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Global Financial Transmission of Monetary Policy Shocks*

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Abstract

The paper analyses the transmission of US monetary policy shocks to global equity markets and the macroeconomic determinants of the underlying transmission process. We show that there is a substantial cross-country heterogeneity in reactions across 50 equity markets worldwide, with returns falling on average around 2.7% in response to a 100 basis point tightening of US monetary policy, but ranging from a zero response in some to a reaction of 5% or more in other markets. As to the determinants of the strength of transmission to individual countries, we test the relevance of their macroeconomic policies and the role of real and financial integration. We find that in particular the degree of global integration of countries – and not a country's bilateral integration with the United States – is a key determinant for the transmission process.

I. Introduction

The interdependence of economies has been a topic of research for a number of decades. Beyond studies of business cycle co-movement (e.g. Gerlach, 1988; or Baxter and Stockman, 1989; more recently, Forni *et al.*, 2000; Camacho, Perez-Quiros and Saiz, 2006), analyses of the international transmission of identified structural shocks have improved our understanding of the channels by which developments in one economy spread to other countries (e.g. Ahmed *et al.*, 1993; Canova and Marrinan,

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1998). At the same time, our knowledge on the interdependence of financial markets has also progressed substantially. In this area, studies have generally focused on the co-movement of asset returns in reduced-form models, disentangling cross-country factors, global factors, sectoral factors and country-specific effects. An important contribution in this vein is Forbes and Chinn (2004), who use a factor model and show that both trade and financial linkages have become relevant determinants of cross-country co-movements in asset prices since the mid-1990s.[1] The nature of this integration and the transmission channels through which shocks dissipate are, however, still not well understood. What are the factors that cause such a co-movement? Are they global in nature or can they be traced to specific developments in individual countries and sectors?

In this paper, we attempt to combine the two approaches by analysing the transmission of monetary policy shocks to a large number of equity markets, and by studying its macroeconomic determinants. Specifically, we look at the transmission of US monetary policy shocks to 50 equity markets worldwide, covering not only advanced economies but all of the major emerging market economies, over the period 1994–2004. This approach allows us to make use of a precisely identified structural shock (Kuttner, 2001; Gürkaynak, Sack and Swanson, 2005), which is well known to exert substantial effects not only on financial markets,[2] but also on the US and international macroeconomies (among many others, see Christiano, Eichenbaum and Evans, 1999).

This approach allows us to address two related issues. First, we identify the overall *strength* of the transmission of US monetary policy shocks to equity markets and find that global equity markets fall by around 2.7% in response to a 100 basis point (bp) tightening of US monetary policy. Equally importantly, we show that there is a substantial degree of heterogeneity in the reaction across the 50 countries we analyse in this paper. Some markets fall by more than 5% because of a 100 bp tightening, thus reacting even more strongly than the US equity market itself, while other countries' stock markets do not react at all to US monetary policy shocks.

As to the second issue, we study the *determinants* of the strength of transmission by explaining the differential effects across countries and over time through macroeconomic policies and the degree of real and financial integration of countries. Countries with open and well-developed equity markets and financial sectors react significantly more to US monetary policy shocks than closed ones, as do countries with more volatile exchange rates. However, we find no evidence that countries with *de jure* fixed or with floating exchange rate regimes react differently to US monetary policy shocks.

[1]Other seminal studies on international co-movements of asset prices and on quantifying financial market integration are King and Wadhwani (1990), Lin, Engle and Ito (1994), Bekaert and Harvey (1995), and more recently by Campbell *et al.* (2001), Griffin and Stulz (2001), Forbes and Rigobon (2002), Chinn and Frankel (2005) and Andersen *et al.* (2007).

[2]Thorbecke (1997) and Patelis (1997) are important earlier studies using VAR frameworks for identification, while more recent studies on this topic are Bernanke and Kuttner (2005), Bomfim (2001), Rigobon and Sack (2004), Faust *et al.* (2007) and Ehrmann and Fratzscher (2004).

For the analysis of the role of real (i.e. trade) and financial integration in the transmission of US monetary policy shocks to global markets, we employ a novel database that contains holdings of capital stocks vis-à-vis the United States as well as the rest of the world for all elements of the capital account – foreign direct investment (FDI), portfolio equity investment, portfolio debt investment and loans. We find that stock markets in countries that hold a large amount of foreign financial assets (relative to gross domestic product GDP) and also that owe a large amount of domestic financial assets to foreigners react two to three times more strongly to monetary policy shocks than less financially integrated countries. We show that this holds quite independently of which type of capital is concerned – countries that are more financially integrated either with regard to FDI, portfolio equity investment, portfolio debt investment or with regard to loans all face an equity market response that is at least twice as strong as that of less financially integrated countries.

A further finding of the paper is that it is in particular the degree of *global* integration, that is, integration of individual countries vis-à-vis all other countries, rather than the degree of *bilateral* integration with the United States that determines the magnitude of transmission. This underlines the complexity of the channels of the global financial transmission process. It also has important implications for portfolio diversification and risk-sharing through global capital markets.

To the best of our knowledge, this is the first study that systematically analyses the transmission of structural shocks, such as US monetary policy shocks, to global financial markets and links the underlying transmission process to macroeconomic determinants. Nevertheless, the paper is related to a few studies that analyse similar issues in different contexts. The present paper is closest in its objective to the aforementioned work by Forbes and Chinn (2004). Specifically, in their factor model they distinguish between cross-country factors, global factors, sectoral factors and country-specific factors. They study cross-country co-movements of asset prices, and find both trade and financial linkages to be important, mainly since the mid-1990s. Furthermore, they show that there are regional spillovers from the largest economy in a given region to nearby countries. More recently, Wongswan (2006) and Fratzscher (2008) analyse the transmission of macroeconomic news or surprises to equity markets and exchange rates, respectively. Wongswan (2006) in particular shows that such high-frequency macroeconomic news stemming from mature economies (the US and Japan) exert a significant impact on equity market volatility and trading volume in some emerging economies (Korea and Thailand). Finally, Craine and Martin (2008) use a factor model and detect a significant and sizeable effect of US and Australian monetary policy shocks to Australian equity markets.

Related analyses at the macroeconomic level have tested to what extent US monetary policy shocks affect economies other than the United States. However, typically only a small number of countries have been looked at in such studies. Kim (2001), using a vector autoregression (VAR) framework with low-frequency data, finds that US monetary expansions have a positive effect on G6 output, and identifies changes in world interest rates as the most important channel of transmission. This

conclusion is shared by Canova (2005), who also employs a VAR framework to study the effect of US monetary policy on Latin American countries. He furthermore finds that the strength of countries' response to US monetary policy depends on exchange rate regimes, although differences with the *de jure* classification appear relatively small. Finally, Miniane and Rogers (2007) assess whether capital controls manage to insulate countries from US monetary shocks, by estimating their effect on the exchange rate and foreign interest rates of 26 countries, also in the context of a VAR analysis. The study does not find evidence for the notion that countries with capital controls might exhibit systematically smaller responses.

The paper is structured as follows. We proceed by describing the data in detail in section II. Section III then discusses the empirical methodology employed and presents the estimates for the strength of the financial transmission process, at a global level and also distinguishes across countries and across sectors. Section IV contains the analysis of the macroeconomic determinants of the strength of transmission, together with several robustness tests of the empirical results. Section V summarizes the findings and concludes by drawing some implications for future work.

II. Data

We proceed by first outlining the data for the financial market returns, for the monetary policy shocks and for the macroeconomic variables relevant to the transmission channels. In the subsequent section, we will then turn to the empirical methodology and modelling of the financial transmission process.

Financial market data

The main focus of this paper is on the transmission of US monetary policy shocks to foreign equity markets. A first important choice is therefore what type of equity indices to chose. We decided to take Datastream price indices in national currencies (expressed as daily percentage changes in equity prices) for several reasons. First, they offer a maximum amount of comparability across countries. Second, they are based on a broad sample of stocks, including many small firms in the indices. Third, the indices are available for 50 countries, covering all major advanced economies and major emerging market economies. Fourth, each national index is furthermore available disaggregated into sector indices. Finally, the choice of currency implies that we are able to calculate national equity returns pure of exchange rate effects.

An important issue is the sector composition of the different equity markets. As discussed before, a potentially relevant determinant for differences in the transmission of shocks to equity markets may be the different sector composition of the overall market indices. For instance, the equity market of a particular country may react more to foreign shocks because of the concentration of firms of a particular sector in that index, rather than because of the other factors of interest here. We control for such

sector effects in the empirical analysis next by constructing aggregate indices that are calculated as the unweighted average of the sector returns in each country.

Finally, the analysis and empirical modelling is based on daily financial market data, using closing quotes of the respective equity markets. We choose this frequency because of the fact that several equity markets, that is, those in Asia but also in Europe, are closed when US monetary policy decisions are announced. Hence, tomorrow's equity returns for these countries are included to test the effect of a US monetary policy shock today.

Monetary policy shocks

The second issue is how to measure US monetary policy shocks. To obtain an as clean and exogenous as possible proxy for such shocks, we use the change of the Fed funds future rates in the 30-minute window surrounding Federal Open Market Committee (FOMC) decisions. The data stems from Gürkaynak *et al.* (2005) and builds on the important work by Kuttner (2001).[3]

FOMC meetings usually take place eight times per year, about every 6 weeks. Starting in February 1994, the Federal Reserve announces its decisions on the day of the FOMC meetings, whereas before, markets needed to infer decisions from the open market operations. Accordingly, we start our sample period in February 1994, as from this date monetary policy surprises on the day of the FOMC meetings can be accurately measured. Most FOMC announcements since February 1994 have taken place at 14.15 EST, such that markets in Asia and in Europe were closed and affected only on the subsequent business day. Over the whole period of February 1994–December 2004, we have a total of 93 FOMC meetings. These include also unscheduled FOMC meetings, except for the one on 17 September 2001 following the 11 September attacks.[4]

Integration and macroeconomic determinants

As discussed in the introduction, an important part of the analysis is to understand the determinants of the strength of transmission. For that purpose, we use various measures. One key element we analyse is the degree of financial openness of countries. We use the openness of the capital account, which is a dummy that takes the value zero if a country's capital account is closed and one if it is open. The source of this data is the IMF's Annual Report on Exchange Arrangement and Exchange Restrictions (AREAER). For the openness of the domestic equity markets as well as for the openness of the domestic financial sector we take the indicators developed

[3] See Gürkaynak (2005) for a detailed explanation of the methodology for calculating policy expectations based on Fed funds futures of different maturities.

[4] Excluding the other four unscheduled meetings from the sample reduces the overall effect of US monetary policy shocks somewhat. However, such an exclusion does not change the results shown next, in particular the cross-country heterogeneity and the analysis of the channels of determinants in any significant way.

by Kaminsky and Schmukler (2008) and complemented by Bussiere and Fratzscher (2008). All of these openness variables are dummies, being zero if a country's market is closed and one if it is open.

As for the exchange rates, we use both *de facto* measures of exchange rate flexibility from Reinhart and Rogoff (2004) as well as a *de jure* classification from the IMF's AREAER. We also use the actual exchange rate volatility, which is measured as the standard deviation (SD) of a country's daily exchange rate changes against the US dollar over the previous 12 months. Other volatility proxies based on shorter or somewhat longer periods show very similar results to the ones presented next.

TABLE 1

Summary statistics

	Mean	*SD*	*Minimum*	*Maximum*
US monetary policy shock	−1.388	9.035	−43.8	16.3
Openness, exchange rates and macroeconomic variables				
(A) Openness				
Capital account	0.643	0.479	0	1
Equity market	0.894	0.308	0	1
Domestic financial sector	0.878	0.327	0	1
Stock market capitalization	0.677	4.951	0.132	113.5
(B) Exchange rate				
Volatility of effective exchange rate	0.027	0.030	0	1.086
Volatility vis-à-vis US dollar	0.028	0.035	0	1.894
Regime – *de jure*	0.689	0.463	0	1
(C) Other				
GDP correlation with US	0.365	0.311	−0.131	0.889
Net indebtedness	−0.009	0.114	−0.361	0.474
Geographic distance	8.585	0.420	6.981	9.154
Real and financial integration				
(A) With the world – assets and liabilities, inflows and outflows				
Total trade	0.137	0.115	0.027	0.960
Total capital	0.210	0.338	0.084	2.577
FDI	0.078	0.134	0.036	1.189
Portfolio equity	0.065	0.091	0.024	0.053
Portfolio debt	0.012	0.016	0.008	0.064
Other investment/loans	0.114	0.223	0.000	1.737
(B) With the United States – assets and liabilities, inflows and outflows				
Total trade	0.003	0.007	0.008	0.045
Total capital	0.018	0.020	0.010	0.098
FDI	0.044	0.048	0.004	0.051
Portfolio equity	0.008	0.015	0.001	0.066
Portfolio debt	0.019	0.018	0.004	0.066
Other investment/loans	0.026	0.058	0.001	0.034

Note: The table shows summary statistics for the monetary policy shock, in basis points; the openness, exchange rate and macroeconomic variables, as defined in the text and in the Appendix; and the financial integration variables, in per cent of gross domestic product (GDP) of country *i*.

Finally, for the degree of real and financial integration, we look at both the current and financial accounts of countries. Trade data are flows of exports and imports and stem from the IMF's Direction of Trade Statistics. Financial account data are all stocks of assets and/or liabilities for FDI (source: UNCTAD), portfolio investment equity and debt (source: IMF CPIS), and other investments, which are mostly loans (source: BIS ILB). A key strength of this dataset is that it contains a geographic decomposition of trade and financial linkages, so that both real and financial integration can be measured vis-à-vis the rest of the world and, alternatively, vis-à-vis the United States alone.

Most of the integration and macroeconomic variables vary over time and across countries, although there are some exceptions and some variables are not available for the full sample of the countries. The data frequency is annual. Variables that are time-invariant are the geographic distance across country pairs as well as the net indebtedness of countries. GDP correlations are 5-year moving averages. For the CPIS data, for which the first observations are available in 1997, we use data for 1997 also for the time before 1997. The Appendix provides a more detailed summary of the sources and characteristics of all the variables. Table 1 provides some summary statistics of the variables, including the US monetary policy shock.

III. The strength of financial transmission

Our empirical modelling strategy consists of two parts. In the first part, which is presented in this section, we measure the overall transmission of US monetary policy shocks to US and foreign equity markets. We also decompose this transmission process by taking into account the cross-country heterogeneity. In the second part, we then turn to an analysis of the macroeconomic determinants in section IV.

Benchmark results

Our first objective is to measure the overall transmission of US monetary policy shocks to foreign equity markets. As the most simple benchmark specification, we model daily equity returns, r_t, as follows:

$$r_t = \alpha + \beta S_t + \delta Z_t + \varepsilon_t. \tag{1}$$

Daily equity returns are thus a function of US monetary policy shocks, S_t, as well as a vector Z_t of controls, which for simplicity includes only day-of-the-week effects.[5]

[5]More specifically, we include dummies for Mondays and Fridays, which is standard in the finance literature mainly in order to control for systematic differences in liquidity and trading because of the fact that traders tend to close positions on Fridays and open them on Mondays. As is standard in event-study analyses of the response of asset prices to monetary policy, the controls do not include lagged equity returns (as equity returns should be approximately unforecastable at daily frequencies). Checks for the validity of the underlying model assumptions confirm that autocorrelation in equity returns is not a serious issue. We have tested for autocorrelation for the empirical models presented next, using a Durbin Watson test and find the test statistic to be very close to 2 (between 1.95 and 1.99) so that the null hypothesis of no serial correlation cannot be rejected. Moreover, we emphasize that the estimates of β are not sensitive to the specific inclusion of the controls Z_t.

TABLE 2

Transmission of US monetary policy shocks – benchmark model

Benchmark effects	*Parameter estimates* β	*SE*	R^2
(1) US, weighted by market capitalization	−0.070***	0.019	0.38
(2) US, unweighted across sectors	−0.046***	0.013	0.35
(3) Global transmission, weighted by market capitalization	−0.017*	0.010	0.34
(4) Global transmission, unweighted across countries and sectors	−0.027***	0.007	0.34

Notes: The table shows the response of equity returns to US monetary policy shocks S_t estimated for the different equity returns r_t as:

$$r_t = \alpha + \beta S_t + \delta Z_t + \varepsilon_t,$$

with the dependent variable being the US equity return weighted by market capitalization in (1), unweighted across sectors in (2), and the global equity return (excluding the United States) weighted by countries' market capitalization in (3), unweighted across countries and sectors in (4). *** and * indicate statistical significance at the 99% and 90% levels, respectively.

β is our main parameter of interest, which measures the strength of the transmission of the shock to foreign equity markets. As discussed before, one would expect that the coefficient has a negative sign, as a positive monetary policy shock, that is, higher interest rates than expected, induces negative equity returns.

Model (1) is estimated repeatedly, using the returns of individual countries or aggregate returns across a set of countries.[6] Table 2, row (1), shows the results for US equity returns weighted by market capitalization whereas row (2) gives the analogous results when using the US equity returns unweighted across sectors, that is, using a simple average across the ten US sector returns, as explained before in section II. We find that US stock markets respond significantly to US monetary policy shocks. Overall, a tightening of US monetary policy by 100 bp lowers the weighted US equity index by 7.0% and the unweighted index by 4.6%. These effects are roughly in line with those of the literature, which are estimated at 5.3% by Bernanke and Kuttner (2005), at 5.5% by Ehrmann and Fratzscher (2004) and at 6.2% by Rigobon and Sack (2004).

We next turn to the transmission of US monetary policy shocks to global equity markets. Table 2 presents the findings for two different aggregate global equity returns. The first [row (3) of Table 2] aggregates the 49 non-US equity returns according to market capitalization of each of the markets. The second [row (4)] is an unweighted average across countries and sectors, that is, the simple average of the sectoral market returns across the 49 countries in our sample.

The results show that a 100 bp tightening in US monetary policy leads to a drop of global equity returns by 1.7% when weighted by market capitalization and by

[6]An alternative is to estimate the model in a panel setting. As all regressors are common to all return series, both yield identical estimates. The panel dimension is exploited in the next section, when we analyse the determinants of the cross-country heterogeneity in the transmission coefficients β. For these, we use an ordinary least square estimator with panel-corrected standard errors (PCSE), which corrects for heteroskedasticity and for the correlation of residuals across stock market indices.

TABLE 3

Country effects of transmission of US monetary policy shocks

	Parameter estimates		*Diff. to mean*	
Country	β_i	*SE-value*	$\beta_i - \beta$	R^2
Argentina	−0.040*	0.021	−0.018*	0.09
Australia	−0.019**	0.008	0.003	0.15
Austria	−0.022	0.014	0.000	0.18
Belgium	−0.009	0.008	0.013*	0.04
Brazil	−0.044**	0.018	−0.022	0.15
Canada	−0.046***	0.014	−0.024**	0.29
Chile	−0.011*	0.006	0.011*	0.09
China	0.019	0.018	0.041**	0.04
Colombia	−0.002	0.008	0.020*	0.01
Cyprus	−0.029***	0.010	−0.007	0.08
Czech Republic	−0.022**	0.010	0.000	0.11
Denmark	−0.015	0.011	0.007	0.15
Finland	−0.040***	0.014	−0.018*	0.16
France	−0.011	0.015	0.011	0.05
Germany	−0.010	0.013	0.012	0.08
Greece	−0.019	0.026	0.003	0.09
Hong Kong	−0.057***	0.016	−0.035**	0.25
Hungary	−0.028	0.019	−0.006	0.15
India	−0.021*	0.012	0.001	0.11
Indonesia	−0.007	0.026	0.015	0.10
Ireland	−0.011	0.011	0.011	0.11
Israel	−0.030**	0.014	−0.008	0.18
Italy	−0.027	0.019	−0.005	0.06
Japan	−0.007	0.015	0.015	0.01
Korea	−0.057**	0.024	−0.035*	0.19
Luxembourg	−0.017***	0.006	0.005	0.23
Malaysia	−0.012	0.009	0.010	0.13
Mexico	−0.044***	0.012	−0.022*	0.26
The Netherlands	−0.009	0.016	0.013	0.06
New Zealand	−0.015	0.010	0.007	0.12
Norway	−0.028	0.018	−0.006	0.18
Pakistan	0.025	0.015	0.047***	0.03
Peru	−0.007	0.008	0.015*	0.11
Philippines	−0.039**	0.017	−0.017	0.09
Poland	−0.007	0.015	0.015	0.04
Portugal	−0.009	0.008	0.013*	0.03
Romania	0.005	0.011	0.027	0.10
Russia	−0.032***	0.010	−0.010	0.05
Singapore	−0.039**	0.020	−0.017	0.14
South Africa	−0.046**	0.021	−0.024	0.16
Spain	−0.038*	0.021	−0.016	0.12
Sri Lanka	−0.007	0.015	0.015	0.02
Sweden	−0.040**	0.019	−0.018	0.18

continued overleaf

TABLE 3

(continued)

	Parameter estimates		*Diff. to mean*	
Country	β_i	*SE-value*	$\beta_i - \beta$	R^2
Switzerland	−0.007	0.011	0.015*	0.11
Taiwan	−0.033*	0.017	−0.011	0.03
Thailand	−0.031	0.019	−0.009	0.13
Turkey	−0.038	0.028	−0.016	0.02
United Kingdom	−0.024*	0.014	−0.002	0.14
Venezuela	0.018	0.015	0.040*	0.02

Note: The model estimates the effect of US monetary policy shocks on the return indices of each of the 49 countries i in the sample:

$$r^U_{i,t} = \alpha_i + \beta_i S_t + \delta_i Z_t + \varepsilon_{i,t}.$$

Note that the return index for each country is unweighted across sectors in order to control for differences in the sector composition of different country indices. 'Diff. to mean' shows the difference between the country coefficients and the global average, as well as the statistical significance of this difference. ***, ** and * indicate statistical significance at the 99%, 95% and 90% levels, respectively.

2.7% when unweighted. This difference is interesting and intuitive as it suggests that countries with a relatively large market capitalization (such as Japan) respond less than smaller markets. This is indeed the case, which is shown in Table 3, to which we will return next. As such, the magnitude of the international stock markets response is around half of the domestic one within the US. Moreover, in terms of goodness of fit of the empirical model, the findings indicate that on days of US monetary policy decisions, US monetary policy shocks explain a substantial share – about 30–35% – of the variations in global equity market returns

Cross-country heterogeneity

Table 2 shows the *average* transmission across all countries and all sectors. To understand the degree of heterogeneity of the transmission process, we now proceed to analyse the differences in the transmission across countries. For this purpose, we estimate – analogously to Table 2 for the aggregate returns – country-specific regressions with US monetary policy shocks. To get at the country-specific impact of US monetary policy shocks, we use as the dependent variable the unweighted return for each country, $r^U_{i,t}$, that is, the unweighted average across the ten sector returns of each country:

$$r^U_{i,t} = \alpha_i + \beta_i S_t + \delta_i Z_t + \varepsilon_{i,t}. \quad (2)$$

Using the unweighted return index ensures that the country's heterogeneity is not an artefact of differences in sector weights in the overall, capitalization-weighted

market index of countries.[7] Table 3 indicates that the cross-country variation in the financial transmission from the United States is substantial. Some of the more closed emerging markets – such as China, Peru, Sri Lanka and Malaysia – do not react significantly or only very weakly to US monetary policy shocks. In contrast, other emerging markets – for instance Brazil, Hong Kong, Korea and the Philippines – react very strongly to US shocks, with some equity returns falling by around 4–5% to a 100 bp tightening in US monetary policy.

There are also substantial differences in the transmission of US shocks to advanced economies.[8] Some markets, such as those in Sweden, Spain and Canada, react relatively strongly, while others, such as Japan's, are far less responsive.

In summary, there is a substantial transmission of US monetary policy shocks to global equity markets. This transmission moreover exhibits a large degree of heterogeneity across countries, ranging from countries that are basically unaffected by US monetary policy shocks to those that react by 4% or more to a 100 bp change in US monetary policy.

IV. Determinants of financial transmission

We now turn to the question of what explains why some countries' equity markets overall respond more strongly to such shocks. We focus in this section on the role of macroeconomic policies, in particular the degree of openness and exchange rate policies, and the extent of real and financial integration of countries, and provide some extensions and robustness checks of the empirical results.

The role of macroeconomic policies

As for the macroeconomic policies, one would expect that countries that are financially open are much more affected by US monetary policy and other shocks. More openness implies that the capital can move more freely. A US monetary policy shock may induce a rebalancing of asset portfolios not only in the United States, but more generally in global markets overall, and in particular in those that are more open financially. We analyse various dimensions of financial openness: the openness of the capital account, the domestic equity market and the domestic financial sector,

[7]As a robustness check, we also estimated all models using the common value-weighted return indices. The parameter estimates are overall similar to whether or not value-weighted or unweighted return indices are used, although there are in some cases sharp differences for individual countries. As explained in detail in section II, our preferred measures are the unweighted indices as these avoid differences in equity market responses across countries arising from differences in sectoral composition. The working paper version (Ehrmann and Fratzscher, 2006) shows the responsiveness of individual sectoral indices, confirming that there are indeed substantial sectoral differences in the response patterns, with the information/high-tech sector responding by far the strongest, while utilities and non-cyclical consumer goods react the least to US monetary policy shocks. Moreover, these results on the sector effects also mirror those found for the United States in Ehrmann and Fratzscher (2004) and Bernanke and Kuttner (2005).

[8]Luxembourg is excluded from subsequent model estimations in part due to its special characteristic as financial centre, and in part due to a lack of some macroeconomic and integration data used next.

as well as the overall market capitalization of the domestic stock market relative to GDP as a proxy for the depth and liquidity of the market. Moreover, exchange rate policies may matter and we therefore also analyse the role of the exchange rate regime.

As discussed before, we expect that countries that are highly integrated with the United States, both in terms of finance and in terms of the real economy, should be more responsive to US monetary policy shocks for several reasons. On the one hand, there should be a closer linkage at the macroeconomic level; on the other hand, individual stocks are more likely to be affected beyond the macroeconomic linkages, through effects on their financing costs and their growth outlook. Finally, for investors, a rebalancing of portfolios should affect these countries more strongly.

As described in section II, we use several proxies for real and financial integration. First, we look at the role of trade, both as the sum of bilateral inflows and outflows between a particular country i and the United States or the whole world as well as separated into inflows and outflows to or from country i. Second, we test whether stocks of FDI, portfolio equity, portfolio debt or other investment/loans play a role in the transmission process. Finally, we also test for the role of business cycle correlation, using the correlation of annual GDP growth rates in 1980–2003 between country i and the United States.

In the empirical model, we use a discrete definition of determinant X_{it}:

$$r_{it}^{u} = \alpha_i + (\beta_1 S_t) X_{it}^{\text{low}} + (\beta_2 S_t) X_{it}^{\text{mid}} + (\beta_3 S_t) X_{it}^{\text{high}} + \eta_1 X_{it}^{\text{low}} + \eta_2 X_{it}^{\text{mid}} + \eta_3 X_{it}^{\text{high}} + \sum_n \delta_n Z_{i,t} + \varepsilon_{it}^{u}, \quad (3)$$

with $X^{\text{low}} = 1$ if the determinant X of country i at time t lies in the lowest third of the distribution across all countries over the sample period, and zero otherwise, and analogously for X^{mid} and X^{high}. This specification has the advantage that it nests a linear model, while providing more information about different segments of the distribution, and that the magnitude of the parameters can be easily interpreted and compared. As X^{low}, X^{mid} and X^{high} are dummy variables, their coefficients indicate directly how differently countries with a low, medium or high degree of integration are affected by US shocks. Note that most determinants vary across both time and countries, although some of the determinants only vary across countries, such as financial integration based on portfolio investment. Finally, note that the dependent variable here is the unweighted average across sectors for each country i, as explained in section II ('Financial market data' subsection), in order to control for differences in sectoral composition of countries' market indices.[9]

[9]Also note, moreover, that the results of this section are essentially unchanged when using weighted return indices instead of unweighted ones, underlining that the sectoral composition of countries' stock indices is not correlated with the macroeconomic determinants analysed in this section. Note that the average of the coefficients across the different categories in Tables 4–6 are different from the estimate of −0.027 in model (4) of Table 2. These differences are explained by the fact that the models for Tables 4–6 include several additional controls, that is, the macroeconomic determinants and integration proxies, which are not included in the benchmark specification of Table 2. Moreover, we note that these differences are relatively modest in size. In the majority of the cases in Tables 4–6 the average coefficient lies between −0.026 and −0.029.

Table 4 shows the estimates for openness, exchange rate regimes and business cycle correlation. There is indeed a strong relationship between the openness of countries and the strength of the transmission of US monetary policy shocks. In particular, US monetary policy affects equity markets only in countries that have an open equity market and an open domestic financial sector; whereas closed markets exhibit no statistically significant response (panel A, Table 4).

As for the exchange rates, it appears that it is not the *de jure* exchange rate regime that matters but the *de facto* regime.[10] Panel B shows that stock markets in countries with more volatile exchange rates, both in effective terms or against the US dollar, react about twice as strongly as those with the least volatile ones – 4.3/4.5% as compared with 2.6% in response to a 100 bp change.[11] In contrast, there is no significant difference in the transmission among countries that *de jure* have declared to have a fixed or a floating exchange rate regime.

These two results on openness and exchange rates may go some way in understanding the cross-country differences in the transmission of US monetary policy shocks discussed in section III ('cross-country heterogeneity' subsection). For instance, the findings may explain to a significant extent why relatively closed emerging markets – such as China, India, Peru, Sri Lanka and Malaysia – do not react significantly or only very weakly to US monetary policy shocks, and why markets such as that of Hong Kong, which has a very open financial sector, show a relatively large response.

Next we turn to business cycle correlation and other macroeconomic variables as shown in panel C of Table 4. There appears indeed a significant relationship between the degree of business cycle correlation with the United States and the extent to which a country's stock market is affected by US monetary policy shocks; equity markets in countries with a low level of GDP correlation with the US react by 2.1%, which is significantly less than the 3.3% in countries with a high correlation. Little systematic role is however found for the degree of indebtedness of a country. There is also only a weak relationship between the transmission of shocks and geographic distance, often used as a proxy for information asymmetries and transaction costs in the gravity literature. A broad set of other macroeconomic variables, such as the correlation of domestic inflation rates with those in the United States, were tested and were not found to be significantly related to the transmission process. They are not shown in the tables for reasons of brevity.

[10]This finding is consistent with Shambaugh (2004), which focuses specifically on comparing the responsiveness of monetary policy with foreign shocks under different *de facto* exchange rate regimes. One interpretation of this result for why countries with pegged exchange rates may be equally strongly affected as those with less flexible regimes is that US monetary policy shocks may induce exchange rate adjustments (rather than changes in domestic macroeconomic variables) in the former, which in turn may affect equity markets of exchange rate floaters through changes in inflation and competitiveness.

[11]The results using real exchange rates are very similar to those with nominal exchange rates shown in the table.

TABLE 4

The role of openness, the exchange rate and other macroeconomic variables

		Parameter estimates				
				Difference		
		β_x	*SE*	*(2)*	*(3)*	R^2
(A) Openness						
Capital account	(1) Closed	−0.029***	0.007	0.934		0.068
	(2) Open	−0.028***	0.006			
Equity market	(1) Closed	−0.002	0.011	**0.010**		0.068
	(2) Open	−0.031***	0.006			
Domestic financial sector	(1) Closed	−0.016	0.011	0.206		0.065
	(2) Open	−0.030***	0.006			
Stock market capitalization	(1) Low	−0.016**	0.007	**0.017**	**0.014**	0.044
	(2) Medium	−0.034***	0.007		0.755	
	(3) High	−0.036***	0.007			
(B) Exchange rate						
Volatility of effective exchange rate	(1) Low	−0.026***	0.007	0.773	**0.015**	0.047
	(2) Medium	−0.024***	0.008		**0.008**	
	(3) High	−0.045***	0.007			
Volatility vis-à-vis US dollar	(1) Low	−0.026***	0.007	0.886	**0.036**	0.045
	(2) Medium	−0.025***	0.009		**0.022**	
	(3) High	−0.043***	0.007			
Regime – *de jure*	(1) Fix	−0.031***	0.006	0.647		0.062
	(2) Float	−0.027***	0.007			
(C) Other						
GDP correlation with US	(1) Low	−0.021***	0.007	**0.060**	**0.095**	0.041
	(2) Medium	−0.032***	0.007		0.944	
	(3) High	−0.033***	0.008			
Net indebtedness	(1) Low	−0.041***	0.010	0.114	0.640	0.035
	(2) Medium	−0.052***	0.010		**0.099**	
	(3) High	−0.036***	0.006			
Geographic distance	(1) Low	−0.026***	0.006	0.261	0.159	0.038
	(2) Medium	−0.021***	0.008		**0.034**	
	(3) High	−0.035***	0.007			

Note: The model estimates the effect of US monetary policy shocks on 49 unweighted country indices, testing for time heterogeneity *and* cross-sectional heterogeneity, as follows:

$$r_{it}^{u} = \alpha_i + (\beta_1 S_t) X_{it}^{\text{low}} + (\beta_2 S_t) X_{it}^{\text{mid}} + (\beta_3 S_t) X_{it}^{\text{high}} + \eta_1 X_{it}^{\text{low}} + \eta_2 X_{it}^{\text{mid}} + \eta_3 X_{it}^{\text{high}} + \sum_n \delta_n Z_{i,t} + \epsilon_{it}^{u},$$

where X^n are 0–1 dummies for $X^{\text{low}} = 1$ if the respective variable $X_{i,t}$ in country i at time t is in the lowest third compared with other countries' respective value and over time; and analogously for X^{mid} and X^{high}. For the openness and exchange rate regime variables there are only two respective categories. Note that not all X vary over time, but some are purely cross-sectional X_i, as discussed in the text. 'Difference' shows the significance level of tests for the null hypothesis that two respective coefficients are equal, with figures at the 90% significance level printed in **bold**.*** and ** indicate statistical significance at the 99% and 95% levels, respectively.

The role of trade and financial integration

As the last step, we turn to the role of real and financial integration as a determinant for the transmission process of US monetary policy shocks. Table 5 shows the estimates when using integration proxies that measure the sum of inflows and outflows or the sum of assets and liabilities of the residents in country *i*, vis-à-vis the whole world in panel A, and vis-à-vis the United States in panel B. Table 6 conducts the same analysis separately for inflows and outflows or assets and liabilities vis-à-vis the United States.

The key finding of Table 5 is that the financial transmission process to equity markets is strongly related to the degree of integration of countries vis-à-vis the whole world (panel A), but basically unrelated to the integration with the United States alone (panel B). In panel A for the integration with the world, countries that have a high degree of trade and that have a large size of financial assets and liabilities with the rest of the world react two to three times more strongly to US monetary policy shocks than countries with a low degree of such integration. This holds almost equally for all four types of capital (FDI, portfolio equity, portfolio debt and other investments). Note that it is hard to disentangle which type of capital plays a relatively more important role for the transmission process as there is a high degree of correlation across these different proxies of financial integration.

In contrast, the relationship between the degree of integration of countries with the United States and the strength of the transmission of US monetary policy shocks to these countries is much weaker (panel B, Table 5). The case of other investment loans is the only one where a high degree of financial integration coincides with a stronger reaction to monetary policy shocks than a low degree.

To understand better the weak evidence regarding integration with the United States, we analyse the issue in more depth by distinguishing between inflows and outflows for trade, and between assets and liabilities for capital stocks in Table 6. But, this split also reveals no systematic relationship between a country's integration with the United States and the strength of the financial transmission of US monetary policy to its equity markets.

An important caveat is that the different proxies for real and financial integration and macroeconomic variables are in some cases significantly correlated with one another; for instance, countries that are very open to trade are generally also open to financial investment from abroad. Hence, one should not give too much weight in interpreting the role of individual variables. Nevertheless, the fact that the results do not change much with regard to the statistical significance of, for example, individual financial integration variables, underlines the robustness of the results.[12]

Another caveat is that other variables omitted from the analysis may also exert an important effect on the transmission mechanism from US monetary policy shocks

[12]As discussed in section II ('Integration and macroeconomic determinants' subsection), not all variables vary significantly over time. Re-estimating Tables 4–6 using country averages, that is, to exploit only the cross-country variation in the data, however, yields qualitatively and quantitatively similar results, although with a lower goodness of fit.

TABLE 5

The role of real and financial integration

		Parameter estimates				
				Difference		
		β_x	*SE*	*(2)*	*(3)*	R^2
(A) With the world – assets and liabilities, inflows and outflows						
Total trade flows	(1) Low	−0.019***	0.007	**0.031**	0.181	0.042
	(2) Medium	−0.034***	0.007		0.820	
	(3) High	−0.032***	0.009			
Total capital stocks	(1) Low	−0.017**	0.007	0.326	**0.001**	0.045
	(2) Medium	−0.027***	0.008		**0.061**	
	(3) High	−0.041***	0.008			
FDI	(1) Low	−0.016**	0.007	**0.000**	**0.081**	0.044
	(2) Medium	−0.039***	0.007		0.212	
	(3) High	−0.030***	0.008			
Portfolio equity	(1) Low	−0.018***	0.007	**0.065**	**0.010**	0.042
	(2) Medium	−0.032***	0.008		0.393	
	(3) High	−0.036***	0.008			
Portfolio debt	(1) Low	−0.012*	0.006	**0.094**	**0.000**	0.045
	(2) Medium	−0.027***	0.008		**0.008**	
	(3) High	−0.046***	0.008			
Other investment loans	(1) Low	−0.020**	0.009	0.133	0.473	0.044
	(2) Medium	−0.037***	0.008		0.312	
	(3) High	−0.029***	0.009			
(B) With the US – Assets and Liabilities, inflows and outflows						
Total trade flows	(1) Low	−0.021***	0.007	**0.031**	0.116	0.044
	(2) Medium	−0.035***	0.007		0.468	
	(3) High	−0.031***	0.007			
Total capital stocks	(1) Low	−0.032***	0.010	0.589	0.637	0.042
	(2) Medium	−0.036***	0.009		0.268	
	(3) High	−0.028***	0.006			
FDI	(1) Low	−0.034***	0.008	0.632	0.197	0.043
	(2) Medium	−0.031***	0.007		0.294	
	(3) High	−0.025***	0.007			
Portfolio equity	(1) Low	−0.021***	0.007	**0.020**	0.268	0.036
	(2) Medium	−0.034***	0.008		0.172	
	(3) High	−0.027***	0.006			
Portfolio debt	(1) Low	−0.025***	0.008	0.674	0.676	0.035
	(2) Medium	−0.028***	0.011		0.994	
	(3) High	−0.028***	0.006			
Other investment loans	(1) Low	−0.017**	0.007	**0.000**	**0.053**	0.044
	(2) Medium	−0.041***	0.007		0.108	
	(3) High	−0.031***	0.008			

Note: The model estimates the effect of US monetary policy shocks on 49 unweighted country indices, testing for time heterogeneity *and* cross-sectional heterogeneity, as follows:

$$r_{it}^{u} = \alpha_i + (\beta_1 S_t) X_{it}^{\text{low}} + (\beta_2 S_t) X_{it}^{\text{mid}} + (\beta_3 S_t) X_{it}^{\text{high}} + \eta_1 X_{it}^{\text{low}} + \eta_2 X_{it}^{\text{mid}} + \eta_3 X_{it}^{\text{high}} + \sum_n \delta_n Z_{i,t} + \varepsilon_{it}^{u},$$

where X^n are 0–1 dummies for $X^{\text{low}} = 1$ if the respective variable $X_{i,t}$ in country i at time t is in the lowest third compared with other countries' respective value and over time; and analogously for X^{mid} and X^{high}. Note that not all X vary over time, but some are purely cross-sectional X_i, as discussed in the text. 'Difference' shows the significance level of tests for the null hypothesis that two respective coefficients are equal, with figures at the 90% significance level printed in **bold**. ***, ** and * indicate statistical significance at the 99%, 95% and 90% levels, respectively.

TABLE 6

The role of real and financial integration with the United States, separated into inflows and outflows or assets and liabilities

		Parameter estimates				
				Difference		
		β_x	*SE*	*(2)*	*(3)*	R^2
(A) From the US						
Trade	(1) Low	−0.025***	0.009	0.566	0.145	0.042
	(2) Medium	−0.021***	0.007		**0.005**	
	(3) High	−0.037***	0.007			
Total capital	(1) Low	−0.022*	0.011	0.676	0.460	0.042
	(2) Medium	−0.027***	0.010		0.691	
	(3) High	−0.030***	0.006			
FDI	(1) Low	−0.026***	0.009	0.742	0.507	0.041
	(2) Medium	−0.029***	0.008		0.669	
	(3) High	−0.031***	0.006			
Portfolio equity	(1) Low	−0.026***	0.007	0.739	0.104	0.040
	(2) Medium	−0.024***	0.008		**0.054**	
	(3) High	−0.036***	0.007			
Portfolio debt	(1) Low	−0.026***	0.009	0.185	0.738	0.041
	(2) Medium	−0.037***	0.010		0.319	
	(3) High	−0.029***	0.006			
Other investment loans	(1) Low	−0.026**	0.010	0.688	0.501	0.042
	(2) Medium	−0.022***	0.008		0.142	
	(3) High	−0.033***	0.007			
(B) To the US						
Trade	(1) Low	−0.025***	0.009	0.566	0.145	0.042
	(2) Medium	−0.021***	0.007		**0.005**	
	(3) High	−0.037***	0.007			
Total capital	(1) Low	−0.042***	0.009	**0.021**	**0.015**	0.045
	(2) Medium	−0.025***	0.007		0.857	
	(3) High	−0.026***	0.006			
FDI	(1) Low	−0.020***	0.007	**0.001**	0.517	0.045
	(2) Medium	−0.044***	0.008		**0.000**	
	(3) High	−0.024***	0.006			
Portfolio equity	(1) Low	−0.036***	0.009	0.160	0.175	0.039
	(2) Medium	−0.026***	0.007		0.889	
	(3) High	−0.026***	0.006			
Portfolio debt	(1) Low	−0.046***	0.009	**0.020**	**0.000**	0.043
	(2) Medium	−0.028***	0.008		0.269	
	(3) High	−0.022***	0.006			
Other investment loans	(1) Low	−0.025***	0.008	0.135	0.721	0.039
	(2) Medium	−0.035***	0.007		0.144	
	(3) High	−0.028***	0.006			

Note: The model estimates the effect of US monetary policy shocks on 49 unweighted country indices, testing for time heterogeneity *and* cross-sectional heterogeneity, as follows:

$$r_{it}^{u} = \alpha_i + (\beta_1 S_t) X_{it}^{\text{low}} + (\beta_2 S_t) X_{it}^{\text{mid}} + (\beta_3 S_t) X_{it}^{\text{high}} + \eta_1 X_{it}^{\text{low}} + \eta_2 X_{it}^{\text{mid}} + \eta_3 X_{it}^{\text{high}} + \sum_n \delta_n Z_{i,t} + \varepsilon_{it}^{u},$$

where X^n are 0–1 dummies for $X^{\text{low}} = 1$ if the respective variable $X_{i,t}$ in country i at time t is in the lowest third compared with other countries' respective value and over time; and analogously for X^{mid} and X^{high}. Note that not all X vary over time, but some are purely cross-sectional X_i, as discussed in the text. 'Difference' shows the significance level of tests for the null hypothesis that two respective coefficients are equal, with figures at the 90% significance level printed in **bold**. ***, ** and * indicate statistical significance at the 99%, 95% and 90% levels, respectively.

to foreign equity markets. For instance, a country may react strongly to US monetary policy shocks because its economy is closely integrated, or because domestic monetary policy may move (or rather be expected to move) in tandem with US monetary policy. It is clearly impossible to capture all omitted variables (such as changes to market expectations about future monetary policy in the 50 non-US economies included in the estimation), but it is important to keep this caveat in mind.

In summary, there is a strong relationship between, on the one hand, macroeconomic policies with regard to financial openness and exchange rates as well as the degree of real and financial integration, and, on the other hand, the financial transmission of US monetary policy to foreign equity markets. Financially open countries and also those with more volatile and flexible exchange rates react substantially more to US monetary policy.

A key finding of this section is that the degree of integration with the rest of the world is strongly linked to the effect of US monetary policy on foreign equity markets, with stock returns in highly integrated countries reacting two to three times more strongly. However, it appears to be the integration with the world as a whole, and not the specific integration with the United States, which determines the strength of the financial transmission process. One interpretation of this transmission pattern is that US policy shocks are transmitted in many cases not directly from the US to individual foreign markets, but may be transmitted in part indirectly through other markets. For instance, a particular country may be affected strongly by a US monetary policy shock – despite having relatively low real and financial linkages with the United States – because of close linkages with economies that do have a high degree of integration with the US economy.

V. Conclusions

How are shocks transmitted through international financial markets? Through which channels does the transmission process take place? This paper has focused on US monetary policy shocks, which are well known to exert substantial effects not only on financial markets, but also on the US and international macroeconomies, to analyse the financial transmission across equity markets for a broad set of 50 equity markets, including those in all major advanced economies and emerging market economies.

We find that a 100 bp tightening of US monetary policy reduces equity returns on average by 2.7%. We show that there is a substantial degree of heterogeneity in the effect of US monetary policy on country-specific equity returns. A few equity markets change hardly at all while others react substantially to US monetary policy shocks – in some cases by as much as 5% in response to a 100 bp change.

Having identified the strength of transmission, the paper has then analysed its determinants. We find particularly strong transmission for countries that have open and relatively liquid financial markets. Moreover, there is substantial evidence that

the transmission process is related to the degree of real and financial integration: equity markets in countries that are relatively open to trade and in particular those that hold a large magnitude of cross-border financial assets react two to three times more strongly to US monetary policy shocks than those of less integrated countries. A striking finding is that it is the degree of integration with the entire rest of the world that appears to matter for the financial transmission process, and not the bilateral integration of countries with the United States.

Overall, considering the evidence of the paper together, the findings suggest that US monetary policy and macroeconomic shocks are to a considerable extent indeed global rather than idiosyncratic shocks, as they affect most if not all markets simultaneously. This implies that diversification and insurance against such shocks is limited, a finding with important implications for portfolio diversification and risk-sharing in global capital markets. Understanding the implications for global capital flows and portfolio choices are important areas for future research.

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Appendix: Variable definitions and sources

Variable definition	Source
US monetary policy shocks – change of the Fed funds future rates in the 30 minutes around FOMC policy announcements on FOMC meeting days	Gürkaynak *et al.* (2005)
Equity market returns – log changes in Datastream price indices for 10 sectors and 50 countries	Datastream
Exchange rates, money market rates and bond yields – log changes in daily spot exchange rates against the US dollar, 3-month (mostly) money market rates and 10-year bonds	Bloomberg, Datastream and national sources
Trade – the sum of imports and exports of goods and services between country *i* and the United States or the ROW, as a ratio of GDP of country *i* and the US or ROW	International Financial Statistics (IFS), IMF
FDI stocks – sum of FDI asset and liability holdings between country *i* and the United States or the rest of the world, as a ratio of GDP of country *i* and the US or ROW	United Nations Conference on Trade and Development (UNCTAD)
Portfolio equity and portfolio debt stocks – sum of asset and liability holdings, averaged over 2001–3, between country *i* and the United States or the rest of the world, as a ratio of GDP of country *i* and the US or ROW	Coordinated Portfolio Investment Survey (CPIS), IMF
Cross-border loans – sum of asset and liability holdings of claims of banks between country *i* and the United States or the rest of the world, as a ratio of GDP of country *i* and the US or ROW	International Locational Banking Statistics (ILB), see BIS (2003)
Capital account openness – dummy equal to one if a country had fully liberalized its capital account and zero otherwise	Annual Report of Exchange Arrangements and Exchange Restrictions (AREAER), IMF
Equity market openness – dummy equal to one if a country had fully liberalized its equity market and zero otherwise	Kaminsky and Schmukler (2008), Bussiere and Fratzscher (2008)
Domestic financial sector openness – dummy equal to one if a country had fully liberalized its domestic financial system and zero otherwise	Kaminsky and Schmukler (2008), Bussiere and Fratzscher (2008)
Stock market capitalization – stock market capitalization relative to domestic GDP	Datastream and IFS
Volatility of exchange rate – SD of daily exchange rate changes (either in effective terms or vis-à-vis the US dollar) the previous 12 months	IFS, IMF and JP Morgan
Exchange rate regime – dummy equal to zero if a country's exchange rate is fixed (classification 1 or 2 of Reinhart–Rogoff) and one if it is more flexible (classification 3 or 4)	Reinhart and Rogoff (2004)
GDP correlation – bilateral correlation of annual real GDP growth rates between a particular country and the United States over the period 1980–2003	IFS, IMF and OECD
Net indebtedness – sum of liabilities of FDI, portfolio investment and other investments as a ratio to GDP	UNCTAD, CPIS and BIS
Geographic distance – log bilateral great circle distance in miles between economic centres of source country and host country	Andy Rose's website

Notes: IMF, International Monetary Fund; GDP, gross domestic product; ROW; rest of the world; OECD, Organization for Economic Cooperation and Development; BIS, Bank for International Settlements.