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Shu Lin and Haichun Ye

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The International Transmission of U.S. Monetary Policy: New Evidence from Trade Data*

Shu Lin**

Fudan University

Hong Kong Institute for Monetary Research

and

Haichun Ye

Shanghai University of Finance and Economics

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Abstract

We make the first attempt in the literature to empirically examine the spillover effects of U.S. monetary policy on trade in other countries. In a large sector-level bilateral trade dataset of 137 countries for the years 1970-2000, we find strong and robust evidence supporting an international credit channel of U.S. monetary policy transmission. We show that: 1) financially more constrained sectors have a more negative exposure of their trade to a tight U.S. monetary policy; 2) this international credit channel works mainly during significant U.S. monetary tightening periods (e.g., a large increase in interest rates); 3) the negative impact of a tight U.S. policy is significantly stronger in financially less developed countries or countries with no monetary autonomy.

Keywords: International Transmission of U.S. Monetary Policy, Trade, Credit Constraints, Credit Channel

JEL Classifications: E52, E44, F14, F33, F42

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** Corresponding author. Address: School of Economics, Fudan University, 600 Guoquan Road, Shanghai 200433, China. Email: shulin75@gmail.com. Phone: (86)18930925057.

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1. Introduction

The international transmission of U.S. monetary policy has long been of interest to both researchers and policymakers. Several studies have documented the transmission of U.S. monetary policy to other countries. For example, Kim (2001) and Canova (2005) provide evidence on the transmission of U.S. monetary policy to non-U.S. G6 and Latin American countries, respectively. Neumeyer and Perri (2005) show that world interest rates have important effects on emerging market business cycles. Existing studies have also explored potential transmission mechanisms of U.S. monetary policy to other countries. Frankel, Schmukler and Serven (2004) document the role of exchange rate regime in the international transmission of U.S. monetary policy. More recently, Cetorelli and Goldberg (2012) provide direct evidence on the transmission of U.S. monetary shocks through lending activity in foreign markets by affiliates of U.S. globally-oriented banks.

In this study, we aim to provide new evidence on the international transmission of U.S. monetary policy. We shall, for the first time in the literature, examine the impact of U.S. monetary policy on foreign countries' exports. While the conventional wisdom holds that (a country's own) monetary policy affects exports mainly through its effects on the relative price of home to foreign goods, we investigate a novel international credit channel through which U.S. monetary policy can potentially affect other countries' exports through its impact on credit availability in exporting countries.[1] Moreover, we also explore whether sector variations in the degrees of intrinsic dependence on external finance and country variations in financial development and monetary autonomy play a role in the transmission of U.S. monetary shocks on exports.

Our work is closely related to the credit channel explored in the monetary policy transmission literature (e.g., Bernanke and Blinder, 1988, 1992; Bernanke and Gertler, 1989, 1990, 1995; Bernanke, Gertler and Gilchrist, 1996; Gertler and Hubbard, 1988; Gertler and Gilchrist, 1994; Kashyap, Stein and Wilcox, 1993; Kashyap, Lamont and Stein, 1994; Oliner and Rudebusch, 1995,1996a, b; Cetorelli and Goldberg, 2012) and the more recent credit constraints and exports literature (e.g., Manova, 2008; Muûls, 2008; Minetti and Zhu, 2010; Amiti and Weinstein, 2011; Ju and Wei, 2011; Manova, Wei and Zhang, 2011; Chor and Manova, 2012; Manova, forthcoming). The former posits that the external finance premium often rises during tight money periods, which amplifies the effects of tight monetary policy on the real economy. The latter literature, on the other hand, emphasizes the crucial role of access to external credit in facilitating firm export activities.[2] In a recent study, Ju, Lin, and Wei (2014) combine the above two strands of the literature and investigate a credit channel through which (a country's own) monetary policy can have a significant impact on (the composition of) exports. Using anchor currency countries' policy changes as exogenous shocks, they find strong evidence supporting the credit channel transmission of monetary policy on exports. In

[1] See, among others, Sekkat and Varoudakis (2000), Bernard and Jensen (2004), Baggs et al.(2009) and Berman et al. (2010) for the effects of exchange rate on trade. Also, see Mishkin (1995) for an excellent summary of the exchange rate channel.

[2] See, for example, Manova (forthcoming) for detailed discussions on the use of external finance in exporting.

particular, they show that the export-reducing effect of a tight monetary policy is significantly stronger in financially more constrained sectors.

The focus of our study is on the spillover effects of U.S. monetary policy on trade. Specifically, we propose an international credit channel through which U.S. monetary policy can affect trade by influencing credit availability to exporting firms in another country. There are good reasons why U.S. monetary policy shocks might be important to access to credit for exporting firms located in other countries. First, U.S. monetary policy can affect local credit supply conditions either through its impact on domestic monetary policy, (e.g., Mundell, 1963; Frankel, Schmukler and Serven, 2004) or the local lending activities of affiliates of U.S. global banks (e.g. Cetorelli and Goldberg, 2012). In addition, for local firms and multinationals that have access to international capital markets, U.S. monetary policy can affect their costs of raising funds internationally (e.g., Foley and Manova, forthcoming).

To test for the existence of such a channel, we rely on sector variations in the degrees of technologically determined financial constraints and examine how the effects of a tight U.S. monetary policy on exports vary across sectors. If a tight U.S. monetary policy affects a country's exports through its impact on domestic credit availability, then one should expect to find a stronger export-reducing effect in financially more constrained sectors. Furthermore, we also take advantage of country variations in financial development and monetary autonomy to provide additional evidence on the international credit channel. Since financial frictions are less severe in financially more developed countries, the international credit channel effect should be weaker for those countries. Moreover, according to the impossible trinity theorem (i.e., the trilemma theorem) in international finance, U.S. monetary policy should have significantly larger impacts on countries with a dollar peg and an open capital account (e.g., Mundell 1963; Obstfeld and Taylor, 1997; 2003; 2004; Obstfeld, Shambaugh and Taylor, 2004; 2005).

Employing a large sector-level bilateral trade dataset for the years 1970-2000, we find strong and robust evidence in favor of our expectations. After carefully controlling for the real exchange rate and foreign demand factors, we find that: 1) the export-reducing effect of a tight U.S. monetary policy is significantly stronger in financially more vulnerable sectors; 2) consistent with the theory, the international credit channel of U.S. monetary policy transmission works mainly during significant U.S. monetary tightening periods; 3) the effect of U.S. monetary policy is significantly more pronounced in financially less developed countries or countries with no monetary autonomy (i.e., countries with a U.S. dollar peg along with an open capital account). Overall, our results suggest that U.S. monetary policy can have significant impacts on other countries' trade volumes (and their sectoral composition) through a credit channel.

Our study contributes to the relevant literature in the following ways. First, we provide novel empirical evidence that U.S. monetary policy has a significant impact on other countries' exports by sector. Second, we explore the potential transmission mechanism through which U.S. monetary policy influences countries' exports: we find strong evidence supporting an international credit channel of

U.S. monetary policy transmission. Third, the results in this paper complement existing empirical results in the credit channel of monetary policy literature and the credit constraints and trade literature. The finding that U.S. monetary policy has stronger impacts in countries with a dollar peg and an open capital account is consistent with the existing evidence in the trilemma literature. Finally, our results offer some new insights on the impact of U.S. monetary policy on trade volumes and their sectoral composition.

The remainder of this paper is organized as follows. In Section 2, we discuss our empirical models and data. Section 3 tests our main hypothesis, and Section 4 explores further the role of financial development and monetary autonomy. Concluding remarks are offered in Section 5.

2. Econometric Specifications and Data

2.1 Empirical Specifications and Estimation Issues

To empirically examine the above hypotheses, we employ an augmented gravity model estimation strategy that features uni-directional exports and separate time-varying importer and exporter fixed effects. The gravity model can be justified theoretically by alternative trade models (e.g., Anderson, 1979; Anderson and van Wincoop 2003; Deardoff, 1998) and has been successfully used in empirical studies on a variety of research questions (e.g., Frankel and Wei, 1993; Subramanian and Wei, 2007; Manova, Wei and Zhang, 2011; Manova, forthcoming). Specifically, we consider the following benchmark empirical specification to examine the effects of monetary policy on exports by sector:

$$\log Exports_{ijkt} = \beta_0 + \beta_1 \Delta usr_t * fv_k + \beta_2 \log RER_{ijt} + Z(i,j)\gamma + \varphi_{it} + \varphi_{jt} + \varphi_k + \varepsilon_{ijkt} \quad (1)$$

The above empirical specification is motivated by the recent theoretical work of Anderson and van Wincoop (2003), which emphasizes the importance of using uni-directional trade as the left-hand-side variable and controlling for separate time-varying exporter and importer fixed effects as proxies for "multilateral resistance".[3]

The dependent variable in Equation (1) is log exports from country i to country j in sector k in year t. Δusr_t is the change in the U.S. federal funds rate, and fv_k represents an empirical measure of credit constraints at the sectoral level. Our main variable of interest is the interaction term between the monetary policy change in the U.S. and the sector financial vulnerability measure, $\Delta usr_t * fv_k$. In particular, we expect to find a significantly negative interaction effect on exports. To account for the potential exchange rate channel of monetary policy transmission, we also control for bilateral real exchange rate (*logRER*) in the regression.[4] *Z(i,j)* is a set of standard country-pair level control

[3] See Anderson and van Wincoop (2003) and Subramanian and Wei (2007) for more detailed discussions.

[4] A higher value means a real appreciation.

variables commonly used in gravity model estimation. We include log distance and a group of bilateral binary variables covering: same-legal-system, common-language, common-border, currency union, FTA, colonial-ties, islands, landlocked countries, and WTO membership in *Z(i,j)*.[5] Finally, φ_{it} , φ_{jt} , and φ_k are time-varying exporter, time-varying importer, and sector fixed effects, respectively. In the above specification, any time-varying exporter and importer specific variables such as their real GDP, real GDP per capita, real GDP growth and the monetary policy variable, *Δusr*, are covered by the inclusion of time-varying exporter and importer fixed effects.

Existing theoretical and empirical studies in the credit channel of monetary policy transmission literature (e.g., Gertler and Hubbard, 1988; Bernanke and Gertler, 1989; Stiglitz,1992; Oliner and Rudebusch, 1996b) often show that a firm's balance sheet affects its ability to borrow especially after a significant monetary tightening (when net worth is low). To capture the potential nonlinear effects of monetary policy, we employ the following empirical model:

$$\log Exports_{ijkt} = \beta_0 + \beta_1 \Delta usr_t * Fv_k + \beta_2 \Delta usr_t * tight_t * fv_k + \beta_3 \log RER_{ijt} + Z(i,j)\gamma + \varphi_{it} + \varphi_{jt} + \varphi_k + \varepsilon_{ijkt} \quad (2)$$

where $tight_{it}$ is a binary indicator of a significant monetary tightening event in the U.S..[6] The estimated coefficient on the triple interaction term, β_2, indicates whether credit channel effects are indeed significantly stronger during tight-money periods as suggested by theory.

Next, to further explore the roles of financial development and monetary autonomy, we expand Equation (1) to including additional interaction terms:

$$\log Exports_{ijkt} = \beta_0 + \beta_1 \Delta usr_t * fv_k + \beta_2 \Delta usr_t * fv_k * fd_{it} + \beta_3 fv_k * fd_{it} + \beta_4 \log RER_{ijt} + Z(i,j)\gamma + \varphi_{it} + \varphi_{jt} + \varphi_k + \varepsilon_{ijkt} \quad (3)$$

$$\log Exports_{ijkt} = \beta_0 + \beta_1 \Delta usr_t * fv_k + \beta_2 \Delta usr_t * fv_k * noma_{it} + \beta_3 fv_k * noma_{it} + \beta_4 \log RER_{ijt} + Z(i,j)\gamma + \varphi_{it} + \varphi_{jt} + \varphi_k + \varepsilon_{ijkt} \quad (4)$$

where fd_{it} represents an empirical measure of financial development in exporting country *i*. $noma_{it}$ is a dummy for exporters with no monetary autonomy (i.e., countries with a U.S. dollar peg and an open capital account). The models (3) and (4) aim to examine the role of financial development and monetary autonomy, respectively. In Equation (3), our main variable of interest is the triple interaction term, $\Delta usr_t * fv_k * fd_{it}$. The estimated coefficient on this term shows whether financial development helps to alleviate the impact of credit constraints on exports. Similarly, the estimated coefficient on $\Delta usr_t * fv_k * noma_{it}$ in Equation (4) tells us whether U.S. monetary policy has significantly higher impacts

[5] See the Data Appendix for detailed variable definitions.

[6] See section 2.3 for details on indentifying significant U.S. monetary tightening dates.

on exports in countries with a dollar peg and an open capital account as predicted by the impossible trinity theorem.

Finally, the following two specifications consider both the non-linear effect of a significant tightening and its interaction with the degree of financial development and monetary autonomy.

$$\log Exports_{ijkt} = \beta_0 + \beta_1 \Delta usr_t * fv_k + \beta_2 \Delta usr_t * fv_k * fd_{it} + \beta_3 fv_k * fd_{it} + \beta_4 \Delta usr_t * tight_t * fv_k + \beta_5 \Delta usr_t * tight_t * fv_k * fd_{it} + \beta_6 \log RER_{ijt} + Z(i,j)\gamma + \varphi_{it} + \varphi_{jt} + \varphi_k + \varepsilon_{ijkt} \quad (5)$$

$$\log Exports_{ijkt} = \beta_0 + \beta_1 \Delta usr_t * fv_k + \beta_2 \Delta usr_t * fv_k * noma_{it} + \beta_3 fv_k * noma_{it} + \beta_4 \Delta usr_t * tight_t * fv_k + \beta_5 \Delta usr_t * tight_t * fv_k * noma_{it} + \beta_6 \log RER_{ijt} + Z(i,j)\gamma + \varphi_{it} + \varphi_{jt} + \varphi_k + \varepsilon_{ijkt} \quad (6)$$

2.2 Sample Coverage and Data Sources

Our sample consists of 137 countries with comprehensive trade and economic data coverage. Country names are listed in Table 1. The full sample period covers the years 1970-2000. In the benchmark case, for each exporter, we exclude its exports to the U.S. as well as exports to countries that peg their currencies to the U.S. dollar, as U.S. monetary policy can potentially have an impact on those countries' demand for imported goods.[7]

We obtain data from a variety of sources. The uni-directional sector trade data are mainly from the NBER-United Nations trade dataset. The NBER-United Nations sector trade data is at the SITC 4-digit level. Since our measures of sector financial vulnerability are constructed at the ISIC 3-digit level, we match the SITC 4-digit product codes to those ISIC 3-digit categories. Interest rates and exchange rates are obtained from the IMF's International Financial Statistics while the CPI, real GDP growth and GDP deflator are drawn from World Bank's World Development Indicators. We obtain log distance and bilateral binary variables from Helpman, Melitz and Rubinstein (2008). Our empirical measures of credit constraints at the sector level are from Krosner, Laeven, and Klingebiel (2007), and financial development data are drawn from Beck and Demirgüç-Kunt (2009). Finally, we classify exchange rate regimes using Reinhart and Rogoff's (2004) de facto classifications and its subsequent update by Ilzetzki, Reinhart, and Rogoff (2011) and obtain measures of capital account openness from Chinn and Ito (2006). Detailed variable definitions and data sources are listed in the Data Appendix.

2.3 Identifying U.S. Monetary Policy Changes and Significant Tightening Dates

Following common practice in the literature, we use changes in the federal funds rate as our measure of changes in U.S. monetary policy. In the benchmark case, we define significant U.S. tightening events (*Tight*) as years in which the federal funds rate rose by at least 2.5 percentage points. In addition to the benchmark significant tightening measure, we employ other definitions, such as

[7] Including those importers in the sample does not affect our results.

changes in the term spread between the federal funds rate and long-term government bond rate to redefine tightening dates or using the Romer-Romer dates to ensure the robustness of our results.

2.4 Measures of Credit Constraints, Financial Development, and Monetary Autonomy

Empirical measures of credits constraints are fairly standard in the literature. It is a common practice in both the credit constraints and growth literature (e.g., Rajan and Zingales, 1998; Claessens and Laeven, 2003; Krosner, Laeven, and Klingebiel, 2007) and the credit constraints and trade literature (e.g., Manova, Wei and Zhang, 2011; Chor and Manova, 2012; Manova, forthcoming) to use US firm level data to construct sector level measures of financial constraints. These measures typically reflect technologically determined sector characteristics that are inherent in the nature of the manufacturing process and beyond the control of individual firms. Following Krosner, Laeven, and Klingebiel (2007) and Manova, Wei and Zhang (2011), we consider four commonly-used measures of sector financial vulnerability.

The first measure captures firms' dependence on external finance for long-term investment and is constructed as the share of capital expenditures not financed by cash flows from operations. The second measure reflects asset intangibility and is defined as one minus the share of net plant, property and equipment in the total book-value assets. Since research and development activities usually occur at the beginning of production, we consider a third financial vulnerability measure defined as the share of R&D spending in total sales. Finally, we use the ratio of inventories to sales to proxy firms' dependence on external financing for short-term working capital.[8] Firms are financially more vulnerable in sectors with higher levels of dependence on external finance for long-term investment, asset intangibility, R&D intensity, and higher inventories to sales ratios. We expect U.S. monetary policy to have more pronounced effects on exports in financially more vulnerable sectors.

To measure financial development, we follow the standard practice in the literature and use private credit as a percentage of GDP from Beck and Demirgüç-Kunt (2009) as an indicator of financial development at the country level.

Based on the impossible trinity theorem, we define a country without monetary autonomy as one that has an open capital account and pegs its currency to the U.S. dollar. Specifically, we define a dollar peg as a hard peg to the U.S. dollar according to Reinhart and Rogoff's (2004) and Ilzetzki, Reinhart and Rogoff's (2011) de facto exchange rate classifications, and consider that a country has an open capital account if the corresponding Chinn and Ito's capital account openness index is above a certain threshold value. We choose the 75th percentile of the sample distribution of this index as the threshold value in our benchmark regressions.[9]

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[8] See Krosner, Laeven, and Klingebiel (2007) and Manova, Wei, and Zhang (2011) for detailed discussions of these sector financial vulnerability measures.

[9] We also tried an alternative threshold value (90th percentile) of the Chinn and Ito index, and the results are similar.

3. Main Empirical Results

3.1 Benchmark Regression Results

This section reports our main results on the role of credit constraints in determining the effect of a monetary tightening on exports by sector. Table 2 shows our benchmark regression results from Equation (1). The four columns correspond to our four financial vulnerability measures at the sectoral level. The overall fit of the regressions is quite reasonable as the estimated R-squared is around 0.59 in each column. The estimated coefficients on the interaction terms are negative and statistically significant at the 1% level in all regressions, indicating that an increase in the U.S. federal funds rate reduces exports significantly more in sectors with higher levels of financial constraints. Quantitatively, the results in Column (1) show that a one-percentage-point increase in the federal funds rate would reduce exports in the sector at the 90th percentile of external finance dependence by 0.66 percentage points more than exports in the sector at the 10th percentile.[10] Similarly, Column (3) suggests that a one-percentage-point increase in the federal funds rate would reduce exports in the sector at the 90th percentile of asset intangibility by 2.62 percentage points more than exports in the sector at the 10th percentile.[11] The evidence from the benchmark regressions strongly supports our hypothesis that an increase in the federal funds rate has a significantly larger negative effect on foreign countries' exports in financially more constrained sectors through an international credit channel.

As for the control variables, we find that distance is negatively associated with export volumes while the estimated coefficients on other controls are all positive. Most of the control variables are statistically significant, and the only exception is the islands dummy.

3.2 Non-Linear Effects of a Monetary Tightening

The above results illustrate the average effect of an increase in interest rates on exports by sector. The theory of the credit channel of monetary transmission, however, predicts that a firm's balance sheet affects its ability to borrow mainly during periods of significant monetary tightening. To explore this potential non-linear effect, we add a triple interaction term, $\Delta usr_t * tight_{it} * fv_k$ to the benchmark empirical model. Here *tight* is a binary indicator of a significant U.S. tightening event, and it takes the value of unity if the federal funds rate increases by at least 2.5 percentage points in a year.

Table 3 shows the results. The estimated coefficients reported in the second row show the effects of U.S. monetary policy during a significant tightening event while those reported in the first row illustrate the effects in other periods. We find that, once the triple interaction term is added to the regressions, three of the four estimated coefficients in the first row become positive. The estimated coefficients in

[10] This number is obtained by multiplying the estimated coefficients (-0.010) by the difference between the 90th and 10th percentiles of external finance, which is 0.66.

[11] This number is obtained by multiplying the estimated coefficients (-0.238) by the difference between the 90th and 10th percentiles of asset intangibility, which is 0.11.

the second row, however, are all negative and statistically significant at least at the 5% level. Moreover, we find that the estimated coefficients in the second row are quantitatively much larger than those reported in the first row. For example, Column (1) suggests that, during a significant tightening period, a one-percentage-point increase in the federal funds rate reduces exports in the sector at the 90th percentile of the distribution by external finance dependence by 1.06 percentage points more than exports in the sector at the 10th percentile.[12] A significant U.S. tightening event, therefore, reduces exports in the sector at the 90th percentile of the distribution by external finance dependence by at least 2.65 (1.06*2.5) percentage points more than exports in the sector at the 10th percentile. As another example, the results in Column (3) indicate that a significant tightening reduces exports in the sector at the 90th percentile of the distribution by dependence on external finance for working capital by at least 45.51 percentage points more than exports in the sector at the 10th percentile.[13] The evidence therefore strongly supports the idea that the international credit channel of U.S. monetary policy transmission works mainly during tight-money periods.

3.3 Robustness Checks

In this subsection, we conduct a series of sensitivity analyses to check whether our main results are robust to alternative definitions of significant tightening events, samples, and model specifications. For the sake of saving space, we only reported the estimated coefficients on two key variables, $\Delta usr_t^* fv_k$ and $\Delta usr_t^* tight_t^* fv_k$. In Table 4, we examine whether our results are sensitive to the method we use to identify significant U.S. tightening events. Since the short-term nominal interest rate reflects not only the U.S. monetary policy stance but inflation as well, previous studies in the literature have identified the monetary policy stance using large increases in the term spread between the short-term nominal interest and the long-term government bond rate (e.g., Laurent, 1988; Goodfriend, 1991; Bernanke and Blinder, 1992; Kashyap, Stein and Wilcox, 1993; Oliner and Rudebusch, 1996b). In panel A of Table 4, we follow this alternative approach and define a significant tightening event as one where the term spread between the federal funds rate and the 10-year treasury note rose by at least 2 percentage points. Use of this alternative definition of a significant tightening event does not alter our findings. We still find that the international credit channel works mainly during significant tightening periods as the estimated coefficients reported in the second row of Panel A remain negative and statistically significant.

Based on a reading of the narrative history of the Federal Reserve, the Romer dates identified by Romer and Romer (1989, 1994) are often used in studies that focus on the U.S. experience. In Panel B we employ the Romer-Romer dates to conduct an additional sensitivity analysis.[14] We find that,

[12] -0.016*0.66=-1.06%.

[13] The difference between the 90th and 10th percentiles of external finance for working capital is 0.11. -1.655*0.11*2.5=87.6%.

[14] According to Romer and Romer (1989, 1994), the Romer dates in our sample period are April 1974, August 1978, October 1979, and December 1988. Since we use annual data, we consider years 1974, 1978, 1979 and 1989 as monetary tightening years in the U.S.. We chose year 1989 because the tightening in December 1988 is more likely to affect a country's exports in year 1989 rather than year 1988. We also tried to use years 1974, 1978, 1980 and 1989 as tightening years, the results are similar.

three out of the four estimated coefficients on the triple interaction term have the correct sign and are significant. Overall, the results in Table 4 suggest that our results are quite robust to alternative definitions of significant tightening events.

Next, we check if our results hold in different samples. We divide our full sample into two subsamples. One contains advanced exporting countries, and the other includes developing exporting countries. We estimate Equation (2) for each subsample and report the results in Panels A and B of Table 5, respectively. Dividing the full sample into two subsamples does not alter our main findings as the estimated coefficients on $\Delta usr_t * tight_t * fv_k$ are negative and significant in both panels. We also find that, quantitatively, the estimated coefficients in the developing-exporter subsample are much larger than those in the advanced-exporter subsample.[15]

In the third set of robustness checks, we test if our results are robust to additional control variables. In Panel A of Table 6, we include the interaction of importers' real GDP growth and sector financial vulnerability as an additional control to account for any potential interactions between sector financial vulnerability and demand conditions in an importing country. In Panel B, we control for interactions of U.S. monetary policy with sector measures of physical and human capital intensities to make sure that our previous results are not driven by the omission of the potential interaction effects of U.S. monetary policy and other sector characteristics. Our results are not affected by the inclusion of additional control variables: we continue to find that U.S. monetary tightening has significantly stronger trade-reducing effects in financially more vulnerable sectors.

Finally, we check if our results are robust to alternative estimation methods. Silva and Tenreyro's (2006) argue that estimating the gravity models using ordinary least squares (OLS) can be problematic as the error terms are generally heteroskedastic. They develop a Poisson pseudo-maximum-likelihood (PPML) method to correct this bias. We re-estimate Equation (2) using their PPML method and report the results in Table 7. Using this estimation method does not alter our results: the estimated coefficients on $\Delta usr_t * tight_t * fv_k$ are again found to be negative and significant.

All in all, the above sensitivity analyses deliver a fairly consistent message. That is, U.S. monetary policy has a significantly larger effect on exports in financially more vulnerable sectors, and this effect works mainly during significant U.S. monetary tightening periods.

4. The Roles of Monetary Autonomy and Financial Development

The empirical results in Section 3 suggest that credit constraints can significantly amplify the negative effects of U.S. tight monetary policy on exports. In this section, we explore further the roles of an exporting country's financial development and monetary autonomy in determining the effect of U.S.

[15] One possible reason is that advanced countries are financially more developed. See Section 4 for discussions on the role of financial development.

monetary policy on its exports. We suspect that: 1) by reducing financial market frictions at the country level, financial development can help to alleviate the adverse impact of credit constraints on exports; and 2) U.S. monetary policy should have a significantly larger impact on exporters with no monetary autonomy.

To test the first hypothesis, we estimate Equation (3) and (5) for each sector financial vulnerability measure and report the results in Panel A and B of Table 8, respectively. To save space, we only report the estimated coefficients on our main variables of interest. In Panel A, we find that the estimated coefficients on the triple interaction term, $\Delta usr_t*fv_k*fd_{it}$, have a positive sign and most are significant. That is, financial development helps to alleviate the negative impact of tight U.S. monetary policy on a country's exports in financially vulnerable sectors. Panel B of Table 8 considers further the non-linear effect of significant tightening events. In the last row of Panel B, the estimated coefficients on $\Delta usr_t*tight_t*fv_k*fd_{it}$ are all negative and highly significant. The evidence therefore strongly supports the idea that there is a significantly weaker international credit channel effect of U.S. monetary tightening events on countries which are more financially developed.

Table 9 explores the role of monetary autonomy. It is expected that U.S. monetary policy will have a stronger effect on countries without monetary autonomy. Based on the trilemma theorem, we define a country without its own monetary autonomy as one that pegs its currency to the U.S. dollar and maintains an open capital account. The estimation results of Equations (4) and (6) are reported in Panels A and B of Table 9. In Panel A, the estimated coefficients on Δusr_t*fv_k (reported in the first row) are all negative and significant, indicating that U.S. monetary policy can even impact countries with an independent monetary policy. Reported in the second row, the estimated coefficients on the triple interaction term, $\Delta usr_t*fv_k*noma_{it}$, are also negative and significant. Consistent with the trilemma theorem, this finding implies that the impact of U.S. monetary policy is significantly stronger in countries without monetary autonomy. Moreover, the evidence suggests that, quantitatively, the effect of U.S. monetary policy is much larger in countries without monetary autonomy, as the estimated coefficients in the second row are much larger than those reported in the first row in magnitude. In the last row of Panel B, we also find that three out of the four estimated coefficients on $\Delta usr_t*tight_t*fv_k*noma_{it}$ are negative and significant. Overall, the evidence is consistent with the prediction of the trilemma theorem.

5. Conclusions

This study examines the impact of U.S. monetary policy on other countries' exports. We hypothesize that, by making domestic external finance more costly/difficult to obtain, a tight U.S. monetary policy can have an impact on other countries' exports in a credit constrained environment through an international credit channel.

We use cross-sectoral variations in the degree of technologically determined financial constraints and cross-country variations in financial development to empirically test the above hypothesis. We make

an effort to isolate the effects of monetary policy on exports, controlling for changes in the real exchange rate and foreign demand. Employing a gravity model approach and a large sector bilateral trade dataset for the years 1970-2010, we find strong evidence supporting an international credit channel transmission of U.S. monetary policy which affects the exports of other countries. We show that the export-reducing effect of a tight U.S. monetary policy is significantly larger in financially more constrained sectors, and the effect of U.S. monetary policy works mainly during significant tightening events. We also demonstrate that, by relaxing credit constraints at the country level, financial development can indeed significantly alleviate the impact of a tight U.S. monetary policy. Finally, consistent with the trilemma theorem, our results indicate that U.S. monetary policy has significant stronger effects in countries without monetary autonomy.

The findings of our paper contribute to the literature on the international transmission of U.S. monetary shocks, and other literature as well, exploring the credit channel of monetary policy transmission, credit constraints and trade, and the trilemma faced by sovereign authorities. They also have important policy implications for global trade.

References

Aizenman, Joshua, Menzie D. Chinn and Hiro Ito (2008), "Assessing the Emerging Global Financial Structure: Measuring the Trilemma's Configuration over Time," NBER Working Paper No.14533.

Amiti, Mary and David Weinstein (2011), "Exports and Financial Shocks," *Quarterly Journal of Economics,* 126: 1841-77.

Anderson, James E. (1979), "A Theoretical Foundation for the Gravity Equation," *American Economic Review,* 69(1): 106–16.

Anderson, James E. and Eric van Wincoop (2003), "Gravity with Gravitas: A Solution to the Border Puzzle," *American Economic Review,* 93(1): 170-92.

Baggs, Jen, Eugene Beaulieu and Loretta Fung (2009), "Firm Survival, Performance, and the Exchange Rate Shocks," *Canadian Journal of Economics,* 42(2).

Beck, Thortsen and Asli Demirgüç-Kunt (2009), "Financial Institutions and Markets across Countries and over Time: Data and Analysis," World Bank Policy Research Working Paper No.4943.

Berman, Nicolas, Philippe Martin and Thierry Mayer (2010), "How do Different Exporters React to Exchange Rate Changes? Theory, Empirics and Aggregate Implications," CEPR Discussion Papers No.7493.

Bernanke, Ben S. and Alan S. Blinder (1988), "Credit, Money, and Aggregate Demand," *American Economic Review,* 78: 435–9.

Bernanke, Ben S. and Alan S. Blinder (1992), "The Federal Funds Rate and the Channels of Monetary Transmission," *American Economic Review,* 82: 901–21.

Bernanke, Ben S. and Mark Gertler (1989), "Agency Cost, Net Worth, and Business Fluctuations," *American Economic Review,* 79: 14–31.

Bernanke, Ben S. and Mark Gertler (1990), "Financial Fragility and Economic Performance," *Quarterly Journal of Economics,* 105: 87–114.

Bernard Andrew B. and J. Bradford Jensen (2004), "Why some Firms Export?" *Review of Economics and Statistics,* 86: 561-9.

Canova, Fabio (2005), "The Transmission of U.S. Shocks to Latin Data," *Journal of Applied Econometrics*, 20: 229-51.

Cetorelli, Nicola and Linda Goldberg (2012), "Bank Globalization and Monetary Transmission," *Journal of Finance,* LXZ11(5): 1811-43.

Chaney, Thomas (2005), "Liquidity Constrained Exporters," University of Chicago, mimeo.

Chor, Davin and Kalina Manova (2012), "Off the Cliff and Back: Credit Conditions and International Trade During the Global Financial Crisis," *Journal of International Economics,* 87: 117-33.

Claessens, Stijn and Luc Laeven (2003), "Financial Development, Property Rights, and Growth," *Journal of Finance,* 58(6): 2401-37.

Deardorff, Alan V. (1998), "Determinants of Bilateral Trade: Does Gravity Work in a Neoclassical World?" in J. A. Frankel, ed., *The Regionalization of the World Economy*, Chicago: University of Chicago Press: 7-22.

Frankel, Jeffrey A., Sergio Schmukler and Luis Serven (2004), "Global Transmission of Interest Rates: Monetary Independence and the Currency Regime," *Journal of International Money and Finance,* 23(5) (Sept.): 701-34.

Frankel, Jeffrey A. and Shang-Jin Wei (1993), "Trade Blocs and Currency Blocks," NBER Working Paper No.4335.

Fleming, J. Marcus (1962), "Domestic Financial Policies under Fixed and Floating Exchange Rates," IMF Staff Papers, 9: 369–79.

Foley, C. Fritz and Kalina Manova (forthcoming), "International Trade, Multinational Activity, and Corporate Finance," *Annual Review of Economics*.

Gertler, Mark and Simon Gilchrist (1994), "Monetary Policy, Business Cycles, and the Behavior of Small Manufacturing Firms," *Quarterly Journal of Economics,* 109: 309-40.

Gertler, Mark and R. Glenn Hubbard (1988), "Financial Factors in Business Fluctuations," *Financial Market Volatility:* 33–71, Federal Reserve Bank of Kansas City.

Goodfriend, Marvin (1991), "Interest Rates and the Conduct of Monetary Policy," *Carnegie-Rochester Conference Series* (Spring): 7–30.

Helpman, Elhanan, Marc Melitz and Yona Rubinstein (2008), "Estimating Trade Flows: Trading Partners and Trading Volumes," *Quarterly Journal of Economics,* 123: 441-87.

Ju, Jiandong, Shu Lin and Shang-Jin Wei (2014), "The Credit Channel of Monetary Policy and Exports: Solving Causality by Using the Impossible Trinity," Mimeo.

Ju, Jiandong and Shang-Jin Wei (2011), "When is Quality of Financial System a Source of Comparative Advantage?" *Journal of International Economics,* 84(2): 178-87.

Kashyap, Anil K., Owen A. Lamont and Jeremy C. Stein (1994), "Credit Conditions and the Cyclical Behavior of Inventories," *Quarterly Journal of Economics,* 109: 565–92.

Kashyap, Anil K., Jeremy C. Stein and David W. Wilcox (1993), "Monetary Policy and Credit Conditions: Evidence from the Composition of External Finance," *American Economic Review,* 83: 78–98.

Kim, Soyoung (2001), "International Transmission of U.S. Monetary Policy Shocks: Evidence from VAR's," *Journal of Monetary Economics,* 48: 339-72.

Kroszner, Randall, Luc Laeven and Daniela Klingebiel (2007), "Banking Crises, Financial Dependence, and Growth," *Journal of Financial Economics,* 84(1): 187-228.

Laurent, Robert D. (1988), "An Interest Rate-Based Indicator of Monetary Policy," *Federal Reserve Bank of Chicago Economic Perspectives:* 3–14.

Manova, Kalina (2008), "Credit Constraints, Equity Market Liberalizations and International Trade," *Journal of International Economics,* 76: 33-47.

Manova, Kalina (forthcoming), "Credit Constraints, Heterogeneous Firms, and International Trade," *Review of Economic Studies*.

Manova, Kalina, Shang-Jin Wei and Zhiwei Zhang (2011), "Firm Exports and Multinational Activity under Credit Constraints," NBER Working Paper No.16905.

Minetti, Raoul and Susan Chun Zhu (2011), "Credit Constraints and Firm Export: Microeconomic Evidence from Italy," *Journal of International Economics,* 83: 109-25.

Mishkin, F.S. (1995), "Symposium on the Monetary Transmission Mechanism," *Journal of Economic Perspectives,* 9(4): 3-10.

Mundell, Robert A. (1963), "Capital Mobility and Stabilization Policy under Fixed and Flexible Exchange Rates," *Canadian Journal of Economic and Political Science,* 29(4): 475–85.

Muûls, M. (2008), "Exporters and Credit Constraints. A Firm Level Approach," London School of Economics mimeo.

Neumeyer, Paolo and Fabrizio Perri (2005), "Business Cycles in Emerging Economies: The Role of Interest Rates," *Journal of Monetary Economics,* 52: 345-80.

Oliner, Stephen D. and Glenn D. Rudebusch (1995), "Is There a Bank Lending Channel for Monetary Policy?" *Federal Reserve Bank of San Francisco Economic Review,* 2: 3–20.

Oliner, Stephen D. and Glenn D. Rudebusch (1996a), "Monetary Policy and Credit Conditions: Evidence from the Composition of External Finance: Comment," *American Economic Review,* 86: 300-9.

Oliner, Stephen D. and Glenn D. Rudebusch (1996b), "Is There a Broad Credit Channel for Monetary Policy?" *Federal Reserve Bank of San Francisco Economic Review,* 2: 3–13.

Obstfeld, Maurice, Jay Shambaugh and Alan M. Taylor (2004), "Monetary Sovereignty, Exchange Rates, and Capital Controls: The Trilemma in the Interwar Period," IMF Staff Papers*,* 51: 75–108.

Obstfeld, Maurice, Jay Shambaugh and Alan M. Taylor (2005), "The Trilemma in History: Tradeoffs among Exchange Rates, Monetary Policies, and Capital Mobility," *Review of Economics and Statistics,* 3(December): 423-38.

Obstfeld, Maurice and Alan M. Taylor (1997), "The Great Depression as a Watershed: International Capital Mobility in the Long Run," NBER Working Paper No.5960.

Obstfeld, Maurice and Alan M. Taylor (2003), "Globalization and Capital Markets," in Michael Bordo, Alan M. Taylor and Jeffrey G. Williamson, eds., *Globalization in Historical Perspective,* Chicago: University of Chicago Press.

Obstfeld, Maurice and Alan M. Taylor (2004), *Global Capital Markets: Integration, Crisis, and Growth,* Cambridge: Cambridge University Press.

Rajan, Raghuram G. and Zingales Luigi (1998), "Financial Dependence and Growth," *American Economic Review,* 88(3): 559-86.

Romer, Christina D. and David H. Romer (1989), "Does Monetary Policy Matter? A New Test in the Spirit of Friedman and Schwartz," in Olivier Jean Blanchard and Stanley Fischer, eds., *NBER Macroeconomics Annual:* 121–83, MIT Press, Cambridge, MA.

Romer, Christina D. and David H. Romer (1994), “Monetary Policy Matters,” *Journal of Monetary Economics,* 34: 75–88.

Sekkat, K. and A. Varoudakis (2000), “Exchange Rate Management and Manufactured Exports in Sub-Saharan Africa,” *Journal of Development Economics,* 61: 237-53.

Subramanian, Arvind and Shang-Jin Wei (2007), "The WTO Promotes Trade: Strongly but Unevenly," *Journal of International Economics,* 72: 151-75.

Stiglitz, Joseph (1992), “Capital Markets and Economic Fluctuations in Capitalist Economies,” *European Economic Review,* 36: 269–306.

Table 1. Country List

ALBANIA	ECUADOR	KOREA REP	ROMANIA
ALGERIA	EGYPT	KUWAIT	RWANDA
ANGOLA	EL SALVADOR	LAOS P.DEM.R	SAUDI ARABIA
ARGENTINA	EQ. GUINEA	LEBANON	SENEGAL
AUSTRALIA	ETHIOPIA	LIBERIA	SEYCHELLES
AUSTRIA	FIJI	LIBYA	SIERRA LEONE
BAHAMAS	FINLAND	MADAGASCAR	SINGAPORE
BAHRAIN	FRANCE	MALAWI	SOUTH AFRICA
BANGLADESH	GABON	MALAYSIA	SPAIN
BARBADOS	GAMBIA	MALI	SRI LANKA
BELGIUM	GERMANY	MALTA	ST KITTS NEVIS
BELIZE	GHANA	MAURITANIA	SUDAN
BENIN	GREECE	MAURITIUS	SURINAME
BERMUDA	GREENLAND	MEXICO	SWEDEN
BOLIVIA	GUATEMALA	MONGOLIA	SWITZERLAND
BRAZIL	GUINEA	MOROCCO	SYRIA
BULGARIA	GUINEA-BISSAU	MOZAMBIQUE	THAILAND
BURKINA FASO	GUYANA	NEPAL	TOGO
BURUNDI	HAITI	NETHERLANDS	TRINIDAD-TOBAGO
CAMBODIA	HONDURAS	NEW CALEDONIA	TUNISIA
CAMEROON	HONG KONG	NEW ZEALAND	TURKEY
CANADA	HUNGARY	NICARAGUA	UGANDA
CENTRAL AFR.	ICELAND	NIGER	UNITED KINGDOM
CHAD	INDIA	NIGERIA	UNTD ARAB EM
CHILE	INDONESIA	NORWAY	URUGUAY
CHINA	IRAN	OMAN	UNITED STATES
COLOMBIA	IRAQ	PAKISTAN	VENEZUELA
CONGO	IRELAND	PANAMA	VIETNAM
COSTA RICA	ISRAEL	PAPUA N.GUINEA	YEMEN
COTE D'IVOIR	ITALY	PARAGUAY	ZAIRE
CUBA	JAMAICA	PERU	ZAMBIA
CYPRUS	JAPAN	PHILIPPINES	ZIMBABWE
DENMARK	JORDAN	POLAND	
DJIBOUTI	KENYA	PORTUGAL	
DOMINICAN REP	KIRIBATI	QATAR	

Table 2. Benchmark Regressions

	Dependence on External Finance for Long-term Investment	Ratio of intangible assets	R&D Intensity	Dependence on External Finance for Working Capital
U.S. interest rate change*	-0.010	-0.033	-0.238	-0.061
external finance dependence	(0.002)***	(0.007)***	(0.029)***	(0.016)***
Log real exchange rate	-0.283	-0.283	-0.283	-0.283
	(0.101)***	(0.101)***	(0.101)***	(0.101)***
Log distance	-0.918	-0.918	-0.918	-0.918
	(0.017)***	(0.017)***	(0.017)***	(0.017)***
Same legal system	0.274	0.274	0.274	0.274
	(0.028)***	(0.028)***	(0.028)***	(0.028)***
Common language	0.181	0.181	0.181	0.181
	(0.033)***	(0.033)***	(0.033)***	(0.033)***
Border	0.538	0.538	0.538	0.538
	(0.069)***	(0.069)***	(0.069)***	(0.069)***
Currency Union	1.193	1.193	1.193	1.193
	(0.282)***	(0.282)***	(0.282)***	(0.282)***
FTA	0.493	0.493	0.493	0.493
	(0.084)***	(0.084)***	(0.084)***	(0.084)***
Colonial ties	0.602	0.602	0.602	0.602
	(0.069)***	(0.069)***	(0.069)***	(0.069)***
Islands	0.100	0.100	0.100	0.100
	(0.075)	(0.075)	(0.075)	(0.075)
Landlocked	0.365	0.365	0.365	0.365
	(0.122)***	(0.122)***	(0.122)***	(0.122)***
WTO members	0.307	0.307	0.307	0.307
	(0.064)***	(0.064)***	(0.064)***	(0.064)***
Time-varying Exporter fixed effects	Y	Y	Y	Y
Time-varying Importer fixed effects	Y	Y	Y	Y
Sector fixed effects	Y	Y	Y	Y
R^2	0.59	0.59	0.59	0.59
N	1211523	1211523	1211523	1211523

Notes: A constant, time-varying exporter and importer fixed effects, and sector fixed effects are included but not reported in each regression. Robust standard errors clustered at export-import pairs are reported in the parentheses.* $p<0.1$; ** $p<0.05$; *** $p<0.01$.

Table 3. The Non-Linear Effect of Monetary Tightening

	Dependence on External Finance for Long-term Investment	Ratio of intangible assets	R&D Intensity	Dependence on External Finance for Working Capital
U.S. interest rate change*	-0.005	0.052	0.206	0.161
external finance dependence	(0.002)**	(0.008)***	(0.037)***	(0.020)***
U.S. interest rate change*tightening	-0.016	-0.312	-1.655	-0.801
*external finance dependence	(0.006)**	(0.023)***	(0.101)***	(0.052)***
Log real exchange rate	-0.284	-0.283	-0.284	-0.284
	(0.101)***	(0.100)***	(0.101)***	(0.100)***
Log distance	-0.918	-0.918	-0.919	-0.918
	(0.017)***	(0.017)***	(0.017)***	(0.017)***
Same legal system	0.274	0.274	0.274	0.274
	(0.028)***	(0.028)***	(0.028)***	(0.028)***
Common language	0.181	0.181	0.181	0.181
	(0.033)***	(0.033)***	(0.033)***	(0.033)***
Border	0.538	0.538	0.538	0.538
	(0.069)***	(0.069)***	(0.069)***	(0.069)***
Currency Union	1.192	1.192	1.192	1.194
	(0.282)***	(0.282)***	(0.282)***	(0.283)***
FTA	0.493	0.493	0.493	0.493
	(0.084)***	(0.084)***	(0.084)***	(0.084)***
Colonial ties	0.602	0.602	0.602	0.602
	(0.069)***	(0.069)***	(0.069)***	(0.069)***
Islands	0.100	0.100	0.100	0.100
	(0.075)	(0.075)	(0.075)	(0.075)
Landlocked	0.365	0.365	0.365	0.365
	(0.122)***	(0.122)***	(0.122)***	(0.122)***
WTO members	0.307	0.307	0.307	0.307
	(0.064)***	(0.064)***	(0.064)***	(0.064)***
Time-varying Exporter fixed effects	Y	Y	Y	Y
Time-varying Importer fixed effects	Y	Y	Y	Y
Sector fixed effects	Y	Y	Y	Y
R^2	0.59	0.59	0.59	0.59
N	1211523	1211523	1211523	1211523

Notes: A constant, time-varying exporter and importer fixed effects, and sector fixed effects are included but not reported in each regression. Robust standard errors clustered at export-import pairs are reported in the parentheses.* $p<0.1$; ** $p<0.05$; *** $p<0.01$.

Table 4. Robustness to Alternative Definitions of Tightening

	Dependence on External Finance for Long-term Investment	Ratio of intangible assets	R&D Intensity	Dependence on External Finance for Working Capital
Panel A: Tightening if change in the term spread>2				
U.S. interest rate change*	-0.007	-0.009	-0.061	0.016
external finance dependence	(0.002)***	(0.007)	(0.031)**	(0.017)
U.S. interest rate change*tightening*	-0.028	-0.214	-1.687	-0.682
external finance dependence	(0.007)***	(0.025)***	(0.116)***	(0.059)***
Panel B: Romer-Romer dates				
US interest rate change*	-0.009	0.021	-0.011	0.063
external finance dependence	(0.002)***	(0.007)***	(0.032)	(0.016)***
US interest rate change*Romer-Romer dates *	-0.004	-0.339	-1.434	-0.772
external finance dependence	(0.007)	(0.026)***	(0.119)***	(0.059)***

Notes: A constant, control variables, time-varying exporter and importer fixed effects, and sector fixed effects are included but not reported in each regression. Robust standard errors clustered at ordered export-import pairs are reported in the parentheses.* $p<0.1$; ** $p<0.05$; *** $p<0.01$.

Table 5. Subsample Evidence

	Dependence on External Finance for Long-term Investment	Ratio of intangible assets	R&D Intensity	Dependence on External Finance for Working Capital
Panel A: Advanced exporters				
U.S. interest rate change*	-0.003	0.020	0.293	0.052
external finance dependence	(0.003)	(0.008)**	(0.039)**	(0.021)**
U.S. interest rate change*tightening*	-0.029	-0.143	-1.597	-0.350
external finance dependence	(0.007)***	(0.023)***	(0.105)***	(0.055)***
Panel B: Developing exporters				
US interest rate change*	-0.001	0.093	0.424	-0.312
external finance dependence	(0.004)	(0.016)***	(0.064)***	(0.036)***
US interest rate change*tightening*	-0.045	-0.496	-2.561	-1.328
external finance dependence	(0.010)***	(0.043)***	(0.171)***	(0.092)***

Notes: A constant, control variables, time-varying exporter and importer fixed effects, and sector fixed effects are included but not reported in each regression. Robust standard errors clustered at ordered export-import pairs are reported in the parentheses.* $p<0.1$; ** $p<0.05$; *** $p<0.01$.

Table 6. Adding Additional Controls

	Dependence on External Finance for Long-term Investment	Ratio of intangible assets	R&D Intensity	Dependence on External Finance for Working Capital
Panel A: Controlling for Importer real GDP growth*external financial dependence				
US interest rate change*	-0.008	0.068	0.171	0.164
external finance dependence	(0.002)***	(0.009)***	(0.040)***	(0.021)***
US interest rate change*tightening*	-0.012	-0.339	-1.673	-0.830
external finance dependence	(0.007)*	(0.025)***	(0.109)***	(0.057)***
Panel B: Controlling for US interest rate change*physical/human capital intensity				
US interest rate change*	-0.001	0.093	0.424	-0.312
external finance dependence	(0.004)	(0.016)***	(0.064)***	(0.036)***
US interest rate change*tightening*	-0.045	-0.496	-2.561	-1.328
external finance dependence	(0.010)	(0.043)***	(0.171)***	(0.092)***

Notes: A constant, control variables, time-varying exporter and importer fixed effects, and sector fixed effects are included but not reported in each regression. Robust standard errors clustered at ordered export-import pairs are reported in the parentheses. Regressions in Panel A include importer real GDP growth*external financial dependence as an additional control. Those in Panel B include US interest rate change*physical capital intensity, US interest rate change*human capital intensity, US interest rate change*tightening*physical capital intensity, and interest rate change*tightening*human capital intensity as additional controls. * $p<0.1$; ** $p<0.05$; *** $p<0.01$.

Table 7. PPML Results

	Dependence on External Finance for Long-term Investment	Ratio of intangible assets	R&D Intensity	Dependence on External Finance for Working Capital
U.S. interest rate change*	0.028	0.106	0.738	0.263
external finance dependence	(0.002)***	(0.017)**	(0.077)**	(0.047)**
U.S. interest rate change*tightening*	-0.181	-0.858	-5.583	-2.504
external finance dependence	(0.006)***	(0.051)***	(0.355)***	(0.151)***

Notes: A constant, control variables, time-varying exporter and importer fixed effects, and sector fixed effects are included but not reported in each regression. Robust standard errors clustered at ordered export-import pairs are reported in the parentheses.* $p<0.1$; ** $p<0.05$; *** $p<0.01$.

Table 8. The Role of Financial Development

	Dependence on External Finance for Long-term Investment	Ratio of intangible assets	R&D intensity	Dependence on External Finance for Working Capital
Panel A: Benchmark				
U.S. interest rate change*external finance dependence*	-0.011	-0.027	-0.250	-0.029
	(0.004)***	(0.014)**	(0.061)***	(0.031)
U.S. interest rate change*external finance dependence*	0.012	0.045	0.332	0.061
financial development	(0.005)***	(0.019)***	(0.087)***	(0.046)
Panel B: Non-linear effect of significant tightening				
U.S. interest rate change*external finance dependence*	-0.010	0.071	0.240	0.261
	(0.005)**	(0.018)***	(0.079)***	(0.040)***
U.S. interest rate change*tightening*	-0.027	-0.352	-2.184	-1.050
external finance dependence	(0.013)**	(0.051)***	(0.231)***	(0.109)***
U.S. interest rate change*external finance dependence*	-0.010	-0.053	-0.444	-0.271
financial development	(0.007)	(0.025)**	(0.113)***	(0.058)***
U.S. interest rate change*tightening	0.136	0.386	3.996	1.346
*external finance dependence*financial development	(0.039)***	(0.093)***	(0.418)***	(0.203)***

Notes: A constant, time-varying exporter and importer fixed effects, sector fixed effects, external finance dependence*financial development, and other controls are included but not reported in each regression. Robust standard errors are in parentheses and are clustered at exporter-import pairs in all other regressions. * $p<0.1$; ** $p<0.05$; *** $p<0.01$.

Table 9. The Role of Monetary Autonomy

	Dependence on External Finance for Long-term Investment	Ratio of intangible assets	R&D intensity	Dependence on External Finance for Working Capital
Panel A: Benchmark				
U.S. interest rate change*external finance dependence*	-0.010	-0.031	-0.248	-0.055
	(0.002)***	(0.007)***	(0.031)***	(0.017)***
U.S. interest rate change*external finance dependence*	-0.038	-0.181	-0.757	-0.307
no monetary autonomy	(0.012)***	(0.062)***	(0.211)***	(0.137)**
Panel B: Non-linear effect of significant tightening				
U.S. interest rate change*external finance dependence*	-0.004	0.053	0.229	0.173
	(0.002)*	(0.009)***	(0.039)***	(0.022)***
U.S. interest rate change*tightening*	-0.021	-0.314	-1.789	-0.826
external finance dependence	(0.007)***	(0.026)***	(0.108)***	(0.058)***
U.S. interest rate change*external finance dependence*	-0.043	0.022	-0.391	0.102
no monetary autonomy	(0.014)***	(0.063)	(0.248)	(0.142)
U.S. interest rate change*tightening	0.018	-0.700	-1.472	-1.409
*external finance dependence*no monetary autonomy	(0.040)	(0.209)***	(0.756)*	(0.427)***

Notes: A constant, time-varying exporter and importer fixed effects, sector fixed effects, external finance dependence*no monetary autonomy, and other controls are included but not reported in each regression. Robust standard errors are in parentheses and are clustered at exporter-import pairs in all other regressions. * $p<0.1$; ** $p<0.05$; *** $p<0.01$.

Data Appendix

Trade data: The sector level trade data comes from the NBER-United Nations trade dataset downloaded from Robert Feenstra's website, which contains uni-directional export data at a SITC 4-digit level. Since our measures of sector financial vulnerability are constructed at a ISIC 3-digit level, we match the SITC 4-digit product codes to those in ISIC 3-digit categories. Export flows are measured in constant 2000 U.S. dollar using the U.S. GDP deflator data obtained from the World Bank's World Development Indicators.

Country-level data: U.S. interest rates and nominal exchange rates to the U.S. dollar are obtained from the IMF's International Financial Statistics. The CPI, real GDP growth rate, and GDP deflator are drawn from World Bank's World Development Indicators. Exchange rate regime and arrangement information is obtained from Reinhart and Rogoff's (2004) and Ilzetzki, Reinhart and Rogoff's (2011). The capital account openness index is from Chinn and Ito (2006). Financial development is measured as private credit as a percentage of GDP and is obtained from Beck and Demirgüç-Kunt (2009). The Romer-Romer dates are from Romer and Romer (1989, 1994).

Country-pair-level data: Bilateral real exchange rate depreciation is calculated using each party's nominal exchange rate to the U.S. dollar and is adjusted for CPI changes. Log distance and bilateral binary variables are all from Helpman, Melitz, and Rubinstein (2008).

Sector-level data: Sector financial vulnerability measures are from Krosner, Laeven, and Klingebiel (2007) and Monova, Wei and Zhang (2011).