
Joshua Aizenman* , Menzie D. Chinn†, Hiro Ito‡

USC and NBER; UW-Madison and NBER; Portland State University

Abstract

We investigate why and how the financial conditions of developing and emerging market countries (peripheral countries) can be affected by the movements in the center economies - the U.S., Japan, the Eurozone, and China. We apply a two-step approach. First, we estimate the sensitivity of countries’ financial variables to the center economies [policy interest rate, term spreads, stock market prices, and the real effective exchange rates (REER)], while controlling global and domestic factors. Next, we examine the association of the estimated sensitivity coefficients with the macroeconomic conditions, policies, real and financial linkages with the center economies, and the levels of institutional development. In the last two decades, for most financial variables, the strength of the links with the center economies have been the dominant factor over, while the movements of policy interest rate and term spreads appear more sensitive to those of the center economies around the time of the emerging markets’ crises in the late 1990s and since the GFC of 2008-9. Higher levels of trade linkage, financial development, and gross national debt lead to closer linkages of the financial conditions between the peripheral and the center countries. The exchange market pressure (EMP) of the peripheral economies is sensitive to the movements of the center economies’ REER and EMP during and after the GFC period. Open macro policy arrangements, especially exchange rate regimes, have mostly indirect effects on the financial linkages between the peripheral economies and the center economies through other macroeconomic and institutional variables. The sensitivity of peripheral economies’ EMP to center’s financial variables can be affected by the interactive effects between open macro policy arrangements and other macroeconomic conditions and policies. Thus, trilemma policy arrangements, including exchange rate flexibility, affect the sensitivity of developing countries to policy changes and shocks in the center economies.

* Aizenman: Dockson Chair in Economics and International Relations, University of Southern California, University Park, Los Angeles, CA 90089-0043. Phone: +1-213-740-4066. Email: aizenman@usc.edu.
† Chinn: Robert M. La Follette School of Public Affairs; and Department of Economics, University of Wisconsin, 1180 Observatory Drive, Madison, WI 53706. Email: mchinn@lafollette.wisc.edu.
‡ Ito (corresponding author): Department of Economics, Portland State University, 1721 SW Broadway, Portland, OR 97201. Tel/Fax: +1-503-725-3930/3945. Email: ito@pdx.edu.

Acknowledgements: The financial support of faculty research funds of University of Southern California, the University of Wisconsin, Madison, and Portland State University is gratefully acknowledged. We also thank Ting Ting Lu for her excellent research assistance, Clas Wihlborg and Arnaud Mehl for helpful comments, and Jing Cynthia Wu, Fan Dora Xia, Jens Christensen, and Glenn D. Rudebusch for sharing the shadow interest rates. This paper was initially titled as “Analysis on the Determinants of Sensitivity to the Center Economies.” All errors are ours.
1. Introduction

The integrated nature of the financial system was amply demonstrated by the turmoil in emerging market currency and bond markets in the wake of Fed Chairman Bernanke’s statements regarding the normalization of U.S. monetary policy, commonly termed the “taper tantrum”. Following close on the heels of complaints about unconventional monetary policy implementation in the preceding years, it is clear that – at a minimum – policymakers in emerging market economies perceive an increasing vulnerability to the whims of the global financial system.

The idea that the monetary policies of financial center countries have large spillover effects on the smaller economies is not new. During the mid-1990’s, when advanced economy central bankers raised policy rates, after several years of negative real interest rates, similar complaints were lodged, and some may partly trace the financial crises in Latin America and subsequently in East Asia to the cycle in core country policy interest rates.

One key difference is that in the earlier episode’s aftermath, the semi-fixed exchange rate regimes were tagged as a contributing factor. In contrast, countries adhering to a variety of exchange rate regimes all experienced challenges in insulating their economies in the most recent episode. This has led to a grand debate about the continued relevance of the “impossible trinity” or “monetary trilemma”.

Since Mundell (1963) outlined the hypothesis of the monetary trilemma, fundamental policy management in the open economy has been viewed as policy trade-offs among the choices of monetary autonomy, exchange rate stability, and financial openness. The hypothesis and its extensions in recent years suggest a continuous trade off between the three trilemma dimensions, with the possibility that a fourth policy goal, financial stability, may augment it and turn it into a quadrilemma, where international reserves may play a role as buffers.

In contrast, in the aftermath of the global financial crisis (GFC), Rey (2013) concluded that the economic center’s (EC) monetary policy influences other countries’ national monetary policy mostly through capital-flows, credit growth, and bank leverages, making the types of exchange rate regime of the non-ECs irrelevant. In other words, the countries in the periphery are all sensitive to a “global financial cycle” irrespective of exchange rate regimes. In this view, the

---

“trilemma” reduces to an “irreconcilable duo” of monetary independence and capital mobility. Consequently, restricting capital-mobility maybe the only way for non-EC countries to retain monetary autonomy. The recent experience of Brazil, India, Indonesia, South Africa, and Turkey – the “Fragile Five” – during the so called taper tantrum may make many observers the “irreconcilable duo” view convincing.

In this paper we investigate whether Rey’s prematurely predicted the end of the trilemma. Inferences based data drawn from times of heightened volatility emanating from the center might be modified once we examine how the propagation of large shocks from the EC can be affected by economic structures and measures of the trilemma variables. In a world of more than hundred countries, one ignores heterogeneity at one’s own risk. For instance, the trade-offs facing the OECD countries may differ from those facing manufacturing based or commodity based emerging markets economies and developing countries. Furthermore, large shocks arising from the EC during the global financial crisis and the Euro debt crisis may have altered the transmission dynamics, especially in comparison to the preceding decade of illusory tranquility.

We first review key global developments in the past decades and preview our methodology and the main empirical results. We begin with Figure 1 which illustrates the 36-month rolling correlations of domestic money market rates with the U.S. money market rate for developed countries (IDC), developing countries (LDC), and emerging market economies (EMG), and China, from 1990 to 2013. For developed economies, the correlation between domestic and the U.S. policy interest rates is high and hovers at relatively high levels in the last decade. In contrast, developing countries tend to retain high monetary independence from the U.S., while emerging market monetary policy independence occupies a middle ground. All the correlations fluctuate, but experience two pronounced dips in recent years, one in 2005 and the other at the time of the global financial crisis. These two dips correspond to rapid changes in the U.S. Federal funds rate.

Figure 2 depicts correlations of long-term interest rates. Again, the long-term interest rates of industrialized countries register high correlations with that of the U.S., particularly in the

---

5 For example, maintaining exchange rate stability could be more important for developing countries whose growth strategy is reliant on the exports of a narrower variety of manufactured goods or commodities than advanced economies with more diversified economic structures.

6 The Federal Reserve started raising the federal fund rate target from 1.00% in June 2004 to 5.25% in June 2006. It started lowering the target from 5.25% in September 2007 all the way essentially to the 0.00-0.25 by December 2008.
first half of the sample period, though the correlation has been on a rising trend again in recent years. Developing countries experience relatively high correlations in the early 2000s but since the late 2000s, the correlations appear to be trendless for these countries. Long-term interest rates across countries, including both developed and developing countries, were highly correlated during the Great Moderation period.

Figure 3 is an interesting picture. It illustrates the comparable correlations of stock market price indexes (expressed in local currency) with the U.S. index. Since the mid-2000s, all the country groups have maintained high levels of correlations of stock market price indexes with the U.S. stock market, with some tail-off since the global financial crisis.

What do these figures tell us? Broadly speaking, the extent of correlations is the highest for stock market price movements, followed by the long-term and short-term interest rates. Given short-term interest rates bear lowest levels of risks, we may conjecture that the prices of assets with higher risk tend to be more highly correlated with that of the United States. Of course, these graphical depictions do not provide conclusive evidence, particularly since we have not controlled for any number of important factors, e.g., the policy regimes, macroeconomic conditions, the extent of trade linkage, the level of institutional development and size of financial markets, and global market conditions.

Many studies such as Ahmed and Zlate (2013), Forbes and Warnock (2010), Fratzscher (2011), and Ghosh, et al. (2012) have documented the importance of global factors such as advanced economy interest rates and global risk appetite in affecting capital flows to small open economies. Nonetheless, these studies have also highlighted that domestic, country-specific factors also retain importance. In particular, the institutional and macroeconomic policy frameworks of the emerging market economies also determine the variations in flows.

Given this context, we focus on the questions of why movements in the major advanced economies often have large effects on other financial markets, how these cross-market linkages have changed over time, and what kind of factors contribute to explaining the sensitivity to the movements in the major economies. More specifically, we will conduct an empirical analysis on what determines the sensitivity of economies to factors pertaining to the core economies in the world, namely, the U.S., the Euro area, Japan, and China.

For the last two decades, the Chinese economy has been growing at impressive rates and quickly moving upward on the development ladder. However, its financial markets may not be
developed or sophisticated to the extent of becoming the center of global financial cycles. Despite data limitations as well as China’s relatively short tenure as one of the G3 countries, we will also examine whether our results are sensitive to the inclusion of China as one of the center economies.

For our empirical exploration, we employ an estimation process similar to that employed by Forbes and Chinn (2004), which is composed of two steps of estimations. First, we investigate the degree to which the sensitivity of several important financial variables to global, cross-country, and domestic factors. Second, treating the estimated sensitivity as a dependent variable, we will examine their determinants among a number of country-specific variables. In so doing, we will disentangle roles of countries’ macroeconomic conditions or policies, real or financial linkage with the center economy, or the level of institutional development of the countries.

In Section 2, we will detail the framework of the two stage estimation exercise. We will report and discuss the estimation results in section 3. In Section 4, we will make concluding remarks.

To anticipate the results, we find that for most of the financial variables we examine, the strength of the links with the center economies have been the dominant factor over the last decade or so. The influence of global financial factors, for which we use VIX and Ted spread, has been increasing since around the time of the global financial crisis. The results we obtain suggest that, across different financial linkages, higher levels of direct trade linkage, financial development, and gross national debt all tend to lead to stronger financial linkages between the sample countries and the three center economies. Open macro policy arrangements such as exchange rate regimes and financial openness can affect the extent of financial linkage but more often indirectly, through interaction with other explanatory variables.

2. The Empirical Methodology
2.1 The First-Step: Estimating Sensitivity Coefficients

The main objective of this first step estimation is to estimate the correlation of a specific financial variable between country $i$ and each of the center economies while controlling for global and domestic factors. The estimated coefficient of our focus is $\gamma_{pi}$. A significantly
positive $\hat{\gamma}_i^C$ indicates a closer linkage between country $i$ and economic center country $C$, as shown in (1):

$$R_{it}^C = \alpha_{Fi} + \sum_{g=1}^G \beta_{Fi}^G Z_{it}^G + \sum_{c=1}^C \gamma_{Fi}^C X_{it}^C + \phi_{Fi} Y_{it} + \epsilon_{it}. \quad (1)$$

Where the $Z_i^G$ is a vector of global factors, the $X_i^C$ is a vector of cross-country factors, and $Y_{it}$ is a control variable for domestic factors. $C$ represents the center economies: the U.S., the Euro area, Japan, and China. $\hat{\gamma}_i^C$ is the estimate of our focus and represents the extent of sensitivity of a financial variable ($R_{it}^C$) to cross-country factors, or more specifically, linkages to the four major economies.

As for the financial variable as the dependent variable, we are interested in 1) the short-term policy interest rate; 2) stock market price changes; 3) the sovereign bond spread; and 4) the rate of change in the real effective exchange rate (REER).

We use money market rates to represent policy short-term interest rate. In recent years, all of the advanced major economies, the U.S., the Euro area, and Japan have implemented extremely lax monetary policy in the aftermath of the GFC. Considering that both the U.S. and Japan have lowered their policy interest rates down to zero or near zero, using official policy interest rates may not capture the actual state of monetary policy. In recent years, many researchers have estimated “shadow interest rates” to represent the actual state of liquidity availability by allowing the estimated shadow rates to be possibly below the zero bound. We use these shadow rates for the three advanced economies to estimate more realistic correlations between the policy interest rates of the center economies and sample countries. For the U.S. and the Euro area, we use the shadow interest rates estimated by Wu and Xia (2014). For Japan, we use the shadow rates estimated by Christensen and Rudebusch (2014).\(^7\)

For stock market prices, we use stock market price indices reported in the IMF’s *International Financial Statistics (IFS)*. The (sovereign) term spread is the difference between

\(^7\) For the U.S. policy interest rates, we use the shadow rates for the entire sample period – the shadow rates deviate from the actual Federal Fund Rate more substantially only after the policy rates hit the zero bound. For the Euro area, we use the estimated shadow rates only after the introduction of the Euro. For Japan, we use the shadow rates after 1996, before which we assume the shadow rates do not deviate substantially from the actual policy rates.
the long-term interest rate (usually 10 year government bond) and the policy short-term interest rate – i.e., the slope of the yield curve. We use the REER indices from the IFS.

For a vector of global factors \((\mathbf{Z}^e)\), we have two subsets of global factors. The first subset of global factors include “real” variables – global interest rates (for which we will use the first principal component of U.S. Federal Reserve, ECB, and Bank of Japan’s policy interest rates); oil prices; and commodity prices. To avoid multicollinearity or redundancy, we also calculate the first principal component of oil and commodity prices and use the resultant variable as a control variable for input or commodity prices.\(^8\)

The second subset is “financial.” In this group, we include the VIX index from the Chicago Board Options Exchange (CBOE), as a proxy for the extent of investors’ risk aversion,\(^9\) and the “Ted spread,” which is the difference between the 3-month Eurodollar Deposit Rate in London (LIBOR) and the 3-month U.S. Treasury Bill yield. This latter measure gauges the general level of stress in the money market for financial institutions. The same set of global factors, except for the principal components of the global interest rates, is used for all the estimations regardless of the dependent variable.

The vector of cross-country linkage factors \((\mathbf{X}^c)\) corresponds to the dependent variable. For example, if the short-term interest rate for country \(i\) is the dependent variable, \(x_i^c\) includes the short-term interest rates of the four center economies.\(^10\) We implement the estimation for each of the sample countries for the four different dependent variables and for a sample period of either three or five-year panels \((p)\). To control for domestic economic conditions, we include the year-on-year growth rate of industrial production index.

All the data used for this estimation exercise are monthly frequency. The same set of explanatory variables (except for the world interest rate) is regressed against the four financial variables: policy interest rate, the rate of change in stock market price indices and the rate of change in the REER index, and sovereignty bond spread.

---

\(^8\) When we estimate for the policy interest rate correlation, we do not include the first component of U.S. FRB, ECB, and Bank of Japan’s interest rates as part of the global factor vector because it would overlap with \(X^c\).

\(^9\) The VIX index series starts in 1990, but we use the VXO index, an older version of the VIX index, to extrapolate the VIX index to 1986. The correlation between the two indices is about 99%. A higher VIX index indicates a higher level of risk appetite.

\(^10\) For the Euro Area’s variables, before the introduction of the euro in 1999, the GDP-weighted average of the variable of concern for the original 12 Euro countries is calculated and included in the estimation.
Because we deal with a relatively long sample period, coefficient instability is a concern. Hence, we estimate period specific regressions in each of the three and five year panels, starting in 1986 in the case of three-year panels.\(^{11}\) That means that \(\hat{\gamma}_{Fit}^C\) is time-varying across the panels. For the rest of the paper, we focus on the results from the estimations on the three-year panels since the results from five-year panels are qualitatively similar.

We also conduct estimate two specifications. One specification does not include China as one of the “center economies.” In this model setup, we are testing the sensitivity of our sample economies to the traditionally-defined major economies of the U.S., the Euro area, and Japan. Excluding China mitigates data limitations as well, especially for the second-step of the estimation procedure. The other model does include China as one of the center economies.\(^{12}\)

We estimate equation (1) to a group of about 100 countries including both advanced economies (IDC) and less developed countries (LDC), though the number of countries included in the four models differs depending on data availability. In our sample, the U.S. and Japan are not included in any of estimates. Moreover, China is excluded for the specification in which China is included as one of the major economies. As for the Euro member countries, they are removed from the sample after the introduction of the euro in January 1999 or when they become member countries, whichever comes first. We also have a subsample of emerging market countries (EMG) within the LDC subsample.\(^{13}\)

### 2.2 The Second Step: Explaining the Sensitivity Coefficients

Once we estimate \(\hat{\gamma}_{Fit}^C\) for each of the four dependent variables for all the samples, we regress \(\hat{\gamma}_{Fit}^C\) on a number of country-specific variables.

\[
\hat{\gamma}_{Fit}^C = \theta_0 + \theta_1 OMP_{Fit} + \theta_2 MC_{Fit} + \theta_3 LINK_{Fit} + \theta_4 INST_{Fit} + \theta_5 CRISIS_{Fit} + u_{Fit}
\]  

---


\(^{12}\) Including China changes the sample periods when the dependent variable is stock market price index changes, as a consequence of data limitations.

\(^{13}\) The emerging market countries (EMG) are defined as the countries classified as either emerging or frontier during the period of 1980-1997 by the International Financial Corporation plus Hong Kong and Singapore.
There are four groups of explanatory variables. The first group of explanatory variables is a set of open macroeconomic policy choices ($OMP_i$), for which we include the indexes for exchange rate stability ($ERS$) and financial openness ($KAOPEN$) from the trilemma indexes by Aizenman, et al. (2013).\(^\text{14}\) A country that has a fixed exchange rate arrangement with a major country, or the base country, is more subject to financial shocks occurring to the base country if it has more open financial markets. Saxena (2008) found the extent of pass-through from foreign interest rates to domestic interest rates is higher under floating exchange rate regimes than pegging regimes, however.\(^\text{15}\) Christiansen and Pigott (1997) also suggest that even under floating exchange rate regimes, foreign factors play an important role in affecting long-term interest rates. Hence, it is an empirical question how and to what extent both financial openness and exchange rate stability matter for transmitting financial shocks. As another variable potentially closely related to the trilemma framework, we suspect the level of international reserves (IR) holding may affect the extent of cross-country financial linkages and include a variable for IR holding (excluding gold) as a share of GDP. Aizenman, et al. (2010, 2011) show the macroeconomic impact of trilemma policy configurations can depend upon the level of IR holding.

The group $MC_i$ includes macroeconomic conditions such as inflation volatility, current account balance, and public finance conditions. As the measure of public finance conditions, we include either gross national debt, or general budget balance, both expressed as shares of GDP. These variables are included as deviations from the major economies. We use the data from the IMF’s *International Financial Statistics* and *World Economic Outlook* Database.

In addition to these groups of variables, we will include variables that reflect the extent of linkages with the center countries ($LINK$). One linkage variable is meant to capture real, trade linkage, which we will measure as: \( TR_{LINK} = GDP_{IMPLINKTR} = \frac{IMP_{C}}{GDP_{ip}} \) where $IMP_{C,i}$ is total imports into center economy $C$ from country $i$, that is normalized by country $i$’s GDP. Another linkage

---

\(^\text{14}\) As Mundell (1963) argued and Aizenman, et al. (2013) and Ito and Kawai (2012) have empirically shown it holds, a country may simultaneously choose any two, but not all, of the three goals of monetary policy independence, exchange rate stability, and financial market openness to the full extent. Given this linearity, we only include the two trilemma indexes out of the three. On the trilemma, also see Obstfeld (2014), Obstfeld, Shambaugh, and Taylor (2005) for further discussion and references dealing with the trilemma.

\(^\text{15}\) To explain the counterintuitive results, Saxena argues that the classification of exchange rate regimes may allow some of the countries that conduct active but incomplete foreign exchange interventions to be classified as “floating” regimes so that the results for the floating regimes may include those of de facto pegging regimes. Also, she argues countries with floating exchange rates tend to have more developed financial markets which tend to follow the trend of the center country’s financial markets.
variable is financial linkage, \( FIN\_LINK_{ip} \). For one, we will measure it with the ratio of the total stock of bank lending from country \( C \) in country \( i \) as a share of country \( i \)’s GDP \( ( BL_{i}^{C} ) \) for which we use the BIS consolidated banking statistics data. As another variable of financial linkage, we also use the ratio of the total stock of foreign direct investment from country \( C \) in country \( i \) as a share of country \( i \)’s GDP \( ( FDINV_{i}^{C} ) \).\(^{16}\)

Another variable that also reflects the linkage with the major economies is the variable for the extent of trade competition \( ( Trade\_Comp ) \). \( Trade\_Comp \) measures the importance to country \( i \) of export competition in the third markets between country \( i \) and major country \( c \). Shocks to country \( c \), and especially shocks to country \( c \) that affects country \( c \)’s exchange rate, could affect the relative price of country \( c \)’s exports and therefore affect country \( i \) through trade competition in third markets. See Appendix for the variable construction. A higher value of this measure indicates country \( i \) and major economic \( c \) exports products in similar sectors so that their exported products tend to be competitive to each other.

Theoretical prediction of this variable is not straightforward. For example, if a major economy lowers its policy interest rate, that would help depreciate the major economy’s currency and therefore make its exports more competitive. If country \( i \) tends to export similar products in terms of the aggregated industrial sectors, which may also lead to a fall in the policy interest rate of country \( i \), which makes a positive estimated coefficient on this variable. However, if a fall in the policy rate in this example foresees some underperforming productivity growth in the future, that may make competitors’ exports appear more attractive. A rise in the demand for competitors’ exports may lead a rise in the policy interest rate, making the expected sign of the estimate for the correlation of the policy interest rates negative.

The fourth group is composed of the variables characterize the nature of institutional development \( ( INST ) \), namely, variables for financial development and legal development. As Caballero-Farhi-Gourinchas (2008) theoretically predict and Chinn and Ito (2007) empirically show, both Financial and legal development are important factors for the volume and directions of cross-border capital flows. Alfaro, et al. (2008) argue that institutional development is also an important factor. If these factors affect cross-border capital flows, they should also affect the extent of sensitivity to financial shocks occurring to the center economies.

\(^{16}\) These two financial link variables, however, turned out to be persistently insignificant across different estimation models. Therefore, we decided to drop them from the models.
There is no agreement about what would be the best way to measure the extent of financial development, because the development of financial markets can be gauged in terms of size, depth, activeness, unit or transaction costs, and profitability to name a few. Here, to measure the level of financial development, we calculate a composite index, or the first principal component, of financial development ($FD$) using the data on private credit creation, stock market capitalization, stock market total value, and private bond market capitalization all as shares of GDP. Additionally, we also include a measure of legal development, for which we use $LEGAL$ which is the first principal component of law and order ($LAO$), bureaucratic quality ($BQ$), and anti-corruption measures ($CORRUPT$), all from the ICRG database.$^{17}$

The precision of $\hat{\gamma}_{Fit}^C$ could be reduced by economic or financial disruptions. To control for that, we include a vector of currency and banking crises ($CRISIS$). We use the crisis dummies from Aizenman and Ito (2013) to identify the two types of the crises. For currency crisis, Aizenman and Ito use the exchange market pressure (EMP) index using the exchange rate against the currency of the base country. The banking crisis dummy is based on the papers by Laeven and Valencia (2008, 2010, 2012).

For each of the four financial variables we estimated in the first-step regression, we have $(i \times C \times t)$ $\hat{\gamma}$’s where $t$ refers to either three- or five-year panels and $C$ is four when we include China as a major economy and three if not. The variables in $MC$ and $INST$ are included in the estimations as differences from the U.S., Japanese, Chinese, and Euro Area’s counterparts. The variables in vectors $OMP$, $MC$, and $INST$ are sampled from the first year of each three (or five) year panels to minimize the effect of potential endogeneity. Also, to capture global common shocks, we also include time fixed effects.

As we previously mentioned, our discussions focus on the results from three-year panel estimations. For each of the three- or five-year panels, we average all the explanatory variables.$^{18}$ By so doing, we will essentially form non-overlapping three- or five-year panels.

3. Empirical Results

3.1 First-Step Estimations

---

$^{17}$ Higher values of these variables indicate better conditions.

$^{18}$ As for the crisis dummies, if a crisis occurs in any year within the three- or five-year period, we assign the value of one.
The Contributions of Different Factor Vectors

For the first-step estimation, we have four variables to estimate: policy interest rate, stock market price changes, REER changes, and sovereignty debt spread. We regress each of these dependent variables on four groups of explanatory variables: real global, financial global, cross-country link, and domestic factors for three-year, non-overlapping panels in the 1986-2012 period.19

To grasp the general trend of the groups of factors that influence the four financial variables, we focus on the joint significance of the variables included in the real global, financial global, cross-country, and domestic groups. Figure 4 illustrates the proportion of countries for which the joint significance tests are found to be statistically significant (with the $p$-value less than 10%) for each of the four financial variables. These figures are based upon the specification that includes China as a major economy while the figures based on the specification without China as a center economy yields similar observations. The figure illustrates the proportion for the groups of advanced economies (IDC) and less developed economies (LDC) after 1992.20

These graphical depictions lead to the following four conclusions. First, the movements of the financial variables of the center economies not only matter for all of the four financial variables, but contribute the most among the groups of explanatory variables to jointly explaining the variation of the variables for both the IDC and LDC groups. The influence of the major economies appears to be the biggest for the policy interest rates of the LDC economies, though it tends to be high also for term spreads and real effective exchange rates and less so for stock market price changes.21 While the policy interest rate specification shows for the LDC economies that the proportions of joint significance remain constantly high throughout the sample period, the influence of the major economies increased particularly in the last two three-year periods in the specifications for the other three financial variables. In the model of stock market price changes, the major economies’ influence appears to be relatively smaller than in the models for the other three financial variables, reflecting that many of LDC’s stock markets are

19 For the model that includes China as a center economy, the sample for the stock market price estimation starts in 1992 due to data availability.
20 The figures for the EMG group are quite similar to those of the LDC group. Hence, we omit discussing them here.
21 When we restrict our sample to emerging market economies (not reported), the contribution of the major economies becomes bigger, which is expected considering that this group of economies have more developed and open financial markets.
less developed, though the proportion of joint significance is now in a moderately rising trend in
the last decade or so.\textsuperscript{22}

Second, as far as policy interest rate is concerned, the proportion of joint significance is
also relatively high for the group of financial global variables, especially for the EMG countries.
Unsurprisingly, the last two three-year panels indicate high proportions of joint significance for
both country groups, suggesting the policy interest rates of the center economies have been quite
influential since the global financial crisis. In the panels for 1998-2000 and 2001-2003, the
proportions also appear high for both country groups. Given the emerging market crises in the
1998-2000 period, and dot com bust of the 2001-2003 period, these results suggest that
economies tend to follow center monetary policies during periods of financial turbulence.

Third, stock market movements in almost all the developed economies are influenced by
those in the center economies. The fact that many of the countries in this group have highly
sophisticated stock markets explain the high proportion of joint significance.\textsuperscript{23} Among
developing countries, the proportion of these economies subject to movements in the center
economies is generally lower, though the proportion has been moderately rising over the last
decade.

Fourth, the center economies play a centrally important role for developed economies’
term spreads. For developing economies, the center economies’ spreads matter less though they
appear quite influential in the two global crisis periods. Unlike the previous two financial
variables, “real global” factors seem to matter in many of the three-year periods, though
“financial global” factors are, unsurprisingly, important in the 2007-09 period.

Last, for the changes in the REER, the movements of the center economies are critically
important for both country groups. Interestingly, the highest proportion of developing countries
appear sensitive to the REER movements of the center economies in 2010-2012. These results
are consistent with the reactions expressed by emerging market policy makers to the taper in Fed
quantitative easing.\textsuperscript{24}

Overall, in accord with Rey (2013), these figures suggest that economies, both advanced
and developing, are subject to the financial conditions of the center economies. We investigate

\textsuperscript{22} The rising trend is more discernable for the EMG group.
\textsuperscript{23} This subsample includes most of the European Monetary Union members. That also contributes to the high
proportion of joint significance.
\textsuperscript{24} Another observation is that the contribution of industrial production growth as the domestic factor is generally low,
though it tends to be slightly higher for the policy rate and term spread estimation models.
the determinants of the degree of sensitivity to the financial conditions of the center economies in the next subsection.

Figure 5 provides a closer look at the influences of the center economies. It presents the proportion of the countries for which the estimated coefficients of the center economies’ variables are found to be significantly positive (with the p-value less than 20%) for each of the four financial variables ($\gamma_c > 0$) and for each of the center economies. We display only the results for the group of developing countries. The positive estimate indicates that the financial conditions of the center economies are influential on other non-CE countries. By comparing the $\gamma_c$’s for different center economies, we can see to which center economy’s financial conditions the sample countries are more sensitive to.

Policy interest rates in many developing countries appear to be positively correlated with the Euro area’s policy interest rate in the last three-year period. The high proportion of the countries with $\gamma_{EURO} > 0$ likely reflects the Euro debt crisis. We also find relatively high proportions of countries with positive correlations with Euro area stock market price changes, although unsurprisingly it is the U.S. that affects other countries’ stock market price movements.

The U.S. is also a relatively dominant influence in terms of the real effective exchange rate movements. The influence of the center economies for term spread is hard to pin down, except for that, again, the Euro area is a dominant economy in the 2007-09 period.

**Contributions of China as a Major Economy**

So far, the empirical results illustrated in Figures 4 and 5 are based on the assumption that China is one of the center economies. However, one can still question whether China’s financial influence matches its impact on real activity. Many studies have shown that there is still much room for China to further develop and open its financial markets.25

Hence, we repeat the previous exercise of testing the joint significance of each vector of explanatory variables, but excluding China from the group of the center economies (i.e., removing the Chinese variable from the cross-country linkage vector). The general characteristics we observed in Figure 4 remain qualitatively intact, suggesting that the financial influence of China remains minimal.

---

To test this assertion more formally, we compare the adjusted R-squared values of the two specifications for each country and each three-year panel, and for each of the four financial variables. Figure 6 illustrates the cross-country average differences in the adjusted-R squared values between the estimation with China as one of the center economies and the one without for the four financial variables. The averages of the gap are calculated for the groups of developed countries, developing countries, emerging market countries, and East Asian emerging market economies as a comparison.26

Overall, the extent of contribution to the adjusted R-squared of including China as one of the center economies depends on the financial variable examined. Regarding the policy interest rate model, including China as a major country increases the adjusted R-squared, especially in the last three years of the 1990s that correspond to the Asian crisis years. Among East Asian emerging market economies, including the Chinese policy interest rate in the estimation model would increase the adjusted R-squared as much as over 15% on average. Despite the recent impressive rise as an economic power, however, the contribution seems negligible in the last two three-year panels. A similar observation can be also made for the term spread model.

In the REER figure, we see a high increase in the adjusted R-squared in the crisis years of 2007-2009 for emerging market countries, especially those in East Asia (with the additional contribution of about 18% to the adjusted R-squared). This may reflect the situation where international trade shrank significantly immediately after the outbreak of the global financial crisis in 2008. In the tight international trade market, trade competitiveness of the world’s largest exporter may have had a large influence on other trading partners.

China’s stock markets do not appear influential in most of the sample period, except for the 2004-2006 period. Given that China’s stock markets only became open recently, the lack of influence of China’s stock markets is unsurprising.

3.2 Results of the Second-Step Estimation

Now that we have $\hat{\gamma}_{Fi}^{C}$ for the four financial variables, we investigate the determinants of the extent of linkages using the estimation model based on equation (2). We estimate two specifications with two different dependent variables for each of the four financial variables. The

26 The group of East Asian emerging market economies includes: Hong Kong, India, Indonesia, Korea, Malaysia, the Philippines, Singapore, Thailand, and Vietnam.
first type of estimation has the dependent variable of $\hat{\gamma}^C_{Fi}$ from the first-step estimation that does not include China as one of the center economies. Hence, for country $i$ in one three-year panel $t$, there are three (i.e., $\hat{\gamma}^{US}_{Fi}$, $\hat{\gamma}^{JP}_{Fi}$, and $\hat{\gamma}^{EURO}_{Fi}$), making $(i \times 3 \times t)$ observations. The second type is the one for which the first-step estimation is conducted with China included as one center economy. Hence, for the second-step estimation, country $i$ in one three-year panel $t$ has four $\hat{\gamma}^C_{Fi}$ ($(i \times 4 \times t)$ observations in total). In what follows, however, we only report the results from the specifications without China as a center economy, since we determined the financial influence of China is minimal. The regressions with China as a center economy yield results qualitatively similar to those without China.\textsuperscript{27}

Tables 1-1 through 1-4 report the estimation results for the extent of sensitivity of each of the four financial variables for the FULL, IDC, LDC, and EMG samples. The bottom rows of the tables also report the joint significance tests for each vector of explanatory variables. We will focus our observations on the results for the subgroups of LDC and EMG.

As for the linkage of policy interest rates, reported in Table 1-1, the variables that characterize countries’ open macro policies do not appear to affect the extent of sensitivity to the monetary policies of the center economies. The vector of exchange rate stability, financial openness, and IR holding are not jointly significant for any of the samples. The lack of statistical significance for the exchange rate stability variable is consistent with Rey’s argument in the sense that the type of exchange rate regime does not affect the sensitivity of policy peripheral economies’ interest rates.

Macroeconomic conditions seem to play an important role; the variables in the macroeconomic condition vector are jointly significant. The more volatile inflation a developing country experiences, the bilateral linkage with the center economies tends to be greater. This result suggests that a country with volatile inflation tends to be more vulnerable to changes in the monetary policy of the center economies. Neither the level of gross debt nor budget balances seems to affect the degree of vulnerability to the movements of policy interest rate of the center economies. However, current account balances do matter especially for emerging market countries. Running current account deficit would make the country more susceptible to the monetary policies of the center economies.

\textsuperscript{27} The estimation results with China as a center economy are available from the authors upon request.
Among the factors of external links, direct trade linkages are the most important variable in determining how shocks to the center economies’ monetary policies could affect those of other non-center economies across all subsamples. A country with more trade with the center economies tends to be more sensitive to changes in the monetary policies of the center economies.\textsuperscript{28}

Financial development also matters significantly for the IDC and LDC samples. Countries with more developed financial markets tend to be more sensitive to the changes in the monetary policies of the center economies. That suggests that countries with deep financial markets can be good investment destinations for foreign investors, so that their arbitrage actions may lead those countries to follow the monetary conditions of the center economies more closely.

Table 1-2 shows that the estimation results for stock market price changes are much less robust and share few characteristics with the model for the policy interest rates. A developing or emerging market country with larger government debt tends to be more vulnerable to stock market movements of the center economies, while financial development, if any, seems to help its market shun shocks arising in the center economies’ markets unlike in the case of policy interest rates.

Unlike in the case with policy interest rates, the degree of exchange rate stability matters for stock market price changes. A country with greater exchange rate stability tends to experience a smaller degree of co-movement of stock market prices with the center economies. This result is somewhat counterintuitive considering that greater exchange rate stability may leave an economy more susceptible to external financial shocks. However, if a shock occurs in the center economies, international investors may try to reorganize their portfolios in the markets where the exchange rate is flexible because the exchange rate risk is greater than in a fixed exchange rate regime. Unlike exchange rate stability, financial openness continues to be an insignificant contributor. Among the external link variables, the degree of trade competition positively affects the stock market price change link between peripheral and center economies though only insignificantly. If a developing country exports products in similar sectors to the center economies, that country tends to be more vulnerable to changes in stock market prices in

\textsuperscript{28} We dropped cross-bank lending and FDI stock since both variables are found to be persistently insignificant contributors to the extent of sensitivity.
the center economies, possibly reflecting that similar industrial structures should pass around shocks to stock markets.

Table1-3 shows that the movements of sovereignty bond term spread among developing and emerging market countries tend to be more responsive to those of the center economies if the former group of countries have more direct trade linkages with the latter, or if peripheral economies have more developed financial markets as was in the case of policy interest rate. That peripheral economies with deeper or more developed financial markets tend to be vulnerable to shocks occurring to the center economies is consistent with what Ito (2014) finds who argues that peripheral economies face the following dilemma of financial development. On the one hand, developing countries want to develop or deepen their financial market to reap the benefit of greater financial intermediation. On the other hand, more developed financial markets could attract more foreign investment, which could make their markets more susceptible to external financial shocks.

Higher inflation volatility, however, would lead a developing economy to have weaker linkages of term spread with the center economies, an opposite, and somewhat counterintuitive, result from the case with policy interest rates. One possible explanation for that would be: an economy with highly volatile inflation should be experiencing constantly high inflation expectation, which would make the longer end of the yield curve stuck at high levels. In such a situation, term spread should be less responsive to changes in the term spread of the center economies.

Generally, the models for REER present results with best goodness-of-fit as Table 1-4 reports. Given certain degrees of price stickiness, pursuing greater exchange rate stability would lead both nominal and real effective exchange rate to be more sensitive to that of the center economies. Our results show the positive impact of greater exchange rate stability on the REER connectivity for all the subsample country groups. Greater financial openness also contributes to greater sensitivity for developing countries, though not significantly so for the EMG group. Interestingly, irrespective of group, a country with a higher level of IR holding tends to be more sensitive to REER changes of the center economies. One interpretation is that a country could respond to changes in the center economies’ real currency appreciation through foreign exchange market interventions, inducing a positive correlation; the interpretation of this coefficient is then not causal.
Countries with larger government debt or budget deficits tend to be less sensitive to the REER of the center economies. These results may reflect that such countries, which should tend to face higher inflationary expectations, often face some difficulty in maintaining real exchange rate stabilities against the currencies of the major economies despite their general desire to pursue greater (nominal) exchange rate stability (Aizenman, et al. 2013, Calvo, et al. 2000).

Not surprisingly, countries with greater bilateral trade links with the center economies tend to be more sensitive to the REER movements of the center economies. The negative impact of trade competitiveness means that peripheral countries with more competitive trade structure to that of the center economies tend to become alternative investment destination if a shock occurs to the center economies. For example, if a shock happens in a way that causes real depreciation of the center economies’ currencies such as predicted output growth, an institutional change that would increase the level of labor rigidities, and a decrease in the appetite for the center economies’ financial assets, the demand for financial assets in peripheral economies can rise and push the real values of their currencies.

In contrast, countries with more developed financial markets tend to be less sensitive to the REER movements of the center economies. These results are consistent with the observation that greater financial development allows a country to have more flexible exchange rate movements; countries could afford to detach their currency values’ movements from those of the center economies.

3.3 Robustness Checks

In order to check the robustness of our results, we implement robust regression techniques that account for outliers in both the dependent variable and explanatory variables by recursively down-weighting them to obtain converged estimates. In addition, we undertake other sensitivity analyses.

As a first attempt, we remove both the fifth and the 90th percentiles of the $\hat{\gamma}$ sample, and then re-estimate by reapplying the robust regression technique to the truncated sample. The results (not reported) remain qualitatively intact. While the magnitude of the estimates change, their statistical significance remain unchanged. When we repeat by removing the observations below the 10th percentile and above the 90th percentile of the $\hat{\gamma}$’s, still we obtain qualitatively
similar results. These findings indicate that the results we report in Tables 1-1 through 1-4 are not driven by outliers.

Some of the countries in our sample have experienced financial crises. During periods of financial turbulence, economic variables could exhibit anomalous behavior, leading to extreme observations. Hence, as a second way to check the robustness of the estimation results, we interact all the independent variables with a dummy for currency crises to account for potential effects of currency crisis. For all the $\gamma$’s of the four financial variables, we again obtain qualitatively similar results. Therefore, we conclude that our estimation results are not driven by extreme values of the explanatory and dependent variables during financial turbulences.

4. Further Analyses

4.1 Open Macro Policy in Conjunction with Other Factors

In the baseline results in the previous subsection, the vector of open macro policy variables is often found to be the jointly least significant, if not insignificant. While these variables may not directly affect the extent of sensitivity to the center economies’ financial variables, it is still possible that they affect the financial linkages indirectly through other variables.

Here, we re-estimate the specifications while including interactive terms between the variables for exchange rate stability and financial openness and some selected variables. More specifically, we are interested in whether exchange rate stability and financial openness affect the impact of current account balances, government gross debt (both as a share of GDP), trade demand from the center economies, and the level of financial development, and report the results in Tables 2-1 to 2-3 for policy interest rates, stock market price changes, and the REER.\(^{29}\)

We obtain several interesting results. First, while greater current account deficit (i.e., negative current account balances) would make developing countries more susceptible to center economies’ monetary policy changes, the significantly positive estimate on the interaction term between current account balances and exchange rate stability suggests that the degree of susceptibility current account deficit would be higher if the country adopts more flexible

\(^{29}\) We omit reporting the results from the estimations for term spread because of the lack of robust results for the interaction terms. For all the financial variables, we continue to use the models that do not include China as one of the center economies. The estimates for inflation volatility, trade competition, legal development, and currency and banking crisis are omitted from presentation in the tables due to space limitation.
exchange rate regime. Considering that more flexible exchange rate movements should allow for greater monetary autonomy, this result is somewhat counterintuitive. The estimate on the interaction term between current account balances and financial openness is also positive, though not significant.

The net impact of a unit change in current account balances is summarized in Table 3, which illustrates the net effects of certain levels of macroeconomic or institutional variables depending on the levels of both exchange rate stability (ERS) and financial openness (KAOPEN) – i.e., \( \beta_0 + \beta_1 \text{ERS} + \beta_2 \text{KAOPEN} \). Table 3 (a) shows the net impact of a unit increase in current account balances conditional of different levels of ERS and KAOPEN such as zero, 0.50, and 1.00.

From the table, we can see that, except for the cases of having a rigidly fixed exchange rate regime with intermediate or open financial markets, the net impact of a unit increase in current account balances is usually negative. In the case of current account deficit – for which we can reverse the signs, the net impact of current account deficits increase as the degree of financial openness decreases, or exchange rate flexibility increases, or both.

Second, while greater government debt alone would increase the sensitivity to the movements of stock market price changes of the center economies, the coefficient on the interaction term of gross debt with exchange rate stability is found to be negative. Table 3 (b) shows that the impact of gross debt is larger as the level of financial openness or exchange rate stability falls. While this finding appears to be counterintuitive, we must note that we include the debt ratio (to GDP) as a deviation from the center economies’, which means that many developing countries tend to take negative values for this variable. Considering that developing countries do not have good accessibility to external financing, and that all of the center economies: the United States, Japan, and the Euro Area, have tended to have high debt ratios during the sample period, a negative gross debt ratio (as a deviation from those of the center economies) is unsurprising.\(^{33}\) A negative value for the ratio would make the net impacts take negative signs in Table 3(b), suggesting that for a certain level of debt (not to the level of the center economies), pursuing greater exchange rate stability and financial openness, especially the former, could make it more subject to the monetary policy of the center economies.

\(^{33}\) In fact, more than 80% of the sample entail negative values for debt deviations.
Also, the positive coefficient on the interaction between import demand by the center economies and exchange rate stability means that greater trade demand from the center economies would make peripheral economies more sensitive to the stock market movements of the center economies if the countries pursue more stable exchange rate movements. The negative, though insignificant, estimate on the interaction between import demand by the center economies and financial openness indicates the demand impact gets smaller as the economy of concern becomes financially open, though its interactive impact is not only insignificant but also smaller compared to the one with exchange rate stability (Table 3 (c)).

Furthermore, for emerging market economies, the interaction between financial openness and current account balances also matters for the vulnerability to the center economies’ stock market price changes. If a country with open financial markets runs current account deficits, the stock market price movements of that country tend to be more sensitive to those of the center economies. This means that financial liberalization might make net borrower countries more susceptible to shocks occurring in the stock markets of the center economies. Furthermore, its effect could be larger if the country pursues greater exchange rate stability, though its interactive effect is found to be insignificant (Table 3(d)).