The Transmission Mechanisms of Monetary Policy Shocks and International Financial Markets

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Abstract: This paper, by using VAR methodology, presents evidence that the monetary policy of a large country causally affects not only that country's stock prices but also asset prices abroad. Besides this it also tests the theoretical implications of the four major international macroeconomic theories and compares the test results with these predictions. In theory expansionary monetary shocks of a large country will reduce domestic and world interest rates, depreciate the domestic currency, and increases domestic output. Increases in the domestic output will raise the demand for foreign goods. The depreciation of the domestic currency, in turn, will decrease foreign price levels and increases foreign real balances, since the depreciation of the currency reduces the foreign currency price of imports. The fall in the foreign country interest rates and the aggregate demand spillover from the large economy will stimulate foreign output, consumption and investment. Thus, expansionary monetary policy in the large economy should not only increase output and, thereby, asset returns domestically, but also abroad.

Keywords: Monetary transmission mechanism, stock returns, monetary policy, exchange rates, interest rates.

Para Politikası Şoklarının Aktarım Mekanizması ve Uluslararası Finansal Piyasalar

Özet: Bu makale, VAR tekniginden yararlanarak, gelismeis ekonomiye sahip bir ulke olan Amerika Birlesik Devletlerinin para politikası soklarinin bu ulke ve diger G-7 ulkelerinin makroekonomik degiskenlerine ve ozellikle uluslararasi finansal piyasalara nasil etki ettigini ortaya koymaktadir. Bunun yaninda, para polikasinin aktarim mekanizmasi ve ilgili ana teoriler aciklanmis ve cikarimlari test edilerek bu test sonuclari teorilerin cikarimlari ile karsilastirilmistir. Teorik olarak, buyuk bir ulkenin genisletici para politikasi yerli ve uluslararasi faiz oranlarini dusururken, paranin degerini dusurur ve yerli mili gelir duzeyinin artmasina sebep olur. Yabanci faiz oranlarinin dusmesi ve buyuk ulkeden gelen ithalat talebinin artmasi sonucu ortaya cikan genisletici etki ayni zamanda yabanci ulkelerin tuketim, yatirim ve milli gelirlerinin de artmasi sonucunu dogurur. Sonuc olarak genisletici para politikasi sadece ilgili ulkenin degil ayni zamanda entegre diger ekonomilerin refah durumunu iyilestirirken, finansal piyasalarada olumlu katkilar saglamis olur.

Anahtar kelimeler: Parasal gecis mekanizmalari, finansal piyasalar, para politikası, döviz kuru, faiz oranları.

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INTRODUCTION

Changes in the stance of the US monetary policy have often caused almost instant reaction from domestic and international financial markets. This response of international stock prices to changes or potential changes in the US monetary policy not only indicates that international markets are linked to one another, but it also shows that the US monetary policy shocks exert real effects on the US and foreign economies. Finance theory suggests that stock prices equal to the expected present value of future net cash flows. If expansionary monetary policy shocks or expansionary monetary environments increase stock returns, these results indicate that expansionary monetary policy exerts real effects either by increasing the future cash flows of firms or by decreasing the discount factors at which those cash flows are capitalized. If monetary policy has real effects, one reason for this could be that it affects firms' balance sheets. Bernanke, Gertler, and Gilchrist (1996, 1998), for example, argue that a monetary tightening can worsen firms' cash flows net of interest, and, consequently, firms' balance sheet positions. This decline in net worth can reduce a firm's ability to borrow, and thereby their ability to spend and invest.

The stylized international business cycles facts show that macroeconomic variables move together. Backus, Kehoe, and Kydland (1993), Stadler (1994) and Basu and Taylor (1999) analyze the international data and find that the balance of trade moves countercyclically, and the trade balance is positively correlated with the terms of trade. They also find that investment is very positively correlated across countries. In a standard model, where mobile capital is flowing in response to a shock by leaving one country and heading overseas, one would expect a negative investment correlation. Finally they report that there is very little cross-country correlation in consumption, demonstrating the extreme lack of risk sharing in the global economy. Backus, Kehoe, and Kydland (1993) also report discrepancies between the international business cycle theory and data and they firstly find that the correlation across countries of output fluctuations is larger than the analogous consumption and productivity correlations. The theory, however, implies that the consumption correlation exceeds the productivity and output correlations. The second anomaly that they pointed out concerns relative price movements: the standard deviation of the terms of trade is considerably larger in the data than it is in theoretical models.

Regarding the movements of stock returns, Campbell (1998), Forbes and Rigobon (1999), Kollman (1999), and Conover, Jensen, and Johnson (1999) find that stock returns are procyclical and international data show co-movements of stock returns. These results are not surprising since there is co-movement of output and

investment, and stock returns are related to future cash returns of firms.

The literature on the link between monetary policy and stocks returns shows that expansionary monetary policy increases ex-post stock returns and hence has real effects. Jensen, Johnson and Mercer (1996) find that stock prices in the US are positively related to expansionary monetary environments, defined by recent changes in the discount rate. Thorbecke (1997) examines how stock returns in the US respond to domestic monetary policy shocks by using different indicators for the stance of the domestic monetary policy and finds that expansionary monetary policies increase ex-post stock returns. Patelis (1997) reports that shocks to the monetary policy can account for the long-run predictability of excess stock returns in the US. Lastrapes (1998) provides cross-country evidence that domestic monetary policy shocks have real effects on domestic stock returns. Rigobon and Sack (2002) and Bordo and Wheelock (2004) also find causal relationship between monetary policy and asset returns by using long term US data. Also, Bernanke and Kuttner (2004) analyze the impact of changes in monetary policy on equity prices and find that, on average, a hypothetical unanticipated 25-basis-point cut in the federal funds rate target is associated with about a one percent increase in broad stock indexes and find that the effects of unanticipated monetary policy actions on expected excess returns account for the largest part of the response of stock prices.

This paper presents evidence that the monetary policy of a large country affects not only that country's stock prices but also asset prices abroad. In theory expansionary monetary shocks of a large country such as the US will reduce domestic and world interest rates, depreciate the domestic currency (US dollar), and increase the level of domestic output and consumption. Increases in the US output will raise the demand for foreign goods. The nominal depreciation of the US dollar, in turn, will decrease foreign price levels and increases foreign real balances, since the depreciation of the US dollar reduces the foreign currency price of imports. The fall in the foreign country interest rates and the aggregate demand spillover from the US will stimulate foreign output, consumption and investment. Thus, expansionary monetary policy in the US should not only increase output and, thereby, asset returns domestically, but also abroad[1].

Developments in one country can be transmitted to another country if the exchange rate has effects in addition to its effects on the trade balance. The appreciation of the

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1 See Forbes and Rigobon (1999) with regards to the mechanisms of stock market comovements.

US dollar as a result of a contractionary monetary policy for example, implies the depreciation of the other country's currency, which increases the domestic currency prices that foreigners have to pay for imports. A contractionary monetary policy in the US will also have an impact on the foreign country's output through its effects on that country's savings, money demand, prices of imported inputs, and wages. The depreciation of foreign currency represents a fall in the purchasing power of a unit of that country's output over a basket of consumer goods that includes imports. Agents in the foreign country react as they would to any loss in real income by reducing saving so as to smooth consumption over time.

The effects of a contractionary US monetary policy shock on the next three variables explain why a depreciation of foreign currency may lower output abroad and lead to output co-movement across countries (see Caves, Frankel, and Jones [1990]):
Demand for Money: if imports have a weight of α in the foreign country's CPI, then a one-percent depreciation of foreign currency that raises that country's import prices by one percent will raise the CPI and reduce the real money supply by α percent. Thus it will shift the LM curve to the left and have a contractionary effect on that country's output. If the dollar appreciation originated from a US monetary contraction, then it represents a positive transmission. The effect through the money demand channel is the opposite of the effect via the trade balance that appears in the standard Mundell-Fleming model. Europeans argued in the 1980s that the mix of tight money and loose budget policies in the US, which resulted in a strong dollar, had adverse effects on European growth.

Prices of imported inputs: if the price of oil or other imported inputs is set in dollars, then an depreciation of the dollar will reduce the price of the input for foreign firms.

Wages: if wages abroad are tied or indexed to the foreign country's CPI, then the depreciation of foreign currency will raise wages in that country relative to the price of goods produced abroad. This will increase input costs for firms, which leads them to cut production.

Even though the main goal of this study is to determine the effects of the US monetary policy shocks on the non-US G-7 countries' stock returns, it also shows how these monetary shocks affect the non-US G-7 countries' macroeconomic variables such as interest rates, interest rates spread, exchange rates and output. This is important since the monetary policy shocks of the US causes the changes of domestic and foreign stock returns by first affecting the mentioned macroeconomic variables. In addition, using previous studies' empirical results and the empirical

results of this study, main international open economy models' predictions regarding above indicated macroeconomic variables are compared.

In general equilibrium models with flexible prices, the real equilibrium is independent of monetary developments. Prices and nominal exchange rates depend on the behavior of the money supply in the two countries, and the nominal exchange rate adjustment is the equilibrating mechanism that insulates real output and consumption from monetary effects. Thus, these models indicate that monetary policy does not affect real stock returns at home and abroad. Sticky-price-and-wage open economy models, however, indicate that monetary policy shocks in large countries are transmitted abroad via changing exchange rates and via the effects on saving, money demand, prices of imported inputs, and wages of foreign countries.

Existing empirical studies, unlike the current paper, have not established a causal link between the monetary policy of large country and asset prices abroad. Conover, Jensen, and Johnson (1999) for instance, report that expansionary US monetary policies are positively correlated with international stock returns in 16 OECD countries by using OLS regression and conclude that their results do not mean that there is causation from the US monetary environments to indicated countries' stock returns. Forbes and Rigobon (1999) measured stock market co-movements across many stock markets to show the non-existence of contagion effect. This study, on the contrary, uses a vector autoregression (VAR) technique to show that a positive nominal monetary shock to the US economy positively affects the output and the stock returns of non-US G-7 countries (Canada, Japan, Germany, France, United Kingdom and Italy)[2]. The VAR approach, by using orthogonalized innovations in monetary policy, allows one to make causal statements about the relationship between monetary policy and stock returns.

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2 Kollman (1999) models the international monetary transmission mechanism with nominal rigidities and his simulation results indicate that there are comovements of output, consumption, investment, and asset returns across G-7 countries. He identifies the stands of monetary policy as innovations to M1, while monetary authorities of the countries included target interest rates. Moreover, he weights the effect of each country's monetary policy effect on other countries equally. This study, however, focuses on the US monetary policy effects on other countries output and asset returns because the effects of the US policy on other countries are greater than vice-versa. Also, the indicators used to proxy for the stance of the US monetary policy are the Federal Funds Rate, the ratio of non-borrowed reserves to total reserves and the Romer and Romer index.

Countries that have greater economic ties with the US show more significant responses to shocks to the US monetary policy, such as Canada and the UK. Italy, on the other hand, is the country the least affected by the changes in the stance of the US monetary policy, and this weaker response likely arises because of the relatively reduced economic links between these two countries. For Japan, Germany, and France, the degree of responses of the variables to the shocks are statistically significant but not as high as the cases of the UK and Canada but certainly higher than the responses of the variables from Italy.

LITERATURE SURVEY

In *general equilibrium models with flexible price and/or wage adjustments* (i.e. International Real Business Cycle models and Neo-Classical Equilibrium models), the real equilibrium is independent of monetary phenomena. According to Obstfeld and Rogoff (1995, 1996), in a two-country model with flexible prices, monetary policy has no short run effects on the real interest rate, output, or consumption in either country. Rather, only nominal variables (interest rates, prices and the nominal exchange rate) are affected by changes in the nominal money stock. Therefore, for these general equilibrium open economy models with flexible prices, a monetary policy shock in the US should not have real effects domestically or abroad.

In *the traditional Keynesian approach (the Mundell-Fleming-Dornbusch tradition)*, a depreciation of the domestic currency resulting from expansionary monetary policy reduces that country's relative price of exports and redirects world expenditure towards domestic goods. Domestic imports are assumed to have prices that are sticky in terms of the foreign currency, so that a depreciation of the home currency in the foreign exchange market causes a proportional rise in the home currency price paid for goods imported from abroad. Correspondingly, in those models, because domestic export prices are sticky in domestic currency, a rise in exchange rate causes a proportional fall in the foreign currency price of exported home goods. Thus, the domestic currency depreciation automatically raises the terms of trade, shifting domestic demand toward domestically produced tradables and away from imports. In these models, an expansionary monetary policy in the home country increases domestic output, consumption and welfare. However, it crowd-outs the foreign country's investment and output through the transmission mechanism of exchange rates. The implication of these models regarding stock returns is that an expansionary monetary policy in the home country increases stock returns at home, but reduces stock returns abroad, unless the foreign monetary authority reacts accordingly.

In *the Obstfeld-Rogoff open-economy model with sticky prices (1995, 1996) and sticky wages (1999)*, expansionary monetary shocks reduce domestic and world interest rates, increase the level of domestic output, asset returns and consumption, and depreciate domestic currency. The reduction in the world real interest rate and the nominal depreciation translates into a decline in the domestic terms of trade and an increase in foreign consumption. In their model, it is ambiguous whether expansionary US monetary policy increases foreign countries' output and hence stock returns, since the increase in aggregate consumption and the relative price change work in opposite directions. If the foreign authority does not react to the expansionary US monetary policy, foreign interest rates increase relatively to the US interest rate, which appreciates the foreign currency, worsens that country's trade balance and lowers stock returns. If the foreign authority does not remain passive, US monetary policy will not affect the foreign country's asset prices.

Walsh (1998) reaches similar conclusions to those of Obstfeld and Rogoff (1995, 1996 and 1999) outlined above[3]. He uses the federal funds rate to proxy for the stance of the US monetary policy and reports that the output response to monetary policy shocks is much more consistent with empirical estimates of the impact of policy shocks than were the equilibrium models or simple sticky wage modification to a money in the utility function model. Using a two-country model to incorporate open economy considerations, he considers the impact of an expansionary monetary policy shock. In response to this expansionary policy shock, the real exchange rate rises, representing a depreciation of the home currency, which shifts aggregate demand toward the home country. Increases in income in either country increase aggregate demand in the other. A contractionary foreign monetary policy, in turn, induces a domestic output expansion arising from the domestic real depreciation. The rise in the foreign short-term interest rate induces a rise in the domestic interest rate as well, and this dampens the domestic output expansion. According to this reasoning, stock returns both abroad and in the US respond positively to an expansionary monetary policy in the US

Under *the Pricing to Market (PTM)* form of price stickiness for tradables, exchange rate changes lead to proportional short-run deviations from the law of one price[4]. Nominal domestic currency depreciation has no expenditure-switching effect at all in

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3 See also Caves, Frankel and Jones (1990) with regards to the two transmission channels from a large country monetary policy shock to abroad.
4 See Lane (1999) for detailed survey of open economy macroeconomy models especially for the PTM.

the short run because all prices are temporarily fixed in domestic currency units. Producers hold foreign-currency prices constant and allow their foreign markups and profit margins to adjust in proportion to unexpected exchange rate movements. Engel and Devereux (1998) argue that this behavior can largely insulate an economy from foreign monetary shocks. According to Lane (1999), since home and foreign price levels are sticky under the PTM approach, a movement in the nominal exchange rate shifts the real exchange rate and delinks home and foreign consumption growth. In contrast, the correlation of home and foreign output rises, since expansion in domestic demand raises demand for imports at the fixed relative price of imports in terms of domestic currency.

According to the PTM approach, international markets for manufacturing goods are sufficiently segmented so that producers can tailor the prices they charge to the specific local demand conditions prevailing in different national markets. A European firm exporting to the US, for example, may find it optimal to lower its American price mark-up in the face of a depreciation of the dollar against the Euro. In that case, its US dollar prices would not rise one-for-one with the dollar's nominal exchange rate (the degree of pass-through to its US prices would be less than 1). Thus, in these models, nominal exchange rate changes tend to have small or negligible short-run effects on international trade flows. The European firm tolerates a fall in the per-unit profits on its US sales, while presumably maximizing its total profits from global sales[5]. The implication of the PTM approach regarding output and stock returns is that expansionary monetary shocks in the US increase output and stock returns both in the US and abroad, since it improves future cash flows of firms all over the world.

The following table summarizes the predictions of each of these main approaches to the international transmission mechanisms regarding the impact of a large country's contractionary monetary policy shocks on other economies.

Table – Predicted Responses to Contractionary Monetary Policy Shocks

	International RBC	M-F-D Hypothesis	O-R Open Economy Model	PTM Hypothesis
Short-term interest rates (US)	Drop	Rise	Rise	Rise

5 Goldberg and Knetter (1997) find that one-half is the median fraction by which exporters to the US offset dollar depreciation (within a year) by raising their export prices.

Short-term interest rates (Foreign)	No Change	Rise	Rise	Rise
Nominal Exchange rate (US)	Appreciate	Appreciate	Appreciate	Appreciate
Real Exchange rate (US)	No Change	Appreciate	Appreciate	Appreciate
Output (US)	No Change	Drop	Drop	Drop
Output (Foreign)	No Change	Rise	Ambiguous	Drop
Stock returns (US)	No Change	Drop	Drop	Drop
Stock returns (Foreign)	No Change	Rise	Ambiguous	Drop

Four main theoretical models are considered here: the general equilibrium models with flexible price and wage adjustments (international real business cycles models), the traditional Keynesian approach (Mundell-Fleming-Dornbusch tradition), the open economy models with sticky prices and wages (Obstfeld and Rogoff [1995, 1996 and 1999], Walsh [1998] and Caves, Frankel and Jones [1990], for example) and the PTM – Pricing to Market approach.

The International Transmission of Interest Rates and Exchange Rates Responses
Eichenbaum and Evans (1995), Christiano, Eichenbaum and Evans (1998), and Frankel, Schmukler, and Serven (2000) have provided empirical evidence on international monetary transmission mechanisms, which allows one to confirm which of the theories' predictions with regards to exchange rates, interest rates and interest rates spreads outlined in the table above hold in reality.

Frankel, Schmukler, and Serven (2000)[6] for instance, investigates the sensitivity of local interest rates to international interest rates, and how this sensitivity is affected by the countries' choice of exchange rate regime. They find evidence for a full transmission of interest rates, and they also show that more rigid currency regimes tend to exhibit a stronger transmission of interest rates than more flexible regimes. Eichenbaum and Evans (1995), in turn, using three measures of shocks to monetary policy[7], find substantial evidence of a link between monetary policy and exchange rates. Contractionary shock to US monetary policy leads to a sharp, persistent

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6 See also Mishkin (2001) for the monetary transmission mechanism with regards to interest rates and exchange rates.
7 These are shocks to Federal Funds Rate, to the ratio of non-borrowed to total reserves, and the changes in the Romer and Romer index of monetary policy.

increase in the US interest rate as well as a persistent rise in all of the non-US G7 countries' interest rates. In all cases, the increase in the US interest rate exceeds the corresponding increase in the other countries' interest rates. So, the shock leads to a fall in foreign and domestic interest rate spread ($R^F - R^{us}$). This can be interpreted as reflecting a policy in which foreign monetary authorities initially only partially accommodate the increase in US interest rates. Thus, contractionary shocks to US monetary policies are followed by sharp, persistent decreases in the spread between foreign and US interest rates. The same shocks lead to sharp, persistent appreciation in US nominal and real exchange rates. As it is mentioned before, International Real Business Cycle models and Neo-Classical Equilibrium models, on the contrary, imply that contractionary shocks to the money supply cause domestic interest rates to fall and lead to a rise in the spread between foreign and domestic interest rates. The maximal impact of the monetary shock on real and nominal exchange rates does not occur contemporaneously; instead the dollar continues to appreciate for a substantial period of time. These results are inconsistent with rational expectations overshooting models of the sort considered by Dornbusch. However, they could be viewed as supporting a broader view of overshooting in which exchange rates eventually depreciate after appreciating for a period of time.

According to Eichenbaum and Evans (1995), this gradual appreciation of the dollar after a contractionary monetary policy is related to the literature on the forward premium bias. That literature finds that future changes in the exchange rate tend to be negatively related to the forward premium. This pattern is often referred to as the forward premium puzzle. What is new about their result is that they find a monetary-policy-induced forward premium puzzle. A contractionary US monetary policy shock leads to a rise in the US interest rate relative to foreign interest rates. This rise is associated with a persistent appreciation of the dollar. Consequently, high interest rate differentials will be associated with an appreciating currency, thus leading to a conditional negative forward premium bias.

Eichenbaum and Evans's (1995) results indicate that contractionary the US monetary policy shocks not only increase domestic short and long run interest rates and reduces domestic economic activity but also reduces economic activity abroad, by increasing international interest rates and reducing its external demand from abroad. Since investment is determined by interest rates (especially long-term rates) and by current and future aggregate domestic and external demand, contractionary US monetary policies have real negative effects on investment, output, cash flows and profitability at domestic markets and abroad. Thus, we expect that contractionary US monetary policies will reduce the US and foreign ex-post stock

returns[8].

DATA AND METHODOLOGY
The main goal of this study is to show that the monetary policy of large countries has real effects not only domestically, but also abroad. Because of the aggregate demand externality, output and asset prices in foreign countries are negatively affected by contractionary monetary policies of large countries. This paper focuses on the impact of the US monetary policy on output and asset returns of Canada, Japan, Germany, France, United Kingdom and Italy.

The results also provide evidence on whether the implications of each different theory outlined above hold empirically. The Mundell-Fleming-Dornbusch and Obstfeld-Rogoff models imply a negative relation between shocks to monetary policy in the large country and output and asset prices in the other country. On the other hand, the PTM models and this study imply a positive relationship.

The data set includes monthly data from 1971:1 to 1998:12. The data set is limited to end of 1998 because of the entrance of many European countries to European Monetary union and the use of the euro as joint currency. To see the affect of an external shocks on the financial variables of the member countries of European Monetary Union could be subject of another study for the periods of pre and post euro base. The main source of the US data is the Federal Reserve Bank of St. Louis Database, while foreign data is mainly obtained from the International Financial Statistics and OECD Statistical Compendium. Germany: OECD, 1998 (CD-ROM version). The US monetary policy shocks are proxied by the Federal Funds rate (FFR) and by the ratio of Non-borrowed Reserves to Total Reserves (NBRX).

The methodology to be used here is similar to that of Eichenbaum and Evans (1995) and of Christiano, Eichenbaum and Evans (1998)[9]. Because both foreign and the US indicators may be endogenous, a vector autoregression technique (VAR) is used. The tests show the dynamic response functions of (i) the interest rate differential between each foreign country and the US, (ii) foreign output and (iii) the stock market returns in that country to a contractionary monetary policy shock that is

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8 Malliaropulos's (1998) predictions are also in same line as Eichenbaum and Evans. He investigates the link between international stock return differentials relative to the US and predicts that depreciation of domestic currencies against dollar will lead to decreases in stock returns in domestic economies.
9 See also Ben S. Bernanke, Jean Boivin, and Piotr Eliasz (2004) for the use of VAR method.

orthogonal to US output, price level and an index of sensitive commodity prices.

Variables in the VAR include the US industrial production (Y^{us}), the US consumer price level (CPI^{us}), the index of sensitive commodity prices (SPCOM), the proxy of the stance of the US monetary policy (FFR, NBRX), stock returns of US (SPI^{us}), a measure of the difference between US and foreign short-term interest rates (R^{F} - R^{US}), the foreign country output (Y^{F}) and the nominal and real stock returns in each foreign country (SPI^{F}). All variables are in logarithms except for R^{F} and R^{US}.

When the FFR is used as the proxy of the stance of the US monetary policy, the variables are ordered as follows:
$$\{Y^{us}, CPI^{us}, SPCOM, FFR, SPI^{us}, (R^{F} - R^{US}), Y^{F}, SPI^{F}\}.$$
This ordering implies that the US monetary authority looks at the contemporaneous values of Y^{us}_{t}, CPI^{us}_{t} and $SPCOM_{t}$ when setting the monetary policy, but not at SPI^{us}, (R^{F} - R^{US}), Y^{F} and SPI^{F}. These last four variables, in turn, respond to the changes in the US monetary policy[10]. Note that the ordering of these variables was changed to test for the robustness of the results.

A measure of the difference between foreign and the US short-term interest rates (R^{F} - R^{US}) is used for two reasons. First, interest rates constitute good proxies for the stance of monetary policies, since most central banks use this indicator to achieve its monetary policy goals. Second, the interest rates differential also predicts exchange rate movements; thus, including this differential eliminates the need to add the exchange rates in the system of equations.

EMPIRICAL RESULTS
The tests were run using (FFR) and the (NBRX) as the proxy of the stance of the US monetary policy. The test results support the hypothesis that the contractionary monetary policies of a large country (i.e., the US) affect negatively not only this country's output and stock prices but also output and asset prices abroad. Contractionary monetary policy shocks in the US increase domestic and world interest rates, decrease the level of domestic output, investment and consumption, and appreciate the domestic currency (US dollar). The decrease in the US output (income) reduces the demand for foreign goods. The nominal appreciation of the US dollar, in turn, increases foreign price levels and decreases foreign real balances,

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10 Note that when NBRX is used the proxy of the stance of the US monetary policy, the FFR will follow the NBRX in ordering and the placement of the other variables will be same.

since the appreciation of the US dollar increases the foreign currency price of imports. The rise in the foreign country interest rates and the negative aggregate demand spillover from the US depress foreign output, consumption and investment. Thus, contractionary monetary policy shocks in the US decreases output and asset returns not only domestically, but also abroad.

After a contractionary US monetary policy shock proxied with the increase of FFR, the interest rate spread (R^F - R^{us}) decreases sharply[11], and this statistically significant decrease takes between 3 months to 6 months depending on which country is being tested. Except for Canada, all the other non-US G-7 countries' output increases initially (even though these increases are not statistically significant), and then they decrease significantly. Following a contractionary US monetary policy shock, stock returns of entire-non-US G-7 countries' decline significantly. The degree and duration of this decline changes depend on the country considered. These results remain similar when running the VARs using the NBRX as the proxy for the stance of the US monetary policy.

The results found remain unaltered when the VARs are rerun using different ordering of the variables from the benchmark described above[12]. In addition, the regression results do not change when the interest rates spread is substituted by the foreign interest rate alone, and when the variable SPCOM is omitted (see appendices 4 and 5).

The following sections discuss the effect of contractionary US monetary policies on the non-US G7 countries' output and stock returns with details.

Changes in the Federal Funds Rate
The dynamic response functions were calculated assuming a Wold ordering of $\{Y^{us}$, CPI^{us}, $SPCOM^{us}$, FFR, SPI^{us}, (R^F - R^{us}), Y^F, $SPI^F\}$. A monetary policy shock is identified as the component of the innovation in FFR_t that is orthogonal to Y^{us}, CPI^{us}, and $SPCOM^{us}$. Among other things, this corresponds to the assumption that the contemporaneous portion of the feedback rule for setting FFR_t involves (Y^{us}, CPI^{us}, $SPCOM^{us}$), but not SPI^{us}, (R^F - R^{us}), Y^F, and SPI^F.

Overall, the test results show that a contractionary US monetary policy shock,

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11 This drop in the interest rate spread occurs because the increase in the US interest rates is greater than the increase in foreign interest rates.
12 These tests results are available upon request.

identified as a positive innovation to the FFR, leads to statistically significant increases in interest rates and decreases in output and stock returns on non-US G7 countries.

Regarding the US macroeconomic variables, their impulse response functions to a contractionary monetary policy shock resemble the existing literature about the real effects of monetary policies. Output decreases continuously after a contractionary monetary policy shock, with the greatest fall occurring around the twentieth month. Prices (CPI) initially rise after a contractionary shock for one year at first, and then falls afterwards. The sensitive commodity price index rises for about ten months, showing a significant reduction afterwards. The federal funds rate, in turn, increases significantly for about two years before returning to its initial level. The US stock returns decrease sharply after a contractionary monetary policy shock, reaching its lowest level around the seventh month, and returning to its initial level around two and half years later. These results are robust to whether the monetary policy shocks are proxied by the FFR or by the NBRX (see Appendix 1, Figures A1.1 and A1.2).

Impact on Canada: Contractionary shocks to the US monetary policy shock causes Canadian interest rates to rise significantly for around 12 months (see Appendix 2, Figure A2.1). Impulse response functions show that the increase in Canadian interest rates is higher than the response of the US interest rates (TBILL). After the contractionary monetary policy shock, the Canadian output decreases and reaches its trough around the fifteenth month, and returns to its initial level around thirty-sixth month (see Appendix 2, Figure A2.1). As with interest rates, the fall in Canadian output is greater than the drop in US output. Moreover, the duration of the contraction in Canadian output in response to the US contractionary monetary policy is longer than the fall in the US output. The response functions of the Canadian stock returns to a contractionary US monetary policy shock is similar to the US stock returns response: the SPI decreases significantly reaching the lowest level around seventh month, and returning to their initial levels around thirty-sixth month (see Appendix 2, Figure A2.1). These robust responses of the Canadian macro variables to the contractionary US monetary policy shocks can be explained by the strong link between the two economies.

Impact on France: The contractionary US monetary policy shocks lead to higher interest rates in France, but this increase is lower than the increase in the US interest rates. Thus, after the contractionary US monetary policy shock, the (R^F- R^{us}) decreases significantly for around six months and reaches its initial level after that point (see Appendix 2, Figure A2.2). The output of France increases (not

statistically significant) after the shock for around eight months and then decreases significantly after that point, and reaches its trough around the thirtieth month (see Appendix 2, Figure A2.2). The stock returns of the France decline after the shock significantly reaching its lowest point around the seventh month (see Appendix 2, Figure A2.2).

Impact on Germany: *The* reaction of the German variables to the contractionary US monetary policy shock is very similar to the response of France's variables. Interest rates in Germany increases significantly until the sixteenth month (see Appendix 2, Figure A2.3), while output falls in response to the shock (as shown in Appendix 2, Figure A2.3, the drop in output is only significant after the twentieth month). The only difference between France and Germany's variables responses occurs on the behavior of German stock returns as a result of an increase in FFR (see Appendix 2, Figure A2.3). Even though the German stock returns decreases after the contractionary policy shock, the decrease is only statistically significant between the second and the twelfth months.

Impact on Italy: The Italian interest rates' response to an increase in FFR is similar to France's and Germany's. A positive innovation to the FFR leads to an increase in the Italian interest rates, which is lower than the increase in US interest rates responses (see Appendix 2, Figure A2.4). Unlike the previous countries' output responses, the Italian output initially increases for seventeen months and then decreases, following an increase in FFR (see Appendix 2, Figure A2.4). The decrease in Italian output becomes statistically significant after two years following the shock. As a result of this late output response, the Italian stock prices decline after the contractionary US monetary policy, but its response is not statistically significant and can be neglected (see Appendix 2, Figure A2.4). Thus, a contractionary US monetary policy causes the Italian output to decrease, but it does not affect the Italian stock returns. This weak response of the Italian macro variables may imply that either the integration of these two countries are not strong or the Italian stock market is not well developed relative to the other countries considered here.

Impact on Japan: Contractionary US monetary policy shocks lead to higher interest rates, to lower output and stock returns in Japan, and these responses are statistically significant (see Appendix 2, Figure A2.5). The Japanese output declines sharply after a positive shock to FFR and reaches its lowest point around the seventeenth month, returning to its initial level after three years. The output response is statistically significant only between the twelfth and eighteenth months. The stock

returns in Japan, in turn, decline significantly only after five months, and this decrease has a short duration.

Impact on UK: A positive innovation to the US FFR leads to statistically significant higher interest rates and lower output and stock returns in the UK (see Appendix 2, Figure A2.6). The output level in the UK decreases right after the shock and reaches its lowest point around the twentieth month. The statistically significant decrease in stock returns occurs after the second month and this variable returns to its initial level around the eighteenth month.

Changes in the Ratio of Non-borrowed Reserves to Total Reserves
When the ratio of non-borrowed reserves to total reserves (NBRX) is used as a proxy for the stance of the US monetary policy, the dynamic response functions are calculated assuming a Wold ordering of $\{Y^{us}, CPI^{us}, SPCOM^{us}, NBRX, FFR, SPI^{us}, (R^F-R^{us}), Y^F, SPI^F\}$. A monetary policy shock is identified as the component of the innovation in $NBRX_t$ that is orthogonal to Y^{us}, CPI^{us}, and $SPCOM^{us}$. Among other things, this corresponds to the assumption that the contemporaneous portion of the feedback rule for setting $NBRX_t$ involves (Y^{us}, CPI^{us}, $SPCOM^{us}$), but not FFR, SPI^{us}, (R^F-R^{us}), Y^F, and SPI^F.

The test results[13] show that an expansionary US monetary policy shock identified as the component of the positive innovation in NBRX leads to results similar to those found when using the innovations to the FFR to proxy for monetary policy shocks. However, the results are not as strong as the case of FFR[14]. The expansionary US monetary policy shocks leads to statistically significant decreases in interest rates and increases in output and stock returns for Canada, Japan and the UK, but not-significant results for France, Italy and Germany.

A positive change in NBRX leads to higher output and stock returns in both the US and Canada. The maximum output increase in the US occurs twelve months after the

13 Due to limitations in publishing test results are only reported without adding the figures of the impulse response functions for NBRX shocks. These tests results (figures of impulse response functions) are available upon request.
14 These weaker results can be explained by two factors. Firstly, as Bernanke and Blinder (1992) show, the FFR is the best indicator of the stance of the US monetary policy. Secondly, if the effects of the contractionary and expansionary monetary policy shocks are not symmetrical, then the positive shocks to the FFR may have a greater impact in economic activity than a positive shock to the NBRX. This will be the case if agents react more to contractionary monetary policies than to expansionary policies.

shock, while for Canada this happens around sixth month. For both countries, the response of the stock returns is significantly positive, and it takes a year to return to its initial level.

For the case of France, the change in the US NBRX increases the French output significantly ten months following the shock, but the initial increase in French stock returns is not statistically significant. The German output and stock returns responses to a change in NBRX are similar to the responses of France's output and stock returns.

The Italian output and stock returns responses, in turn, are negligible. Finally, the expansionary US monetary policy shocks increases both Japan's and the UK's output and stock returns significantly.

Thus, while we get similar results for the NBRX and for the FFR changes, the significance and duration of the impact on non-US G7 countries' output and stock returns are weaker when using NBRX to proxy for the stance of the US monetary policy.

COMPARISIONS OF THE PREDICTIONS OF THE THEORIES WITH THE EMPIRICAL RESULTS

The previously mentioned studies and the empirical test results found here show that contractionary US monetary policy shocks lead to a rise in domestic and international interest rates, and a fall in the spread between the foreign and domestic interest rates causing the nominal and real exchange rates (dollar) appreciation. In addition, contractionary monetary policies in the US cause a decline of both domestic and foreign output and stock returns. These results conform to the international business cycle facts outlined above.

The general equilibrium models with flexible price and wage adjustments (International Real Business Cycles Models and the Neo-Classical Equilibrium Models) fail to explain both domestic business cycle events and international business cycles facts.

The traditional Keynesian approach (Mundell-Fleming-Dornbusch tradition), in turn, partially explains these business cycles facts. Even though these models successfully explain the domestic macroeconomic variables' reaction to a contractionary monetary policy shock, they fail to explain the international transmission effects. Contrary to these models' predictions, after a contractionary US policy shock,

foreign output and stock returns move in the same direction as US output and stock prices.

The open economy models with sticky prices and wages (Obstfeld and Rogoff [1995, 1996, 1999], Walsh [1998] and Caves, Frankel and Jones [1990]) replicate most of the domestic and international business cycle facts. However, in these models, it is ambiguous whether expansionary US monetary policies increase foreign countries' output and hence stock returns, since the increase in aggregate consumption and the relative price shift work in opposite directions. If the foreign authority does not react to US expansionary policy, foreign interest rates increase relatively to the US interest rate, which appreciates the foreign currency, worsens that country's trade balance and stock returns. If the foreign authority does not remain passive, the US monetary policy will not affect the foreign country's asset prices.

Finally, the Pricing to Market (PTM) approach shows the best performance in replicating domestic and international business cycles facts. As predicted by the PTM approach, domestic and foreign interest rates, investment, output and stock returns move in the same directions.

CONCLUSIONS

The existing literature about the effects of monetary policy on output and stock returns has already provided evidence that contractionary shock to monetary policy in the US leads to declining domestic output and stock returns. This paper has shown that, through aggregate demand externalities, not only domestic, but also foreign output and asset prices fall in response to a contractionary monetary shock in US.

As the federal funds rate increases, for example, it reduces output in the US. It also appreciates the US dollar, which increases the input costs of foreign firms that depend on the US products. Because of the fall in the US output, foreign companies' sales are also affected, since they are able to export less to the US. These two factors affect those firms' cash flows, which, in turn, reduce their stock valuation.

A third effect of the aggregate demand externality arises because the increase in the US interest rates also leads to a rise in the international interest rate. This reduces investment, consumption and depresses economic activity worldwide, causing the co-movement of declining output and stock returns in the US and abroad.

Among the three indicators of the US monetary policy stance, the federal funds rate shows the best performance. The impulse response functions are more sensitive to shocks to the federal funds rate not only in terms of the magnitude of the response, but also in terms of statistical significance. When the ratio of non-borrowed reserves to total reserves is used, the results are relatively weaker, even though they still confirm the hypothesis put forth here that a contractionary monetary policy shock in a large country has real effects on other countries' economies.

Overall, all countries analyzed here are affected by monetary policy shocks occurring in the US. Both output and stock prices in the non-US G7 countries decrease significantly following a contractionary monetary policy in the US. Of all these countries, Italy is affected the least from a contractionary monetary policy shock arising from the US. The main empirical findings of this study can be summarized as follows:

Canada is the country whose economy is affected the most by the contractionary policy shock in the US. The decrease in Canadian output and stock returns following the shock is greater than the fall in US output and stock prices, and this response is also statistically significant. This robust result arises due to the strong economic links between the economies of the US and Canada. In the UK, France and Japan, the fall in output and in stock returns is less than that seen in the US output and stock returns, but, still, the impulse response functions are statistically significant. In Italy, the response of this country's interest rates and output shows the expected direction and this response is statistically significant. However, even though the Italian stock prices show a declining tendency, this outcome is not statistically significant. This result may arise either because the ties between the Italian and the American economies are weak or because the Italian Stock Market is not well developed.

The results outlined above largely support the PTM approach to the open economy monetary transmission mechanism. The Keynesian and the Obstfeld-Rogoff models are partially supported by the findings of this study, while the general equilibrium models' predictions do not conform to the empirical results found here.
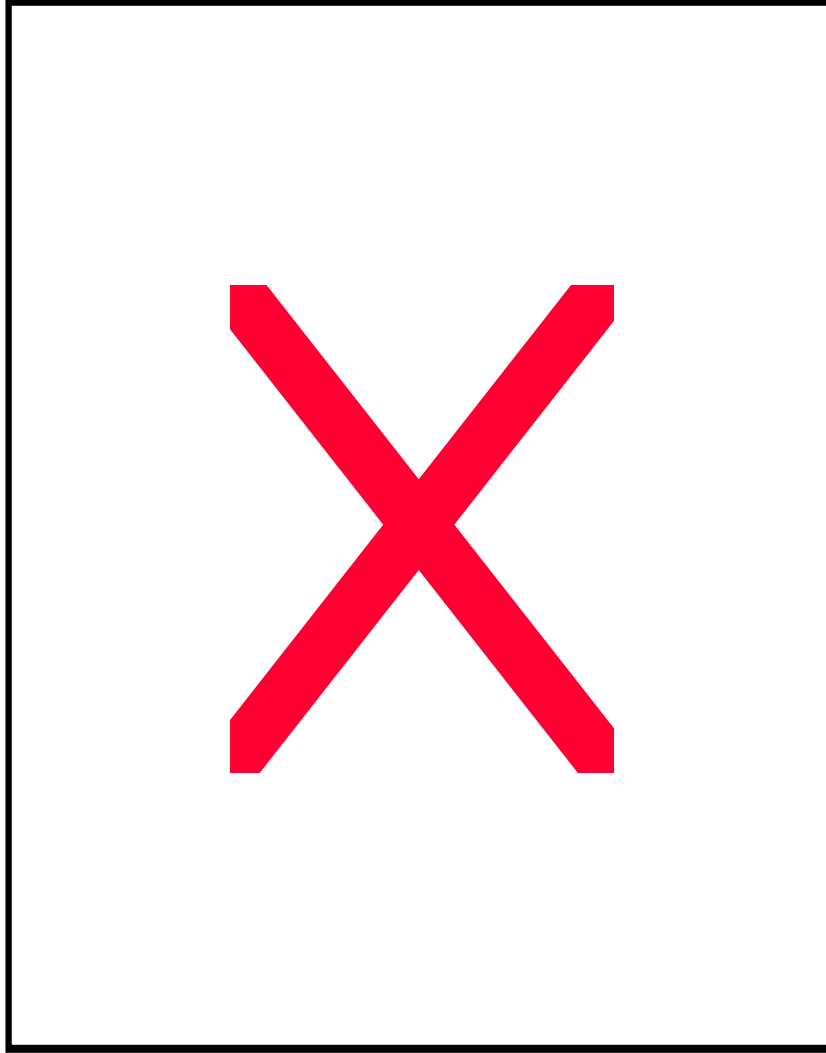
Appendix 1
US Macroeconomic Variables

Figure A1.1. Response of the US Macroeconomic Variables to a Change in the FFR

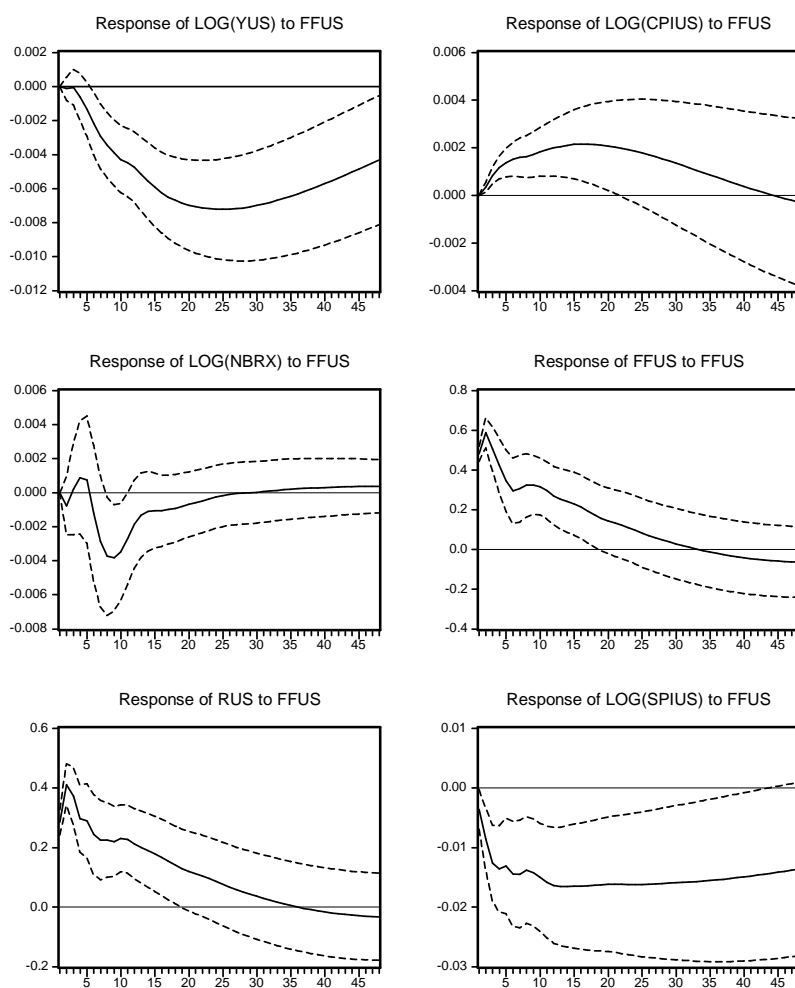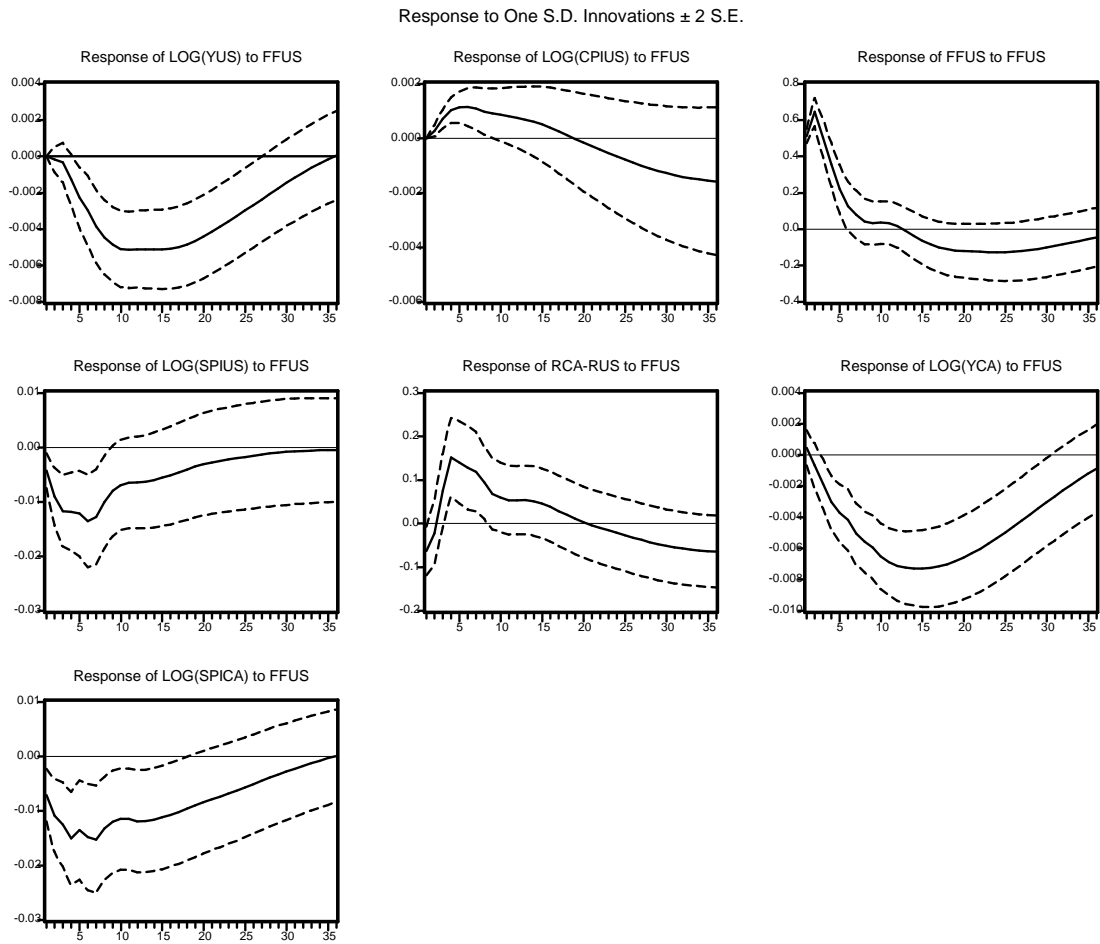Response to One S.D. Innovations ± 2 S.E.

Response of LOG(YUS) to FFUS

Response of LOG(CPIUS) to FFUS

Response of LOG(NBRX) to FFUS

Response of FFUS to FFUS

Response of RUS to FFUS

Response of LOG(SPIUS) to FFUS

Figure A1.2. Response of the US Macroeconomic Variables to a

Change in the Log(NBRX)

Appendix 2
The effect of the U.S. FFR shocks on non-US G-7 Countries'
Macroeconomic Variables - Wold Ordering: $\{Y^{us}, CPI^{us}, FFR, SPI^{us},$
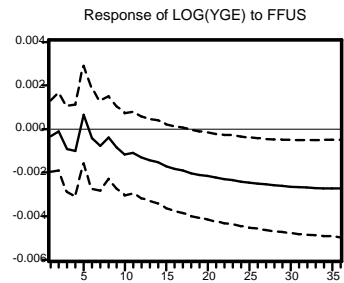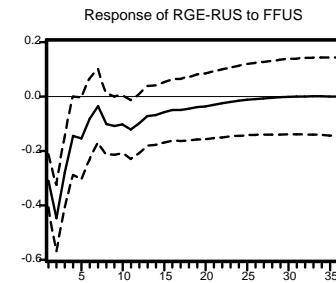**$(R^{f}\text{-}R^{us}), Y^{f}, SPI^{f}\}$**

Response to One S.D. Innovations ± 2 S.E.

Response of LOG(YUS) to FFUS	Response of LOG(CPIUS) to FFUS	Response of FFUS to FFUS

Response of LOG(SPIUS) to FFUS	Response of RCA-RUS to FFUS	Response of LOG(YCA) to FFUS

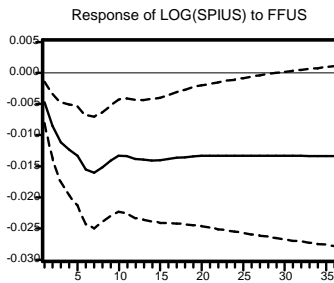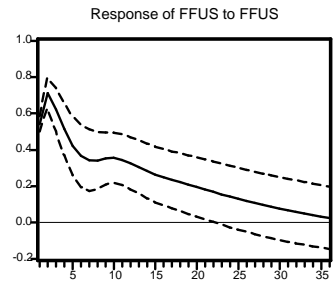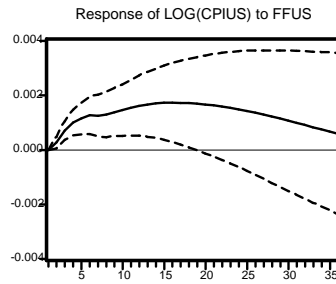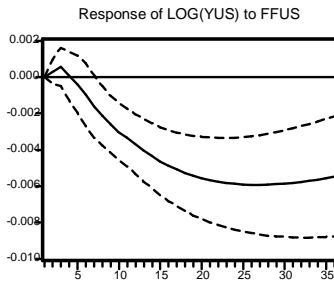| Response of LOG(SPICA) to FFUS |
|---|

Figure A2.1. The effect of the U.S. FFR shocks on Canada's Macroeconomic Variables
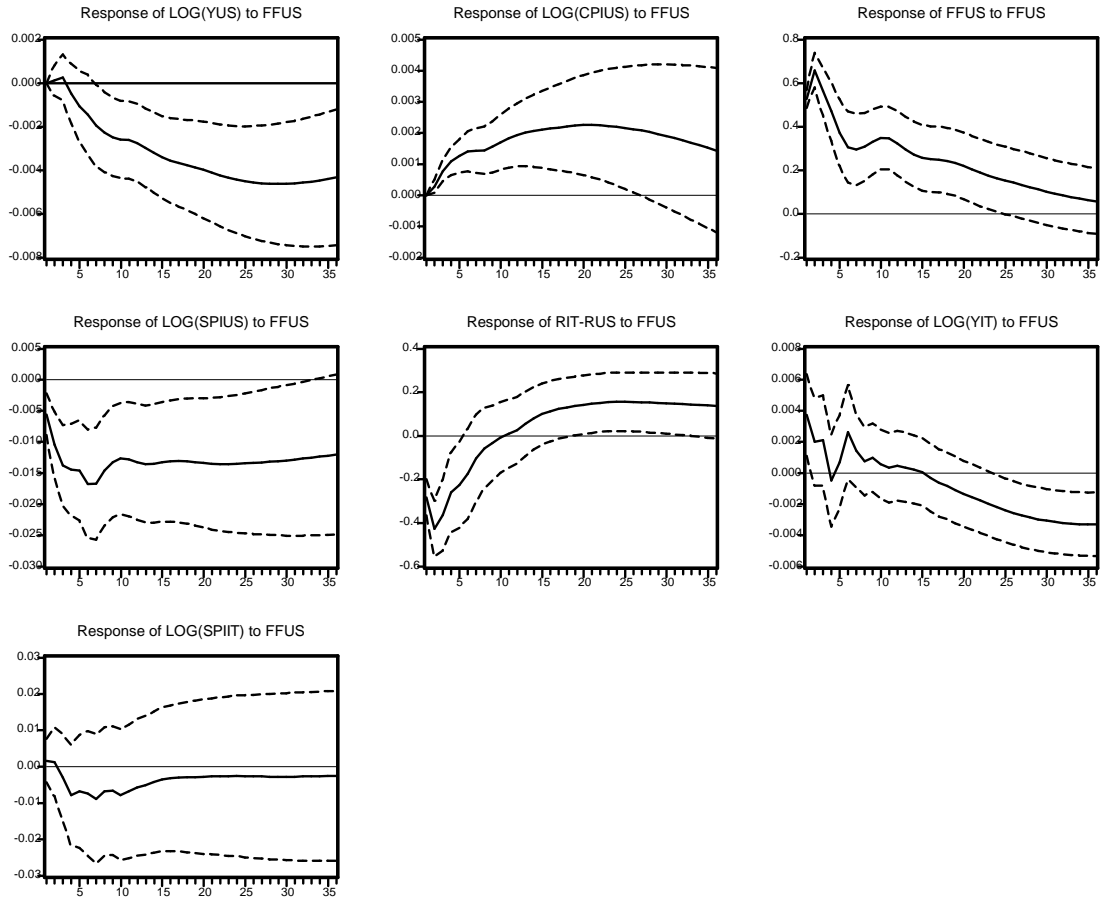
Response to One S.D. Innovations ± 2 S.E.

Response of LOG(YUS) to FFUS	Response of LOG(CPIUS) to FFUS	Response of FFUS to FFUS

Response of LOG(SPIUS) to FFUS	Response of RFR-RUS to FFUS	Response of LOG(YFR) to FFUS

Response of LOG(SPIFR) to FFUS
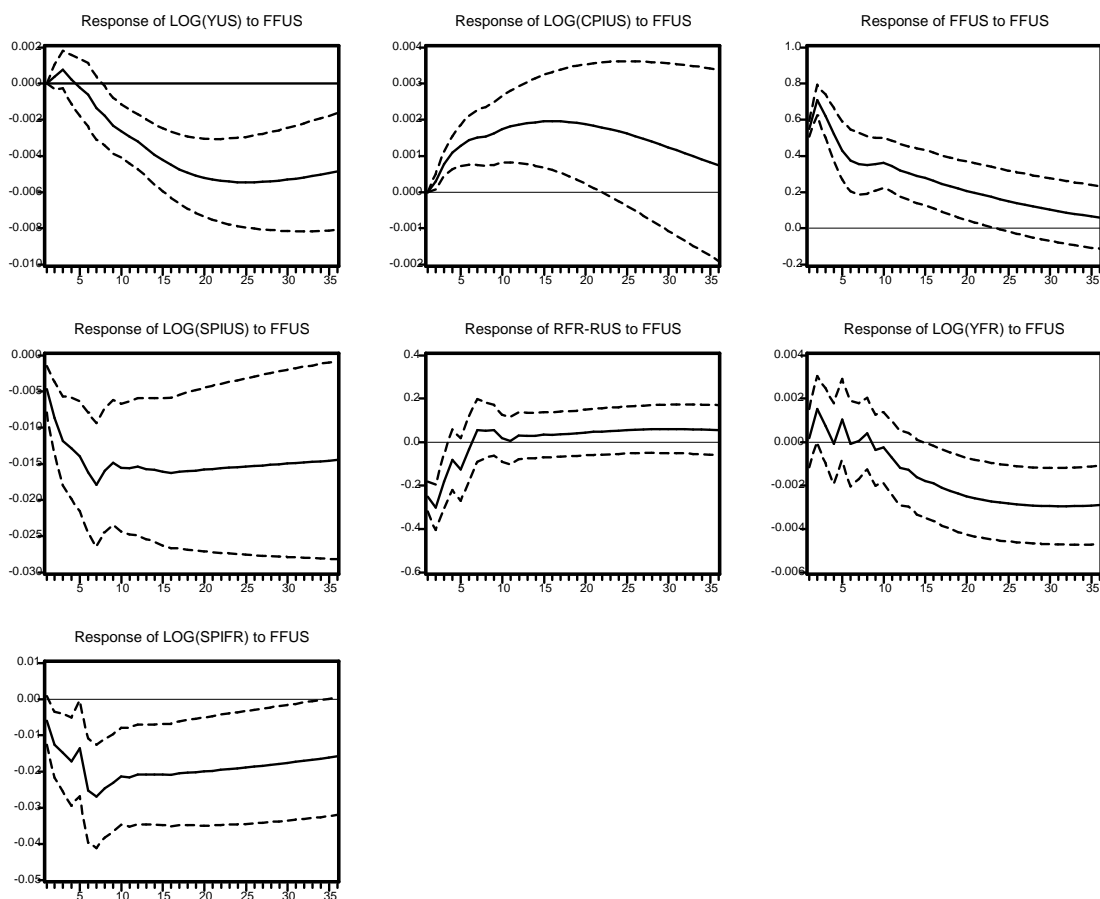
A2.2. The effect of the U.S. FFR shocks on France's Macroeconomic Variables

Response to One S.D. Innovations ± 2 S.E.

Response of LOG(YUS) to FFUS

Response of LOG(CPIUS) to FFUS

Response of FFUS to FFUS

Response of LOG(SPIUS) to FFUS

Response of RGE-RUS to FFUS

Response of LOG(YGE) to FFUS

Response of LOG(SPIGE) to FFUS
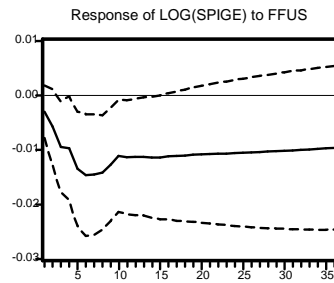
**A2.3. The effect of the U.S. FFR shocks on Germany's
Macroeconomic Variables**

Response to One S.D. Innovations ± 2 S.E.

Response of LOG(YUS) to FFUS	Response of LOG(CPIUS) to FFUS	Response of FFUS to FFUS

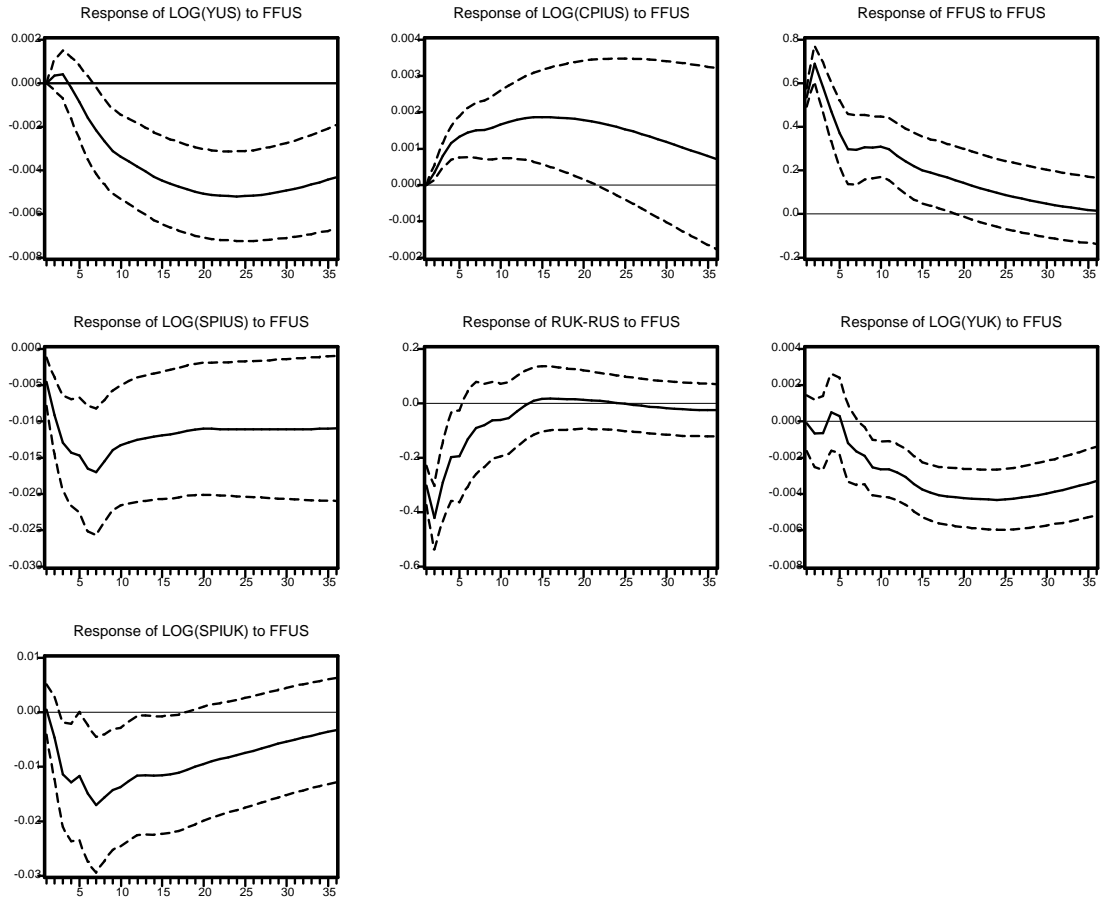| Response of LOG(SPIUS) to FFUS	Response of RIT-RUS to FFUS	Response of LOG(YIT) to FFUS

Response of LOG(SPIIT) to FFUS

A2.4. The effect of the U.S. FFR shocks on Italy's Macroeconomic Variables

Response to One S.D. Innovations ± 2 S.E.
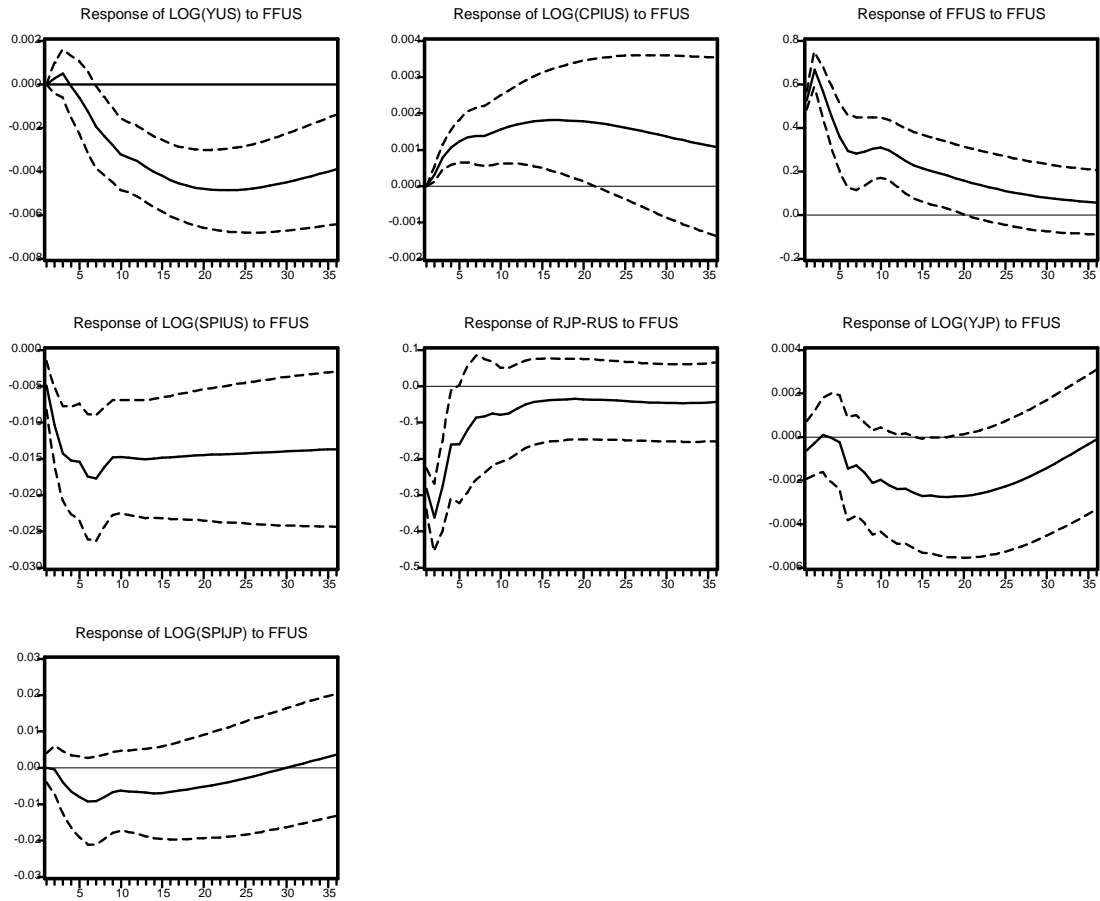
A2.5. The effect of the U.S. FFR shocks on Japan's Macroeconomic Variables

Response to One S.D. Innovations ± 2 S.E.

A2.6. The effect of the U.S. FFR shocks UK's Macroeconomic Variables

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