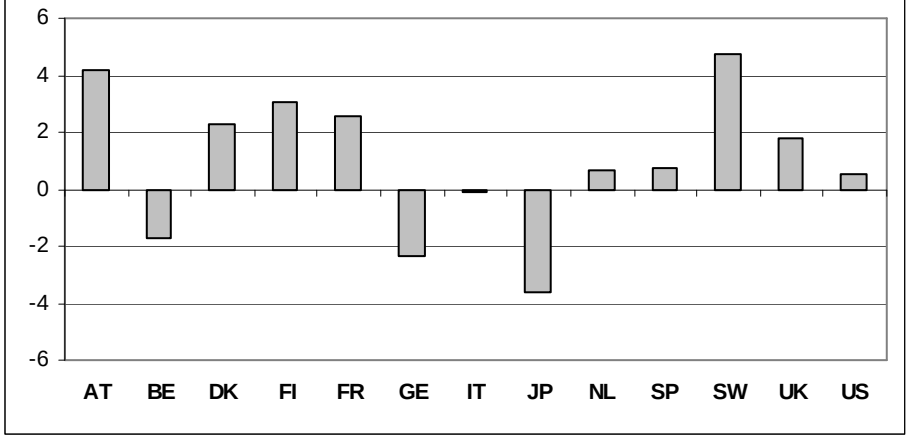
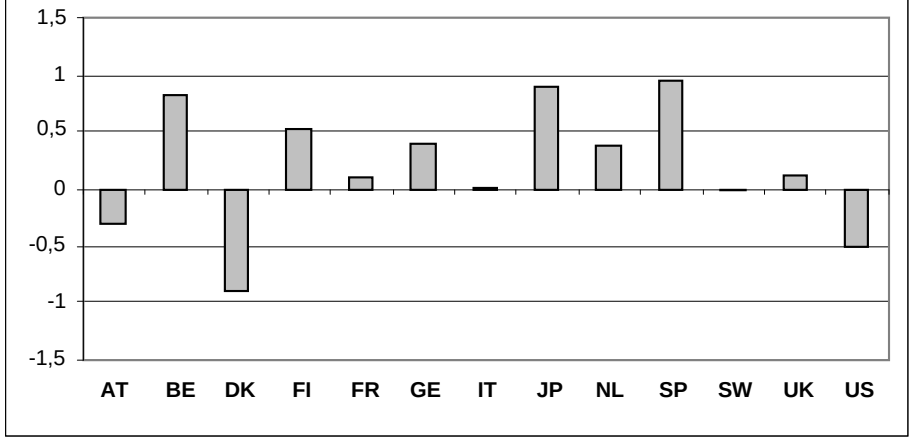


FIGURE 5
Cumulative Impulse-response of real business investment to standardized shock in equity prices



5. Cross-Country Patterns in Cumulative Responses

The above heterogeneity of the CIR_3's for private consumption, residential investment, and business investment may reflect underlying variation in important institutional characteristics. This section exploits this heterogeneity to obtain a better understanding of the wealth, balance sheet, and equity finance channels by examining the relation between the CIR_3's and institutional characteristics that vary very little in the time dimension and measure a country's exposure to asset price movements. (We also present results examining the impact of "noise" in the environment.) Given our small cross-sectional sample of 13 datapoints, it will be most useful to examine these relations with plots of the CIR_3's from Figures 1 to 5 against various institutional characteristics. Figures 6 to 13 present these plots, together with the OLS regression line, the correlation coefficient (r), and the associated p-value (*p*).[10]

Figure 6 analyzes the relation between the response of consumption spending to a house price shock and the percentage of homes that are owner occupied (OWNOCC), a proxy for the size of balance sheet or wealth effects. House price increases might stimulate consumption by strengthening balance sheets (hence relaxing finance constraints) or increasing wealth. This latter channel is believed to have raised economic growth in a number of economies at the end of the 1990s: "Thanks to low interest rates the price of assets, especially homes, has risen steeply, which has made households feel richer and encouraged them to spend" (*The Economist*, 2004). The relation is positive and statistically significant at conventional levels. This is an important result because home ownership varies widely among the 13 countries, from a minimum of 40% in Germany and Japan to 78% in Spain. This spread in homeownership implies substantially different responses to housing price shocks and supports the wealth/balance sheet channel for households.

Figure 7 repeats the above analysis for the CIR_3's associated with the response of residential investment to a housing price shock. Unlike consumption, the response of residential investment is unrelated to the extent of owner occupied housing, and there does not appear to be a wealth/balance sheet channel for residential investment with respect to housing prices. The latter's effect on residential investment may be

[10] It should be noted that the sample periods underlying the CIR_3's and the institutional characteristics do not perfectly coincide due to data limitations. However, since institutional characteristics are quite persistent over time, this data limitation should not hamper the analysis. The Data Appendix lists the sample periods defining the four institutional characteristic variables.

more due to anticipated future gains (perhaps ultimately unsustainable) leading to new owners crossing the extensive margin, rather than fundamental changes in wealth or balance sheets for existing homeowners.

Figure 6
Cumulative response of real consumption to unit house price shock, after 3 years: correlation with home ownership

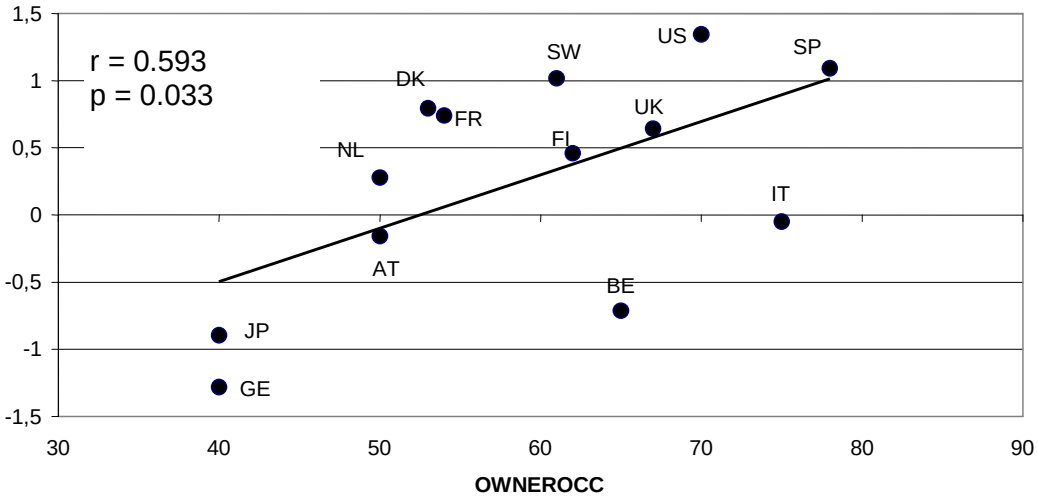
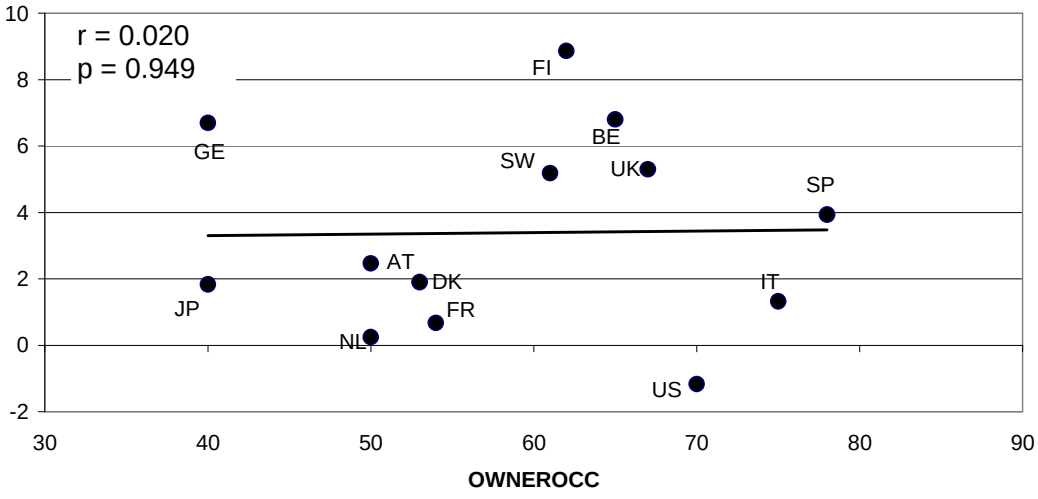


Figure 7
Cumulative response of real residential investment to unit house price shock, after 3 years: correlation with home ownership



Figures 8 and 9 examine the effects of mortgage-induced leverage on the strength of the housing price shock. For a given change in housing prices, the more indebted the household, the greater the impact on net worth, and presumably the greater the impact on spending. However, a leverage effect amplifying the wealth/balance sheet channel is not confirmed in our cross-country evidence, as the sensitivity of consumption (Figure 8) or residential investment (Figure 9) to the housing price shocks is not significantly related to the mortgage debt ratio (MORTGDEBT).

Figure 8
Cumulative response of real private consumption to unit house price shock, after 3 years: correlation with mortgage debt ratio

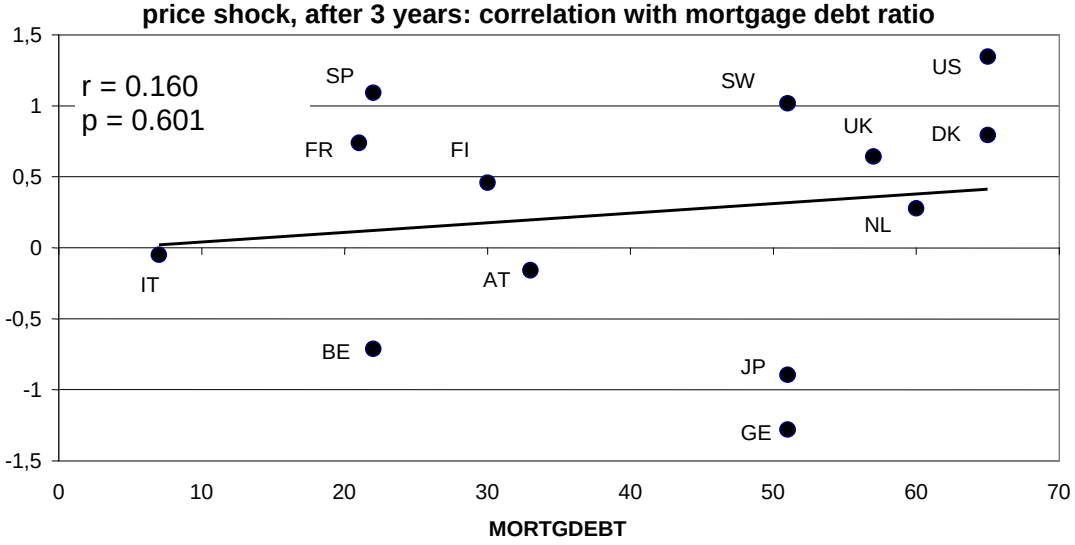
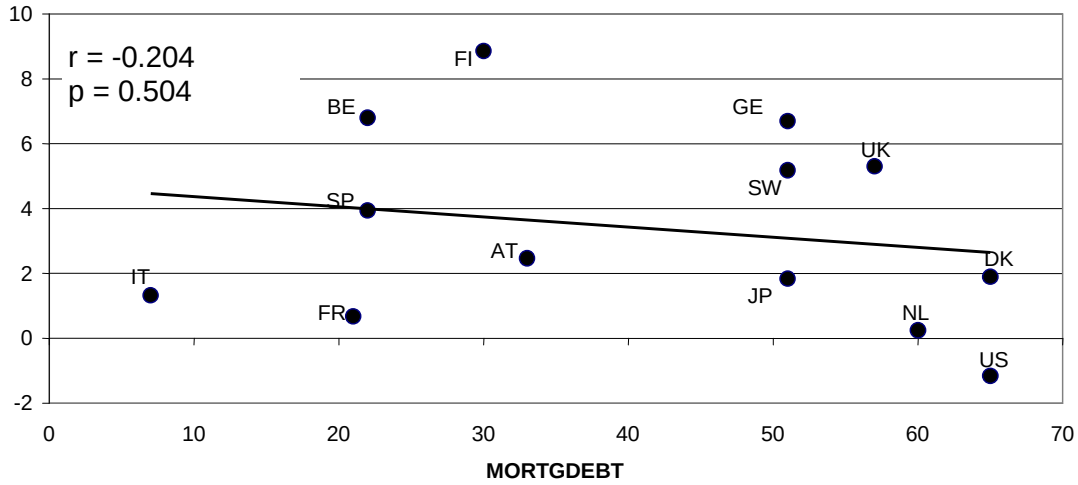


Figure 9
Cumulative response of real residential investment to unit house price shock, after 3 years: correlation with mortgage debt ratio



The remaining four figures focus on the equity shock. Figures 10 and 11 also test for the wealth/balance sheet channel for households with a proxy for the importance of the equity market for the economy, measured by the stock market capitalization to GDP ratio (STOCKCAP). As in Figure 6, we again find a positive response for consumption (Figure 10). The exercise is repeated in Figure 11 for residential investment, and its cumulative impulse responses are also positively related to STOCKCAP. Interestingly, the correlation coefficients in Figures 10 and 11 are nearly identical at 0.60.

Figure 10
Cumulative response of real private consumption to unit equity price shock, after 3 years: correlation with stock market capitalization

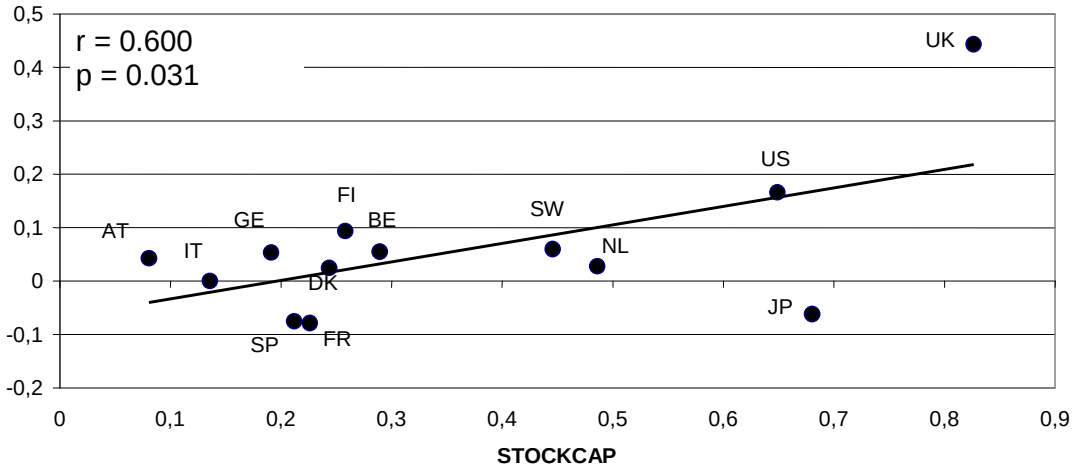
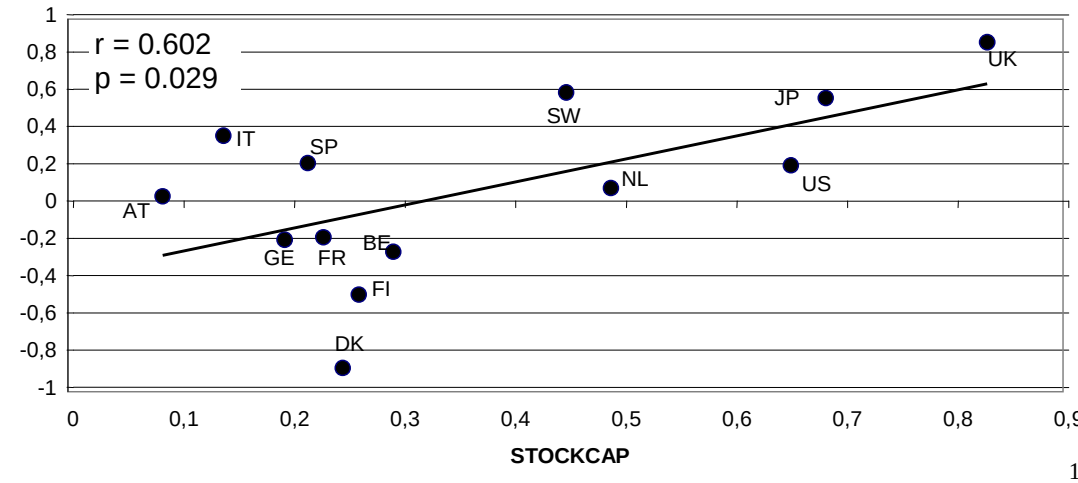
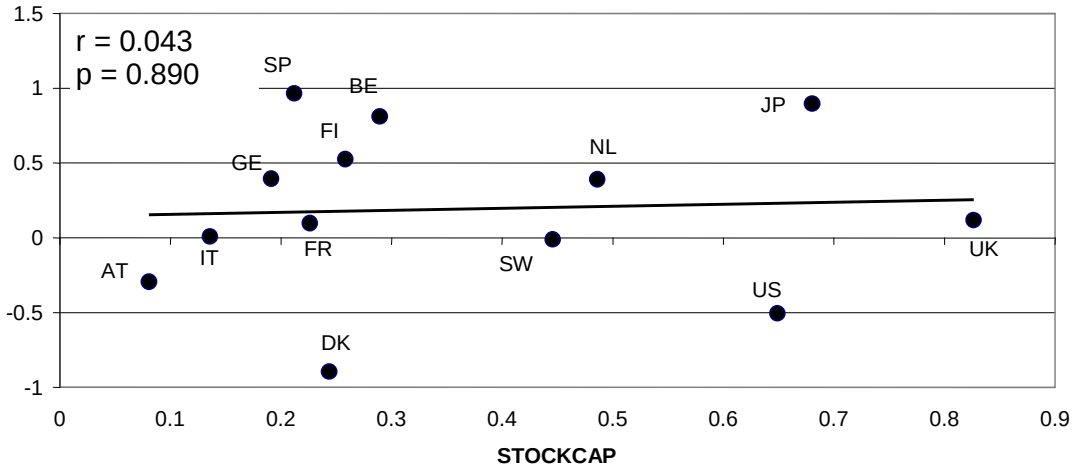


Figure 11
Cumulative response of real residential investment to unit equity price shock, after 3 years: correlation with stock market capitalization



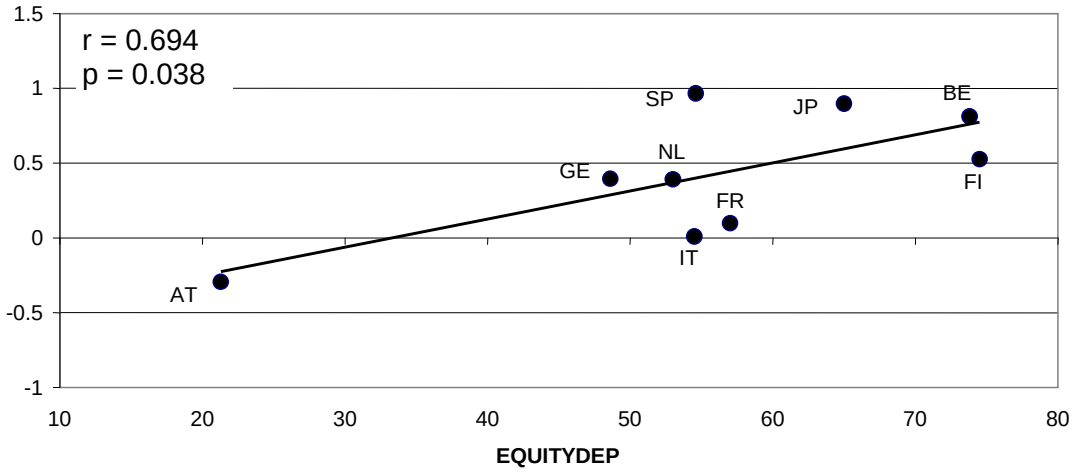
The final two figures examine the sensitivity of business investment to equity shocks in two different ways. Figure 12 plots the CIR_3's against STOCKCAP. In contrast to the comparable plot for consumption (Figure 10) and residential investment (Figure 11), no relation is evident. However, a strongly positive relation is displayed in Figure 13 when the importance of equity is measured by equity dependence (EQUITYDEP), the value of equity of non-financial companies as a percentage of their total liabilities.[11]

Figure 12
Cumulative response of real business investment to unit equity price shock, after 3 years: correlation with stock market capitalization



[11] It should be noted that these balance sheet data are not fully comparable internationally and are not available for all countries in our sample.

Figure 13
Cumulative response of real business investment to unit equity price shock, after 3 years: correlation with equity dependence of firms



A second set of tests focuses on the extent to which the "noise" in the economy mutes asset price channels. In a seminal article, Lucas (1973) shows that the cross-country impact of monetary policy on real activity depends on the amount of variation in the policy variable. The more variation in the environment, the more difficult it is for agents to discern temporary from permanent movements. We apply this logic to the role of asset prices. In economies where the volatility of asset prices is low, we would expect shocks to have a stronger impact than in economies where the variation is high and agents have a difficult time extracting signal from noise. We measure "noise" by the coefficient of variation of housing or equity prices. We also include a third measure for consumer price inflation. In none of these three cases (not reported) is there a systematic relationship between the CIR_3's for housing and equity prices and the coefficients of price variation.

Summing up, these cross-correlations document that the house price channel is stronger in countries where home ownership is high and that the equity price channel is stronger in countries where the stock market or equity finance are important.

6. Are Policymakers Concerned about Asset Prices?

Further information about the role of asset prices can be obtained by examining the percentage of the forecast error in a given variable at a given horizon that is attributable to asset price shocks. These variance decompositions allocate the forecast error to all shocks, and the contributions of all shocks sum to 100%. Here we are interested in the extent to which policymakers are concerned about the impact of asset price movements on the overall economy, as measured by GDP. This impact can be evaluated in terms of the variance decomposition for our monetary policy indicator, RS.[12]

The variance decompositions for RS at a 12 quarter horizon are presented in Table 1, and we are particularly interested in columns 4 and 5 for housing and equity price shocks, respectively. In most cases (Japan and Sweden are the exceptions), the percentage of the variation in forecast error after 12 quarters is very close to the longer-run values at 20 or 30 quarters (not reported). A benchmark value can be obtained if we assume that each of the seven shocks contribute equally to the variation in housing prices. In this case, we would expect the reported percentages to be approximately 15%. By this benchmark, housing prices do not have much influence on monetary policy. Only in Italy (18%) and Sweden (17%) are the responses of monetary policy to the housing market slightly above the benchmark. Monetary authorities seem to resist responding to movements in housing prices.

However, monetary policy has clearly responded to equity shocks. The percentage of the forecast error in RS explained by equity shocks exceeds the benchmark in seven of the 13 countries. These results are consistent with two different interpretations. Policymakers may view equity shocks as having an immediate and potent impact on the economy through one or more of the channels discussed in Section 1. They are also consistent with equity's role as a predictor of future economic activity (as witnessed by its role in several indices of leading economic indicators), and monetary authorities incorporating this information into a forward-looking Taylor rule (see Dupor and Conley, 2004). The results in Table 1 indicate that the monetary authorities pay particularly close attention to developments in equity markets.

[12] Clarida and Gertler (1997, Section 10.4.4) undertake a similar analysis of the Bundesbank monetary policy.

TABLE 1
VARIANCE DECOMPOSITIONS FOR RS AT A HORIZON OF 12 QUARTERS

	GDP	PC	CREDIT	**HOUSE**	**EQUITY**	EX	RS
AUSTRIA	5.1	4.6	13.5	**14.2**	**10.8**	40.5	11.3
BELGIUM	68.4	10.2	4.9	**9.1**	**3.6**	1.5	2.3
DENMARK	2.0	9.9	3.9	**6.8**	**74.2**	2.1	1.1
FINLAND	6.4	4.4	10.9	**8.6**	**21.8**	21.0	26.9
FRANCE	2.2	9.2	26.2	**11.3**	**23.7**	13.7	13.7
GERMANY	11.0	10.2	19.0	**8.1**	**34.3**	9.6	7.8
ITALY	9.1	41.0	8.1	**18.1**	**2.2**	14.7	6.8
JAPAN	12.7	12.0	1.7	**12.1**	**30.0**	13.6	17.9
NETHERLANDS	17.5	1.3	1.6	**9.4**	**12.5**	20.1	37.7
SPAIN	10.9	23.9	13.8	**1.9**	**28.7**	18.2	2.5
SWEDEN	4.2	18.0	15.1	**17.0**	**8.3**	34.7	2.8
UNITED KINGDOM	2.7	17.1	19.1	**9.0**	**10.5**	36.7	5.0
UNITED STATES	26.0	12.5	12.6	**7.5**	**19.7**	7.4	14.2

Explanatory note: GDP is real gross domestic product, PC price deflator for private consumption, CREDIT real bank credit to the private sector, HOUSE market value of stock of private owner occupied houses, EQUITY market value of equity of the business sector, EX nominal effective exchange rate, RS three-month money market interest rate. Variables are defined in the Data Appendix.

7. Summary and Conclusions

This paper examines the response of 13 highly industrialized economies to shocks to housing and equity prices. Our interest in allowing asset prices and monetary policy to interact leads us to develop and estimate a structural VAR. We obtain four key findings. First, the impacts of asset price shocks are heterogeneous across countries. Second, these heterogeneous responses are systematically related to cross-country variation in financial structure, and we are thus able to document the importance of the wealth/balance sheet channel for consumption and residential investment and an equity finance channel for business investment. Third, for a given country, housing shocks have a much greater impact on real variables than equity shocks. Fourth, variance decompositions indicate that monetary policy reacts to equity price shocks but not to housing price shocks.

Perhaps the most important implication of our findings is to fuel the debate on the inclusion of asset prices in the formulation of monetary policy.[13] We document that asset prices have real effects on the economy through wealth or balance sheet

[13] See Bernanke and Gertler (1999), Cecchetti (2006), Gertler, Goodfriend, Issing, and Spaventa (1998), Kohn (2006), and Mishkin (2007, chapters 3 and 19) for discussions of the key issues.

channels. We also present some evidence suggesting that central banks are reluctant (relative to equity price shocks) to react to housing price shocks. The cross-country analysis confirms the finding, developed in the recent literature on finance constraints, that financial structure matters. Our results indicate that the monetary transmission mechanism varies systematically across national financial structures and, in a monetary union, there will be a greater role for national economic information in the formulation of monetary policy (DeGrauwe and Sénégas, 2003). The role of and variation in financial structure is particularly important because it suggests the challenges facing the monetary authorities in setting policy for countries with differing exposures to asset price shocks.

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Data Appendix: Data Definitions and Sources

CONS: Consumption Spending.
Constant prices 1990. All countries - OECD National Accounts.

CREDIT: Bank credit to the private sector.
Constant prices 1990. All countries - IMF, International Financial Statistics. Nominal figures have been deflated by the private consumption deflator.

EQUITY: Market value of equity of the business sector.
All countries - EQUITY = EQUITYR * PEQ/100.
EQUITYR - Real value of equity of the business sector.
EQUITYR = EQUITYR(-1) + INVT-B - D * EQUITYR(-1), where annualized depreciation rate D = 0.06. Starting value derived from OECD, Flows and stocks of fixed capital. INVT-B and PEQ defined elsewhere in this appendix.

EQUITYDEP: Equity of non-financial firms as a percentage of total liabilities.
EMU countries – European Central Bank (2002; data are for end 2000), Japan – Bank of Japan (data are for end 2000).

EX: Nominal effective exchange rate.
Index 1990=100. All countries - Exchange rates from Datastream. Own reweighting using calculated trade weights of 1990.

EXP: Domestic expenditure components, see *CONS*, *INVT-B*, and *INVT-R.*

GDP: Gross domestic product.
Constant prices 1990. All countries - OECD National Accounts.

HOUSE: Market value of stock of private owner occupied houses.
All countries - HOUSE = HOUSER * PH/100.
HOUSER - Rebuilding value of stock of private owner occupied houses.
HOUSER = HOUSER(-1) + INVT-R - D * HOUSER(-1), where annualized depreciation rate D = 0.02. Starting value derived from OECD, Flows and stocks of fixed capital. INVT-R and PH defined elsewhere in this appendix.

INVT-B: Investment in fixed assets of the business sector.
Constant prices 1990. Calculated as total investment in fixed assets minus residential investment and government investment. Source: OECD National Accounts and Quarterly National Accounts. For Austria, Belgium, Germany, Spain, Sweden interpolation of annual data for government investment and residential investment.

INVT-R: Investment in fixed assets of the residential sector.
Constant prices 1990. Source: OECD National Accounts and Quarterly National Accounts. For Austria, Belgium, Germany, Spain, Sweden interpolation of annual data for government investment and residential investment.

MORTGDEBT: Ratio of mortgage debt to GDP.
All countries – BIS and OECD National Accounts (data are for 1995).

OWNOCC: Percentage of homes owner-occupied.
All countries – BIS (data are for 1995).

PC: Price deflator for private consumption.
Index 1990=100. All countries - OECD National Accounts

PCOM: Price of commodities.
(in own currency), index 1990=100. All countries - HWWA. Price denominated in dollars converted into national currencies using dollar exchange rates.

PEQ: *Equity price index*.
Index 1990=100. All countries - IMF, International Financial Statistics.

PH: Residential property prices.
Index 1990=100. Sources:

Austria - Wiener Immobilienbörse, Technische Universität. Price per m^2 new and existing dwellings in Vienna. Series starts in 1986. Semiannual data have been linearly interpolated. Before 1986 linked to interpolated annual data from former housing studies.

Belgium - Antwerpse Hypotheekbank, Valeurs Mobiliers. Quarterly index of prices of small and medium dwellings as from 1981:I. Before 1981 linked to interpolated annual series from former housing studies. Price index is expressed in percent of 'officially appraised value' in 1992.

Denmark - Danmarks Statistik, Monthly Review. Quarterly index of single family dwellings as from 1971:I.

Germany - Bundesbank. Interpolation of annual prices in DEM 1000 of new or existing good quality 'Reihenhaus' in West Germany.

Spain - Banco de España and Ministerio de Obras Publicas, Transportes y Medio Ambiente. Quarterly prices per m^2 in pesetas. Before 1987 linked to interpolated annual data from former housing studies.

Finland - Statistics Finland. Quarterly price index per m^2 of existing flats in housing corporate bodies that have been on sale through real estate agents. Series start in 1978:I.

France - Federation Nationale des Agents Immobiliers, Observatoire National des Marches de l'Ancien. Data compiled from 12,000 transactions by FNAIM members. Annual data as from 1995 of existing dwellings in FFR per m^2. Linked before 1995 to data from former housing studies. Annual data have been interpolated by Ginsburgh method using housing prices in Paris from the French notaryship.

Italy - Banca d'Italia. Semiannual prices of new estate in the capitals of the 96 Italian provinces. Series start in 1970. Semiannual data have been linearly interpolated.

Japan - Bank of Japan, Financial and Economic Statistics Monthly. Data represent changes in residential land prices.

Netherlands - Kadaster as from 1992:I. Before 1992:I Nederlandse Vereniging van Makelaars. Selling price of existing dwellings in thousands of NLG. Monthly data have been converted into quartely averages.

Sweden - Statistics Sweden, Statistika Meddelanden. Price index of owner occupied dwellings based on notary transactions. Quarterly series start in 1986:I. Before 1986 linked to interpolated data from former housing studies.

United Kingdom - Bank of England. Data as from 1993 represent prices of all dwellings from a 5% survey of mortgagers conducted by the Department of the Environment. Before 1993 based on mortgage lending by Building Societies.

United States - Conventional Mortgage Home Price Index of Freddie Mac (Federal Home Loan Mortgage Corporation). Based on actual selling prices of appraised values of a panel of 12.1 million houses mortgaged by Freddie Mac or Fannie Mae throughout the country. Quarterly series start in 1975.

RS: Three-month money market interest rate (%).
All countries – IMF, International Financial Statistics.

STOCKCAP: Stock market capitalization relative to nominal GDP.
All countries – IMF, International Financial Statistics.

WT: Relevant world trade.
Volume index 1990=100. All countries - Reweighted import volumes of the other 11 countries plus the United States, using calculated trade weights of 1990.

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