NBER WORKING PAPER SERIES

FINANCIAL SPILLOVERS AND MACROPRUDENTIAL POLICIES

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Working Paper 24105
http://www.nber.org/papers/w24105

NATIONAL BUREAU OF ECONOMIC RESEARCH
1050 Massachusetts Avenue
Cambridge, MA 02138
December 2017, Revised March 2020

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 would like to thank the discussant Juanyi Xu, conference participants for the ADBI-JMCB Conference "Globalization and Economic Stability," the European Systemic Risk Board, the Banque de France, Bundesbank, Isha Agarwal, Gabriele Galati, Linda Goldberg, Shang-Jin Wei, and anonymous referees for useful comments. All remaining errors are ours. The views expressed herein are those of the authors and do not necessarily reflect the views of the National Bureau of Economic Research.

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NBER Working Paper No. 24105
December 2017, Revised March 2020
JEL No. F38,F4,F41,F42

ABSTRACT

We estimate the impact of the extensity of macroprudential policies on the correlation of the policy interest rates between the center economies (CEs, i.e., the U.S., Japan, and the Euro area), and the peripheral economies (PHs). We find a more extensive implementation of macroprudential policies would lead PHs to (re)gain monetary independence from the CEs when the CEs implement expansionary monetary policy; when PHs run current account deficit; when they hold lower levels of international reserves; when their financial markets are relatively closed; when they are experiencing an increase in net portfolio flows; and when they are experiencing credit expansion.

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1. Introduction

Emerging market economies are vulnerable to changes in the financial and economic conditions of the center economies (CEs). As Rey (2015) argues, global financial liberalization has made economies in the peripheries (PHs) vulnerable to the "global financial cycles" in capital flows, asset prices, and credit growth. According to this view, exchange rate regimes no longer insulate countries from global financial cycles, so that the famous "monetary trilemma," or just "trilemma" – countries can only achieve the full extent of implementation in two, not all, of the three open macro policy goals: monetary independence, exchange rate stability, and free capital mobility – reduces to a dilemma, or an "irreconcilable duo," of monetary independence and capital mobility. Consequently, restricting capital mobility maybe the only way for non-center countries to retain monetary autonomy.

Aizenman, et al. (2016, 2017b) investigate whether Rey's view, the end of the trilemma hypothesis, is supported by the data, and conclude that the trilemma is not dead yet; policy arrangements based on the trilemma do affect the extent of financial linkage between the CEs and the PHs. Many others, such as Obstfeld (2015), Obstfeld, et al. (2005), and Shambaugh (2004), find evidence for the validity of the trilemma.

While the trilemma is not dead, it is true that open economies are subject to ebbs and flows of capital that are heavily influenced by the state of economic and financial conditions of the CEs. That means, policy makers in the PHs need to manage open macro policy to prevent financial instability while being constrained by the trilemma. As Aizenman (2017) put it, we may now live in a world of "quadrilemma" where financial stability have been added to the fourth policy goal.

In the aftermath of the Global Financial Crisis (GFC) of 2008, some emerging market countries, such as Korea, Brazil, Indonesia, Russia, and Thailand, implemented a series of macroprudential policies to ensure financial stability.[4] These policies were generally aimed at building resilience against potential capital flow reversals and other associated financial risks.[5] These recent implementations of macroprudential policies have led to a rise in the literature that investigates the efficacy of macroprudential policies such as Akinci and Olmstead-Rumsey (2017), Buch and Goldberg (2017), Cerutti, et al., (2017a,b), Fendoglu (2017), Ghosh, et al. (2014, 2015, 2018), Lim, et al. (2011), Ostry, et al. (2012), and many others.[6]

This paper will be an addition to this literature. This study focuses on the link between the CEs and the PHs through policy interest rates and examine whether and to what extent this financial link can be influenced by a set of macroprudential instruments. In other words, we investigate whether macroprudential policies are effective for the PHs to delink themselves from the sphere of influence of the CEs and maintain monetary autonomy. This study should provide more clues on how to navigate the world of quadrilemma.[7]

[4] For reviews on macroprudential policies, Bank of England (2009, 2011), Cerutti, et al. (2017a,b), Claessens (2014), Galati and Moessner (2011, 2014), IMF (2013a,b), Lim et al. (2011), Ostry, et al. (2012), and Pasricha, et al. (2017).

[5] Macroprudential policies predate those implemented in the aftermath of the GFC. An oft-cited example is Chile's unremunerated Reserve Requirement (URR) on foreign borrowing. RR was also implemented by Germany and other western European countries in the 1970s to curb capital inflows. For a historical overview of regulatory attempts to control capital flows, refer to Gosh, et al. (2018).

[6] While the papers mentioned in the text conduct cross-country analyses, recently, there are many papers that use detailed, microeconomic data to examine the effectiveness of specific macroprudential policies in a particular country. This type of studies includes Acharya et al. (2018), Auer and Ongena (2016), Barroso et al. (2017), Camors et al. (2019), Epure et al. (2018), and Jimenez et al. (2017).

[7] A possible interpretation of financial instability deals with the presence of multiple equilibria associated with financial fragility. Such financial fragility may reflect concerns regarding the commitment and fiscal viability of policies needed to prevent a run on the banking system in the presence of balance sheet exposure. Bocola and Lorenzoni (2017) provide an insightful model illustrating and explaining these issues in the context of EMs characterized by limited credibility of their fiscal backstop mechanisms. Their framework implies that the "state of fundamentals" (like fiscal space, growth rates, etc.) determines the existence and multiplicity of equilibria. If the fundamentals are very strong, the private sector does not have the incentive to "run on the system," and the regime is

This study differs from other studies that investigate the efficacy of capital controls. Unlike traditional capital controls, the primary goal of macroprudential policies is to ensure financial stability by implementing policies aimed at affecting the balance sheets of both financial institutions and borrowers and targeted at certain sectors, typically corporate and mortgage sectors. Macroprudential policies can smoothen out excessive procyclical movements in financial markets (e.g., rapid growth in credit and liquidity, procyclical capital adequacy, and excessive leverages) and thereby help prevent accumulation of systematic risk and preempt an occurrence of financial crisis.

Capital controls (which in our lexicon is inversely related to financial openness) are typically meant to affect aggregate cross-border transactions irrespective of sector. Or, more precisely, they are aimed at affecting the balance of payments. Hence, capital controls are not usually varied in response to the business cycle.[8] How open a country wants to have financial account transactions is often driven by the government's industrial policy and financial regulatory framework.

Thus, macroprudential policies can be regarded as a set of policy tools to pursue financial stability independent from the three policies in the trilemma while it could also help countries retain monetary autonomy from the CEs.[9] Investigating empirically whether this is true will be

stable. If the fundamentals are very weak, the private sector attacks the system, and the regime collapses. In between the very strong and the weak equilibria, a range of multiple equilibria exist. Under certain conditions, policies like credible deposit insurance, large-enough accumulation of international reserves, macro prudential policies reducing balance sheet exposure, or the provision of hard currency swap lines may prevent the exposure to multiple equilibria by terminating the incentive to run. Earlier examples of such systems include Diamond and Dybvig (1983) and Obstfeld (1996).

[8] However, revenues from imposing levies on cross-border capital flows can have some impacts on the fiscal conditions. Capital controls might also enable, either intentionally or unintentionally, financial repression whereby which the government can secure additional fiscal resources.

[9] In the world of the quadrilemma, ensuring financial stability inevitably affect the other three policy goals including monetary autonomy. For more details, refer to Aizenman (2017).

one of the main contributions of this paper. We examine whether and to what extent implementing a set of macroprudential policies would complement countries' open macro policy management that is dictated by the monetary trilemma.

Our empirical method relies upon a two-step approach. We first investigate the extent of sensitivity of policy interest rate while controlling for global factors. The estimation is done for each of the sample countries and for each of the three-year panels of the period 1986 through 2015, using monthly data. Next, we examine the association of these sensitivity coefficients with the extensity of macroprudential policy implementations while controlling for country's trilemma choices, the real and financial linkages with the CE, the levels of institutional development, and the like.

In what follows, we present the framework of our main empirical analysis in Section 2. Each of the two steps for the estimation is explained in this section. In Section 3, we present empirical results for the estimations while focusing on the effect of macroprudential policies. In Section 4, we investigate the interactive effects between macroprudential policies and macroeconomic conditions and policies. We make concluding remarks in Section 5.

2 The Framework of the Main Empirical Analysis

We extend the same approach as followed in Aizenman et al. (2016, 2017), with special focus on the macroprudential policies as one of the potential determinants of the financial link between the CEs and the PHs. As the first step, we regress the policy interest rate of the PHs on those of the CEs while controlling for global factors.[10]

[10] Ideally, estimation should also control for domestic factors (as the Taylor rule estimation would suggest). In one of our earlier papers (Aizenman, et al., 2017b), we did control for a domestic factor by including the growth rate of industrial production. We also tested the robustness by including the rate of inflation. In neither case, were the distribution of the estimated gammas significantly affected. Since including the growth rate of industrial production

Once we get the estimated coefficients of the CEs' policy interest rates, which we treat as the variable for the degrees of financial sensitivity, as the second step, we regress the estimated degree of sensitivity on potential determinants, including sample countries' macroeconomic conditions or policies, real or financial linkage with the CEs, the level of institutional development of the countries, and the extensity of macroprudential policies. If macroprudential policies can affect the extent of monetary independence in a way that they help economies of our concern to retain monetary independence, the estimated coefficient should be significantly negative.

2.1 The First-Step: Estimating Sensitivity Coefficients

The main objective of this first step estimation is to estimate the correlation of the policy interest rates between the CEs and peripheral economy *i*, while controlling for global factors. We regress the policy interest rate of peripheral economy *i* (Y_{it}) on the vector of the policy interest rates of the three CEs, i.e., the U.S., the Euro area, and Japan, as shown in (1). If country *i* has its monetary policy more susceptible to the monetary policy of one (or more) of the CEs, the correlation of the policy interest rates between the CEs and PHs should be significantly positive, implying a closer linkage between the CEs and PHs, and also that the PH of concern has less of monetary autonomy.

We focus on the estimated coefficient $\hat{\gamma}_{it}^{C}$ (where *C = US, EURO,* or *JP*) which represents the extent of financial sensitivity of peripheral country *i* to the three CEs:

$$Y_{it} = \alpha_{it} + \sum_{g=1}^{G} \beta_{it}^{g} Z_t^g + X_{it}' \Gamma_{it} + \varepsilon_{it}, \qquad (1)$$

or the rate of inflation would constrain the number of observations of the estimated gammas, we decide not to include either industrial production growth or inflation in the first-step estimation so as to maximize the sample size.

where Z_t^g is a vector of global factors and $X_{it}'\Gamma_{it} = (\gamma_{it}^{US} + \gamma_{it}^{EURO} + \gamma_{it}^{JP})\begin{pmatrix} x_{it}^{US} \\ x_{it}^{EURO} \\ x_{it}^{JP} \end{pmatrix}$.

For money market rates that represent policy short-term interest rate, using official policy interest rates may not capture the actual state of monetary policy because all of the CEs have implemented extremely loose monetary policy, whether conventional or unconventional one, in the aftermath of the GFC.[11] Hence, we use the "shadow interest rates" to represent a more realistic state of liquidity availability for the three advanced economies. 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).

We also have global factors (Z_t^g) as a group of control variables in the estimation. As the "real" variable, we include the first principal component of oil prices and commodity prices.[12] Z_t^g also comprises a vector of "financial" global factors, namely, the VIX index from the Chicago Board Options Exchange as a proxy for the extent of investors' risk aversion as well as 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. The latter measure gauges the general level of stress in the money market for financial institutions.

We apply the Ordinary Least Squares (OLS) method to do the estimation for each of the sample countries which amount to 146 developing countries (LDC).[13] The sample period is 1986 through 2015, using monthly data, with regressions implemented over non-overlapping, three-year panels. That means that we obtain time-varying $\hat{\gamma}_{it}^{C}$ across the three-year panels and the

[11] This is true especially after the ECB and the Bank of Japan lowered their policy rates down to zero but before they adopted negative interest rates.

[12] The use of the first principal component of oil and commodity prices is to avoid multicollinearity or redundancy.

[13] Refer to Appendix 2 for the list of the countries included in the estimation.

countries. For all the estimations, we exclude the U.S. and Japan. As for the Euro member countries, they are removed from the sample after the introduction of the euro in January 1999 or they become member countries, whichever comes first.[14]

Before moving on to introduce the function to estimate the determinants of the degree of sensitivity to the CE's financial conditions, we note here that, despite the recent impressive rise as an economic power, we do not consider China is one of the CE's in this paper. In our previous paper (Aizenman, et al., 2016), we compare the adjusted R-squared values of the two specifications, one with China as one of the CE's and the other without for each country and each three-year panel, and found that China's contribution is negligible except for the time around the Asian financial crisis of 1998.[15] Thus, China's contribution in the financial sector is still negligible in a historical context.[16]

2.2 The Second Step: Baseline Model

[14] Endogeneity can be an issue for this type of estimation. As a robustness check, we re-estimated the first-step model by lagging the right-hand-side variables. However, it did not change the characteristics of the results (not reported). Hence, we keep the estimation method as it is.

[15] Aizenman, et al. (2016) also examine the extent of financial connectivity through stock market prices, bond spread, and real effective exchange rates, and test the significance of China's role as one of the CE's. In the models (comparable to equation (1) in this paper) for stock market price changes or sovereign term spreads, China does not appear influential in most of the sample period. Considering that China's financial markets only became open only recently, the lack of influence of China's these financial variables is unsurprising. In the case of the estimation for the connectivity through real effective exchange rates, including China as one of the CE's contributes to increasing the adjusted R-squared in the crisis years of 2007-2009 for emerging market countries, especially those in East Asia, possibly reflecting the spell over of significant shrinkage of international trade immediately after the outbreak of the global financial crisis in 2008.

[16] Considering that the Shanghai stock market crash in the summer of 2015 and the winter of 2016 significantly affected financial markets in the U.S., Japan, and Europe, one expects that the role of China as a CE and connectivity with it will become substantial in the near future. The same kind of argument can be made about whether other large emerging market economies such as Brazil, Russia, and India can be the center economies that exert global influence. While their role as major economies in the world has been rising, we would still have to wait for future research to identify their increasing influence in the global economy.

Once we estimate $\hat{\gamma}_{it}^{C}$, we regress $\hat{\gamma}_{it}^{C}$ on a number of country-specific variables. To account for potential outliers on the dependent variable, we apply the robust regression estimation technique to the following estimation model.[17]

$$\hat{\gamma}_{it}^{C} = \theta_0 + \theta_1 OMP_{it} + \theta_2 MC_{it} + \theta_3 LINK_{it} + \theta_4 INST_{it} + \theta_5 MPI_{it} + \theta_6 CRISIS_{it} + u_{it} \quad (2)$$

Here, the choice of explanatory variables is based on a wide variety of literature pertaining to spillover effects and global synchronization of financial or macroeconomic variables. Hence, we assume that the above estimation model takes a reduced form, rather than a structural form, by which we can address various theoretical predictions at once, rather than relying on one particular theory or model.

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). As another variable potentially closely related to the trilemma framework, we include the variable for IR holding (excluding gold) as a share of GDP because we believe the level of IR holding may affect the extent of cross-country financial linkages.[18]

The group of macroeconomic conditions, or MC_i includes inflation volatility, current account balance, and gross national debt (as a share of GDP).

[17] The robust regression is a form of weighted least squares regression that estimates a model while assigning smaller or zero weights on outliers. To obtain the estimates, the OLS estimation is first conducted to get the Cook's D (Cook, 1977) for each observation. Observations with the Cook's D above a certain cut-off point (e.g., Cook's distance greater than 1) are dropped from the sample. Then, iterative estimations are conducted until the weights converges. The iterations lead to creating smaller weights on larger outliers (i.e., observations with large absolute residuals from the initial OLS estimation). For more details on the robust regression, refer to Hamilton (1991).

[18] Aizenman, et al. (2010, 2011) show the macroeconomic impact of trilemma policy configurations depends upon the level of IR holding.

The group of the variables that reflect the extent of linkages with the center countries (*LINK*) includes trade linkage, which we measure as: $TR\_LINK_{ip} = IMP_{ip}^{C} / GDP_{ip}$ where IMP_i^C is total imports into center economy *C* from country *i*, normalized by country *i*'s GDP. *LINK* also includes variables for financial linkage, for which we use the ratio of bank lending from center economy *C* to country *i* as a share of country *i*'s GDP. [19]

Another variable that 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*.[20] A higher value of this measure indicates country *i* and major economy *C* exports products in similar sectors so that their exported products tend to be competitive to each other.

The fourth group is composed of the variables that characterize the nature of institutional development (*INST*), namely, variables for financial development and legal development.[21] For the measure of the level of financial development, we use Svirydzenka's (2016) "index of financial development" which is the first principal component of two sub-indexes, one that captures the development of financial markets (*FM*) and the other that reflects the development of financial institutions (*FI*). Each of *FM* and *FI* is the first principal components of three variables: "depth," "access," and "efficiency," respectively.[22]

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[19] It is 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.

[20] 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 1 for the variable construction.

[21] However, since the estimate of the legal development variable is found to be persistently insignificant, this variable is dropped from the estimation.

[22] That is, there are FM-depth, FM-access, FM-efficiency, and FI-depth, FI-access, FI-efficiency. Each of the six sub-indexes is the first principal components of the component variables. For further details, refer to Svirydzenka (2016).

The variables in *MC* and *INST* are included in the estimations as deviations from the U.S., Japanese, and Euro Area's counterparts. The variables in vectors *OMP*, *MC*, and *INST* are sampled from the first year of each three year panels to mitigate the effect of potential endogeneity or bidirectional causality.[23] Also, in order to capture global common shocks, we also include time fixed effects for the three-year panels.

Lastly, to control for economic or financial disruptions, we include a vector of currency and banking crises (CRISIS). For currency crisis, we use a dummy variable based on the exchange market pressure (EMP) index which is calculated 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).

2.3 The Macroprudential Policy Index (MPI)

MPI is the variable of our focus. We assume it represents the extensity of the implementation of macroprudential policies, for which we use the macroprudential policy dataset developed by Cerutti, et al. (2017a,b). This dataset is based on a comprehensive survey conducted by the International Monetary Fund (IMF), called Global Macroprudential Policy Instruments (GMPI). This survey sent IMF member countries' central banks questionnaires regarding the use and effectiveness of 18 macroprudential policy instruments. Cerruti, et al. (2017a,b) focus on 12 policy instruments and compiled a panel dataset with dummy indicators on the usage of each instrument for 119 countries during the period 2000-2013.

[23] Sampling data from the first year of each three-year panel could still entail bidirectional causality. As another way of mitigating endogeneity or bidirectional causality, we could lag the right-hand-side variables, but by one three-year panel. Lagging the right-hand-side variables this way could mean that we assume it takes three to five years for the right-hand-side variables to affect the dependent variable, which we do not think is plausible.

MPI is the sum of the following 12 dummies variables: Loan-to-value ratio cap (*LTV_CAP*); Debt to income ratio (*DTI*); Dynamic Loan-loss Provision (*DP*); Countercyclical capital buffer/requirement (*CTC*); Leverage (*LEV*); Capital surcharges on Systematically Important Financial Institutions (*SIFI*); Limits on interbank exposures (*INTER*); Concentration limits (*CONC*); Limits on foreign currency loans (*FC*); FX and/or countercyclical reserve requirements (*RR_REV*); Limits on domestic currency loans (*CG*); and Levy/tax on financial institutions (*TAX*). Each of these variables takes the value of unity when the policy instrument of concern is implemented by the country.[24]

We treat *MPI* as the measure for the *extensity* of macroprudential policy implementation. Cerruti, et al. (2017a,b) make it clear that each of the 12 dummies does not "capture the intensity of the measures and any changes in intensity over time."[25] Although each dummy does not directly refer to the stringency of individual policy measures, MPI, as an aggregate of the 12 dummies, does reflect the *extensity* of the macroprudential measures.

Countries have adopted varying institutional arrangements to avoid the accumulation of systematic risk and the occurrence of financial crisis. Obviously, there is no "one-size-fit-all" macroprudential policy framework. Instead, a broad range and variety of macroprudential policy tools have been in use in many countries with different policy objectives. Some policy tools are intended to build up buffers against accumulating systematic risks so that boom-bust cycles can be mitigated. Other tools are meant to deal with and attenuate the influence of external factors or of interlinkages between different domestic financial markets.

[24] For more details on the dataset, refer to Appendix 3 as well as Cerruti, et al. (2015).

[25] The authors also argue that codifying the degree of intensity of the measures would involve a certain degree of subjective judgements.

Thus, as policy authorities strengthen defenses against financial instability, the set of policy tools would necessarily expand. In other words, an extensive use of macroprudential policies should be warranted to make the aggregate set of policy instruments more effective. Therefore, focusing on the extensity of macroprudential measures could capture addressing the intensity of macroprudential policies. Hence, we examine whether the level of macroprudential policy extensity affects interest rate financial linkages.

Figure 1 illustrates the development of MPI over 2000 through 2013 for different income groups (Panel (a)) and for different regional groups (Panel (b)). We can see that the use of macroprudential instruments is consistently becoming more frequent over years. Emerging market economies (EMG) are the most frequent user of macroprudential policies, which is understandable given that this group of economies are vulnerable to torrents of capital as they liberalize their financial markets while their domestic institutions are not as highly developed as advanced, industrialized countries.[26]

According to Table 1, both the mean and the standard deviation of MPI are the highest for the EMG group. Industrialized countries, which as an aggregate have the lowest mean and standard deviation in the full sample period (Table 1), increased the use of macroprudential policies around the GFC and continued to increase the usage toward the end of the sample period. The U.S. and European industrialized countries were the epicenters of the GFC, and other, mostly European, industrialized countries surrounding these economies took defensive actions to shield themselves from the shocks emanating from the epicenters. That can be observed as rapid increases in the use of macroprudential policies by western and eastern

[26] The emerging market countries (EMG) is a subgroup of the LDCs and 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. The group of "industrialized countries" is included in the figure for comparison purposes. Industrialized countries refer to traditional OECD countries whose IMF code is less than 186.

European economies as shown in Figure 1 (b). Among different regions, economies in Latin America are the most frequent users of macroprudential policy instruments consistently throughout the sample period.

Cerruti, et al. (2017a,b) also group these 12 dummy variables into the group of macroprudential policy tools intended to affect the behavior of borrowers (*BORROWER*) and that of those intended to affect the behavior of lenders (*FINANCIAL*). *BORROWER* is composed of loan-to-value ratio caps (*LTV_CAP*) and debt to income ratio (*DTI*) while *FINANCIAL* is of the remaining 10 tools: *LTV_CAP*, *DTI*, *DP*, *CTC*, *LEV*, *SIFI*, *INTER*, *CONC*, *FC*, *RR_REV*, *CG*, and *TAX*.

Figure 2 illustrates the development of *BORROWER* and *FINANCIAL* for the advanced economies (IDC) and developing economies (LDC).[27] Developing economies have been more likely to implement both *BORROWER* and *FINANCIAL* compared to IDCs. Many LDCs increased the number of borrower-targeted macroprudential policies in 2004 and after 2010 while they steadily increased the use of lender-targeted policies over time. Interestingly, IDCs increased the use of borrower-targeted macroprudential policies rather discretely in 2008 when the Financial Crisis broke out, and in 2010 and 2013 in response to loose monetary policy in the U.S. and the Euro area in the preceding years.

As we previously discussed, the main purpose of macroprudential policies is to contain systematic risk and increase resilience of financial system to shocks. This means that macroprudential policy tools can vary in terms of their purposes and targets. The International Monetary Fund (IMF), the Financial Stability Board (FSB), and the Bank for International

[27] Because the maximal values differ between *BORROWER* (2) and *FINANCIAL* (10), Figure 2 is drawn to show the group average of the portion of the implementation of policy *x* (i.e., $\overline{x_i} = \frac{x_i}{x_{max}}$ where x is *BORROWER* or *FINANCIAL*).

Settles (BIS) categorize macroprudential policies into (1) (broad-based) capital tools; (2) asset-side (sectorial capital) tools; and (3) liquidity-related tools (IMF-FSB-BIS, 2016).

According this categorization, we can disaggregate MPI into *CAPITAL*, which is the sum of *DP*, *CTC*, *SIFI*, and *INTER*; *ASSET*, which is the sum of *LTV_CAP*, *DTI*, *LEV*, and *CONC*; and *LIQUIDITY* which is the sum of *FC*, *RR_REV*, *CG*, and *TAX* (see Appendix 3). The policy tools included in *CAPITAL* aim at increasing resilience of the financial system while maintaining the supply of credit through adverse conditions, while those in *ASSET* seek to break the procyclical feedback between asset prices and credit in the mortgage lending market. Tools in *LIQUIDITY* are aimed at managing the build-up of liquidity and foreign exchange risks associated with lending booms.

Figure 3 shows the trajectories of the three disaggregated measures of macroprudential policies for IDCs and LDCs.[28] Among LDCs, asset-based measures are most implemented among the three types of policies, followed by liquidity-related and broad capital-based. Among IDCs, asset-based measures are still most used and their use has been increasing since the Financial Crisis of 2008. For this group of countries, broad capital-based measures are second most used while liquidity-based measures are least used, though their use has been rapidly rising after the GFC.

Using these MPI-related variables, we examine in the second-step estimation whether and to what extent the implementation of macroprudential policies affects the financial linkages between CEs and PHs. We will primarily focus on investigating the aggregate impact of macroprudential policies using the MPI. We will also disaggregate the impact of macroprudential policies and examine whether and to what extent different types of

[28] As in the case of Figure 2, the group average of the portion of the policy implementation.

disaggregated macroprudential policy variables for affect the CE-PH links. These variables are included in the estimation as three-year averages. Because MPI-related indexes are available for 2000-2013, the sample for the second-step estimation comprises three-year panels that start in 1998-2000 and ending in 2013-14.[29]

3 Empirical Results

3.1 First-Step Estimations – Connectivity with the CEs

As the first step, we estimate the extent of correlation of the policy interest rates between the CEs and the PHs while controlling for two kinds of global factors: "real global" and "financial global," using the three-year, non-overlapping panels in the 1986-2015 period.

To gain a birds-eye view of the empirical results and the general trend of the groups of factors that influence the financial link, we focus on the joint significance of the variables included in the real global and financial global groups, and vector X^C the latter of which includes the policy interest rates of the three CEs.

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 5%) for the real global and financial global groups, and vector X^C of the CEs' policy interest rates.

According to Figure 4, the policy interest rates of the CEs affect most joint-significantly those of the PHs. That is, the CEs' policy interest rates have been dominant for developing and emerging market economies in the last two decades, a consistent result with the findings reported in Aizenman et al. (2016).

[29] Data availability makes the last three-year panel a two-year average. For the last panel, we use the MPI data as of 2013.

Furthermore, the proportion of joint significance is also relatively high for the group of "financial global" variables during the GFC and the last three year panel for developing countries and since the GFC for developed countries and emerging market countries, suggesting global financial factors have been playing an important role in affecting the policy interest of countries regardless of income levels. This result is consistent with the Rey's (2013) thesis of "global financial cycles." Not surprisingly, economies are more exposed to global financial shocks during periods of financial turbulence while also following CEs' monetary policies.

Figure 5 presents the distribution of the estimated degrees of sensitivity (the estimated gammas) to the policy rates of the key economies. Figure 5 (a) shows the median of the estimated gammas with respect to the U.S., the euro area, and Japan. The figure does not show any discernable patterns or trend, except that the estimated gammas with respect to the three key economies tend to show wide swings at the times of financial crises (e.g., late 1990s and late 2000s). This is confirmed with Figure 5 (b) which illustrates the standard deviations of the estimated gammas for each of the key economies.[30] These panels of figures suggest that the estimated gammas contain many outliers, may seem to help make it hard to detect patterns or trends in the estimated gammas.

3.2 Results of the Second-Step Estimation: Do the Macroprudential policies matter?

We now use the estimation model based on equation (2) and investigate the determinants of the extent of linkages through the policy interest rate, $\hat{\gamma}_{Fit}^{C}$, while focusing on the impact of

[30] Both the median and the standard deviations are calculated after removing outliers below the 5th percentile and above the 95th percentile.

macroprudential policies. Table 2 reports the estimation results for the LDC and EMG samples (see Appendix 2).

Generally, compared to the results in our previous study (Aizenman, et al. 2017b), the results are unaffected despite the inclusion of the MPI in the estimation.

PHs with more open financial markets tend to follow the monetary policy of the CEs, though the extent of exchange rate stability they pursue does not matter.[31] The positive coefficient on inflation volatility means that countries with highly volatile inflation cannot maintain monetary independence. Those peripheral countries that export competitive products to the CEs may be more able to delink the link of the policy interest rates with the CEs, while those with stronger trade links with the CEs tend to have a stronger connectivity through the policy interest rates with the CEs. The more developed financial markets a PH country is equipped with, the more connectivity through policy interest rates it has with the CEs. This result may reflect that countries with more developed financial markets tend to be more exposed to arbitrage opportunities so that their interest rates tend more to be equalized or synchronized with those of the CEs. The model, however, does not fit very well for the subsample of EMGs.

The effect of macroprudential policies on the financial link between the CEs and PHs is not observed. Although the estimated coefficient of the MPI variable is negative for both LDCs and EMGs, it is never statistically significant.

As previously described, the MPI index can be disaggregated into those borrower-targeted (*BORROWER*) and those targeted for financial institutions (*FINANCIAL*), or those regarded as capital tools (*CAPITAL*), asset-side tools (*ASSET*), or liquidity-related tools

[31] Aizenman, et al. (2017b) find that the links through other financial variables are affected by the degree of exchange rate stability. Hence, unlike the "global financial cycles" argument by Rey (2013), the type of exchange rate regimes does matter.

(*LIQUIDITY*). We now replace the MPI with *BORROWER* or *FINANCIAL* individually, or both of them together. Table 3 reports the estimation results only for the estimates of *BORROWER*, *FINANCIAL*, or both.

Again, we do not observe any significant effect of these variables – in Table 3, neither *BORROWER* nor *FINANCIAL* enters the estimation as a significant determinant whether the variables are included individually or together.

Even when we include *CAPITAL*, *ASSET*, and *LIQUIDITY* individually or all together, still, we do not observe any significant impact of these variables (results not reported).

Do these results suggest that macroprudential policies do not affect the financial connectivity between the CEs and the PHs? We cannot make such a conclusion too hastily.

The effect of macroprudential policies may differ depending on the conditions of the CEs or PHs. Macroprudential policy instruments received more attention when several important emerging market economies such as Brazil, Korea, and Indonesia, implemented these policies against the influx of capital caused by unconventionally lax monetary policy of the CEs. Given that, the effectiveness of the macroprudential policies may differ whether the CEs implement a policy that contributes to an influx of capital to the PHs or an efflux of capital from the countries.

Figure 6 illustrates the shadow policy interest rates for the three CEs. From the figure, we can see that different three-year panels (shown with vertical dotted lines) present different states of monetary policies among the three CEs. That is, in the three-year panels of 2001-03, 2007-09, 2010-12, the (shadow) policy interest rates steadily fall, indicating the central banks of these economies implemented expansionary monetary policy in these three-year panels. Such monetary expansion usually contributes to causing an influx of capital to emerging market economies. In the other panels, namely, the three-year panels of 1998-2000, 2004-2006, 2013-

2015, the state of monetary policy of the three CEs appears as either contractionary or undiscernible.

From the perspective of the PHs, macroprudential policy may be more important when the CEs relax monetary policy than otherwise, because loose monetary policy by the CEs might necessitate PHs to take some actions against an influx of capital that is departing from the low-yielding advanced economies for higher yields.

Now, let us estimate the variable of financial connectivity again, but this time restricting the sample to the panels of 2001-03, 2007-09, 2010-12, i.e., the time periods when the CEs implemented lax monetary policy consistently. The results are reported in Table 4.

Interestingly, the estimated coefficient of the MPI becomes significantly negative for LDC. That indicates that macroprudential policy help these economies to shield the influence of the CEs' policy interest rate changes. In other words, macroprudential policies may help PHs to delink themselves from the CEs and retain monetary independence. This evidence is consistent with the fact that many emerging market countries implemented macroprudential policies when they experienced a rise in capital inflows in the aftermath of the GFC. The coefficient of the MPI is also found to be negative for the EMG subsample, but it is not statistically significant.

When we run the same regression for the other three-year panels, those with no monetary expansion (i.e., 1998-2000, 2004-2006, 2013-2015), the coefficient of the MPI is found to be insignificant. This result indicates that only when the center economies implement expansionary monetary policy, does macroprudential policy taken by developing countries become effective in allowing them to retain monetary autonomy.

Figure 7 illustrates the contributions of the right-hand side variables to the estimated financial sensitivity for Israel, Korea, and Turkey, using the estimates from the regression for

LDC reported in Table 4. As previously described, we group the right-hand side variables into a group of open macroeconomic policy choices (OMP_i); macroeconomic conditions (MACRO); the variables that reflect the extent of linkages with the CEs (LINK); the variable that characterizes the nature of institutional development (*INST*); and the MPI as the measure of the extensity of macroprudential policies. We show the contributions of each of the groups along with the estimated gamma from the first step regression as well as the gamma predicted from the second step regression for the three-year panels of 2007-09 and 2010-12 – the time periods when the CEs implement expansionary monetary policy.[32]

These countries represent the case where their gamma against the U.S. policy interest rate (i.e., the estimated coefficient of the correlation between these countries' and the U.S. policy interest rates) fell while they increased the level of MPI. In other words, these country's monetary independence *rose* when they implemented more extensive macroprudential policies. For example, Turkey increased the level of MPI from 2.3 in 2007-09 to 4.7 in 2010-12. The (negative) contribution of MPI expands as the level of MPI rises while the estimated gamma against the U.S. policy interest rate goes down from 0.40 in 2007-09 to -0.53 in 2010-12 (i.e., it retained more monetary independence). The proportion of the MPI's contribution, coloured in brown, appears to be significant given the level of the gamma. Similarly, the contribution of the MPI looks significant for both Korea and Israel, both of which experienced a fall in the estimated gamma between the two time periods while their MPI levels went up.[33] Thus, the effect of the MPI is not just econometrically significant, but also economically significant.

[32] For the sake of simplicity of the graph presentation, we omit showing the contributions of the time fixed effects as well as the estimated constant.

[33] As we will see in the next section, the negative correlation between the MPI and the estimated gamma is more applicable to countries running current account deficit and holding lower levels of IR. As of 2007-09 and 2010-12, Turkey ran current account deficit while Korea and Israel ran current account surplus, the latter two countries of

When we disaggregate the MPI into *BORROWER* and *FINANCIAL* and include them either separately or together, the estimation results shown in Table 5 indicate that the negative effect of the MPI variable in Table 4 comes from the macroprudential policy instruments that are targeted for lenders, i.e., financial institutions. This finding is unique because recent studies show borrower-based macroprudential policies tend to be more effective than lender-based policies.[34]

Generally, macroprudential policies targeting lenders seek to make the price of credit more expensive so that borrowers' demand for credit would fall. Authorities in charge could slow down credit growth insofar as borrowers are interest-sensitive. The finding that macroprudential policy instruments targeted at lenders are more effective in weakening the financial linkage with the CEs means that monetary authorities can retain more monetary autonomy by making the price of credit more expensive. This result might arise because it is easier for authorities in charge of macroprudential policies to target financial institutions rather borrowers because the number of lenders can be relatively limited while that of borrowers can be numerous.

What about the impacts of *CAPITAL*, *ASSET*, and *LIQUIDITY?*

We include these variables instead of the previous two variables both individually and jointly and report the results in Table 6. Among the three variables, only *LIQUIDITY* turns out to be a significant and negative contributor to the correlation of policy interest rates between the CEs and the PHs. Given that liquidity-related macroprudential measures are intended to control liquidity growth, especially when the periphery economy is experiencing an influx of capital due

which held relatively sizeable IR. The exercise here does not distinguish between current account surplus and deficit countries, or between high and low IR holders. Hence, we are showing the "average behavior" between these different types of economies. Economies like Korea and Israel could also implement active and preemptive macroprudential policies if they are "prudentially" afraid of the tail risk of rapid worsening of their domestic financial market conditions.

[34] See Ayyagari et al. (2018), Cerutti et al. (2017a,b), Epure et al. (2018), and Fendoglu (2017).

to expansionary monetary policy conducted by the CEs, controls on liquidity growth should be effective in allowing the country to retain control over its own monetary policy.

Lastly, we include each of the 12 dummy variables individually and jointly instead of MPI or the other disaggregated measures (results not reported). Among the dummy variables, the policy that limits banks from exceeding a fixed minimum leverage ratio ("Leverage ratio cap") and the policy of countercyclical reserve requirements are found to have a significantly negative impact on the correlation of policy interest rates between the CEs and the PHs. The countercyclical reserve requirements policy is found to be robust even when all of the dummy variables are included in the estimation. Among the 12 types of macroprudential policies, the cap on the leverage ratio and countercyclical reserve requirements are effective in controlling credit growth, which allows the monetary authorities of the PHs to retain autonomy over interest rate policy.

Interestingly, none of the above findings are observed when the estimation is conducted for the remaining three-year panels. These empirical findings suggest that the effect of macroprudential policy is discernible only when the CEs implement expansionary monetary policy that eventually causes a rise in capital inflows among developing countries, but not when the CEs implement contractionary monetary policy. In other words, the impact of macroprudential policies is asymmetrical, which explains why we did not find a significant impact of macroprudential policies in the baseline regression.[35]

As previously discussed, the purpose of macroprudential policies is to protect the financial system from economic and financial shocks. For small, open peripheral economies, the main purpose of macroprudential policies is to minimize systematic risk that arises from shocks

[35] We cannot differentiate between the hypothesis that the asymmetry occurs post-financial crisis vs. a period of loose monetary policy in the CEs.

emanating from the CEs. When the CEs implement expansionary monetary policy, that can shift the tide of cross-border capital flow toward higher-yielding markets in the PHs, while the PHs could experience capital outflow when the CEs implement contractionary monetary policy. However, the magnitude and the impact of capital outflow on the financial markets and the real economy often depends upon the scale of capital inflow that precedes the event of capital outflow. Monetary authorities often implement macroprudential policies as preemptive measures to mitigate an expansion of credit thereby avoiding severe bubble and bust cycles.

The estimation results we obtained from the above analysis bolster the premise that macroprudential policies are important when credit and liquidity expansion is being "exported" from the CEs.

4. Further Analyses

We saw that macroprudential policies could affect the financial link between the CEs and the PHs through the policy interest rates, especially when the CEs implement expansionary monetary policy. The effect of macroprudential policies might also depend upon several other macroeconomic or policy conditions of the PH countries that implement the policies.

Let us now examine how the effect of macroprudential policies on the financial link might change depending on the macroeconomic or policy environment of the PHs. We test how third factors could affect the effectiveness of macroprudential policies on the interest rate channel between the CEs and the PHs while continuing to restrict our sample period to the periods of CEs' "loose" monetary policy.

First, we test the impact of current account balances. Although we observed that macroprudential policies become effective only when the CEs implement expansionary monetary

policy, the effectiveness of macroprudential policies should differ whether the PH country of concern is a net recipient of capital or a net lender. Historically, current account deficit countries are more receptive to external shocks than surplus countries.

To test that, we divide the sample of LCD, or EMG, into the country-years in which the PH runs current account surplus and those in which they run deficit. Table 7 reports the estimation results for the MPI variable. The negative effect of macroprudential policies on the interest rate link between CEs and PHs is observed only for current account deficit countries for both LDC and EMG subsamples. That means that macroprudential policies allow PHs to retain more monetary independence from the CEs when they are net recipients of capital, while macroprudential policies do not matter for current account surplus countries.

The level of international reserves holding might matter for the effectiveness of macroprudential policies. If a country holds a large volume of international reserves and implement macroprudential policies, those policies may be more effective because holding a large volume of IR could send a positive signal that the country is less vulnerable to external shocks. In this case, it can be argued that IR holding plays a supplemental role to macroprudential policies. At the same time, however, macroprudential policies and IR holding could have a substitutive relationship to each other. In that case, even if a country does not hold a large volume of IR, active implementations of macroprudential policies might function as an alternative buffer to external shocks.

Our estimation results suggest that macroprudential policies and IR holding have a substitutive relationship with each other. Table 8 reports the results from the estimations in which we divide the sample of LDC or EMG depending on the level of IR (as a share of GDP) is greater or lower than the sample medium. According to the estimation results, for EMG countries

which do not hold high levels of IR, implementing macroprudential policies could help them mitigate the impact of a change in the CEs' policy interest rates on their own interest rates, i.e., they can retain more monetary autonomy from implementing macroprudential policies.

The impact of macroprudential policies could also depend upon the degree of openness to international financial markets of the country that implements the policies. We divide the sample into two subsamples depending on whether our measure of capital account openness (the Chinn-Ito index) is above or below the sample medium and rerun the estimations. In Table 9, we observe that macroprudential policies could be more effective when the economy of concern is relatively financially closed. This means that when a PH country tries to shield itself from capital inflows diverted from the CEs, having more closed financial markets would help for the macroprudential policies to be more effective. Conversely, for PH economies with more open financial markets, macroprudential policies would not be sufficient to manage capital inflows.

The purpose of implementing macroprudential policies is to shield the influence of policy changes made by the CEs so that the country that implements the policies could retain its own monetary autonomy. We have seen that PHs' macroprudential policies are effective when the CEs implement expansionary monetary policy. In such a situation, a lax monetary environment among the CEs would cause capital to flow into emerging market economies with higher yields, which could cause credit to expand in the latter. Monetary policy makers of the PHs might become concerned that increased credit in their economies might become out of controls, against which policy makers may implement macroprudential policies. Given this, the effect of macroprudential policies may be more discernable when the PH economy of concern is experiencing an increase in capital inflow and also an expansion of credit.

Table 10 divides the sample depending on the portfolio net inflow (as a share of GDP) is experiencing a positive or negative growth. The coefficient of the MPI is negative for the LDC sample for the economies that are experiencing growth in net portfolio inflows. The estimated coefficient of the MPI for the EMG group is also negative, but only marginally significant (p-value = 16%). Macroprudential policies are discernably effective when the PHs are experiencing an increase in portfolio net inflows.

In Table 11, we divide the sample depending on whether the country of concern is experiencing a growth of credit higher than its own median or not.[36] The MPI variable enters the estimation for both the LDC and EMG subsample with a significantly negative coefficient only for the sample of countries with higher-than-median credit growth. Taken together with the results of Table 10, we can conclude that macroprudential policies can become effective when the CEs implement expansionary monetary policy, that causes a rise in portfolio net inflows and credit expansion in the PHs.

5. Concluding Remarks

In this paper, we empirically investigated whether and to what extent the financial link through policy interest rates between the CEs (i.e., the U.S. the euro area, and Japan) and the PHs can be affected by a set of macroprudential policies implemented by the PHs.

We found that macroprudential policies negatively affect the interest rate connectivity between the CEs and the PHs when we focused on the time periods when the CEs implement expansionary monetary policy. This asymmetrical finding makes sense considering that CEs' lax monetary policy causes massive capital to flow to the PHs while the latter countries try to

[36] We measure credit growth as a percentage growth of liquid liabilities as a share of GDP.

attenuate any negative impact on the real economy of credit expansion caused by capital influx from the CEs.[37]

When we disaggregated the index for macroprudential policies into the group of borrower-targeted macroprudential policy tools and that of lender-targeted tools, we found that the above negative impact of MPI is mainly driven by lender-targeted macroprudential policies. This finding is unique because recent studies show borrower-based macroprudential policies tend to be more effective than lender-based policies.

Furthermore, when we disaggregated the MPI into (broad-based) capital tools; asset-side (sectorial capital) tools; and liquidity-related tools, only liquidity-related tools turn out to be a significantly negative contributor to the correlation of policy interest rates between the CEs and the PHs.

The effectiveness of macroprudential policies can vary depending on the macroeconomic conditions or policies of the PH economies that implement them.

We found that PH countries' policy interest rates could become more independent of CEs' when macroprudential policies are implemented by the countries with current account deficit. In other words, macroprudential policies could work more effectively for countries that import capital from overseas.

When we compared high IR holding countries with low IR holding ones, the estimated coefficient of the variable for macroprudential policies was found to be significantly negative, i.e., weakening the policy interest rate link between the CEs and the PHs, only for low IR holders. This suggests that countries with low levels of IR holding may use macroprudential policies as a substitute to holding high levels of IR.

[37] Similarly, Han and Wei (2018) find asymmetrical effects of capital controls, depending on whether core country monetary policy is tightening or loosening.

We also detected the effect of macroprudential policies only among those with increasing net portfolio inflows, not among those with declining net portfolio inflows. We also compared the PH countries that are experiencing credit growth with those which are not and found that only those which are experiencing credit growth have a significantly effect on their macroprudential policies.

Thus, we have been able to show the effect of macroprudential policies as the "fourth" factor in the quadrilemma. It must be noted that macroprudential policies are not the same as conventional capital controls policies. What makes macroprudential policies different from conventional capital controls is that macroprudential policies are aimed at mitigating the balance sheet exposure associated with short term debt flows while typical capital controls are blunt instruments that focus more on affecting capital flows and less on mitigating the balance sheet exposures. That may explain our findings that the effect of macroprudential policies are detected only when the CEs implement expansionary policy and when the PHs' domestic credit conditions are affected.

Clearly, it is better to use more nuanced or detailed cross-country data on macroprudential policies, rather than relying on crude dummy variables, so that we can identify which types of macroprudential policies are effective or ineffective under what kind of policy or macroeconomic conditions. However, such an exercise is outside the scope of this paper. We will tackle on this issue as one of the future research agendas.

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Appendix 1: Data Descriptions and Sources

Policy short-term interest rate – money market rates. Extracted from the IMF's *International Financial Statistics (IFS)*.

Commodity prices – the first principal component of oil prices and commodity prices, both from the *IFS*.

VIX index – It measures the implied volatility of S&P 500 index options and is available in http://www.cboe.com/micro/VIX/vixintro.aspx.

"Ted spread" – It is the difference between the 3-month Eurodollar Deposit Rate in London (LIBOR) and the 3-month U.S. Treasury Bill yield.

Exchange rate stability (ERS) and financial openness (KAOPEN) indexes – From the trilemma indexes by Aizenman, et al. (2013).

International reserves – international reserves minus gold divided by nominal GDP. The data are extracted from the IFS.

Gross national debt – It is included as a share of GDP and obtained from the World Economic Outlook (WEO) database.

Trade demand by the CEs – $TR\_LINK_{ip} = IMP_{ip}^{C} / GDP_{ip}$ where IMP_i^C is total imports into center economy *C* from country *i*, that is normalized by country *i*'s GDP and based on the data from the IMF *Direction of Trade* database.

FDI provided by the CEs – It is the ratio of the total stock of foreign direct investment from country *C* in country *i* as a share of country *i*'s GDP. We use the *OECD International Direct Investment* database.

Bank lending provided by the CEs – It is the ratio of the total bank lending provided by each of the CEs to country *i* shown as a share of country *i*'s GDP. We use the BIS database.

Trade competition – It is constructed as follows.

$$Trade\_Comp_i^C = \frac{100}{Max(Trade\_Comp)} \sum_k \left[\frac{Exp_{W,k}^C}{Exp_{W,k}^W} * \frac{Exp_{W,k}^i}{GDP_i} \right]$$

$Exp_{W,k}^C$ is exports from large-country *C* to every other country in the world *(W)* in industrial sector *k* whereas $Exp_{W,k}^W$ is exports from every country in the world to every other country in the world (i.e. total global exports) in industrial sector *k*. $Exp_{W,k}^i$ is exports from country *i* to every other country in the world in industrial sector *k*, and GDP_i is GDP for country *i*. We assume merchandise exports are composed of five industrial sectors (*K*), that is, manufacturing, agricultural products, metals, fuel, and food.

This index is normalized using the maximum value of the product in parentheses for every country pair in the sample. Thus, it ranges between zero and one.[38] A higher value of this variable means that country *i*'s has more comparable trade structure to the center economies.

Financial development – It is the first principal component of two sub-indexes, one that captures the development of financial markets (*FM*) and the other that reflects the development of

[38] This variable is an aggregated version of the trade competitiveness variable in Forbes and Chinn (2004). Their index is based on more disaggregated 14 industrial sectors.

financial institutions (*FI*). Each of *FM* and *FI* is the first principal components of three variables: "depth," "access," and "efficiency," respectively.[39]

Currency crisis – It is from Aizenman and Ito (2014) who use the exchange market pressure (EMP) index using the exchange rate against the currency of the base country. We use two standard deviations of the EMP as the threshold to identify a currency crisis. To construct the crisis dummies in three-year panels, we assign the value of one if a crisis occurs in any year within the three-year period.

Banking crisis – It is from Aizenman and Ito (2014) who follow the methodology of Laeven and Valencia (2008, 2010, 2012). For more details, see Appendix 1 of Aizenman and Ito (2014).

Share of export/import – The share of country *i*'s export to, or import from, a major currency country (e.g., Japan) in country *i*'s total export or import. The data are taken from the IMF's *Direction of Trade.*

Commodity export/import as a percentage of total export/import – Data are taken from the World Bank's *World Development Indicators* and the IMF's *International Financial Statistics*.

[39] Also, see footnote 22.

Appendix 2: Country List

ISO	*Country name*
914	Albania*
612	Algeria*
614	Angola
311	Antigua and Barbuda
213	Argentina[EMG,*]
911	Armenia*
314	Aruba
912	Azerbaijan*
313	Bahamas, The
419	Bahrain
513	Bangladesh[EMG, *]
316	Barbados
913	Belarus*
339	Belize
638	Benin
514	Bhutan
218	Bolivia
616	Botswana[EMG]
223	Brazil[EMG, *]
516	Brunei
918	Bulgaria[EMG, *]
748	Burkina Faso
618	Burundi*
522	Cambodia
622	Cameroon
624	Cape Verde
626	Central African Rep.
628	Chad
228	Chile[EMG, *]
924	China[EMG, *]
233	Colombia[EMG, *]
632	Comoros
636	Congo, Dem. Rep.
634	Congo, Rep.
662	Cote d'Ivoire[EMG]
238	Costa Rica*
960	Croatia*
423	Cyprus
935	Czech Republic[EMG, *]
611	Djibouti
321	Dominica
243	Dominican Republic*
248	Ecuador[EMG]
469	Egypt, Arab Rep. [EMG]
253	El Salvador*
642	Equatorial Guinea
939	Estonia*
644	Ethiopia
819	Fiji
646	Gabon
648	Gambia, The
915	Georgia*
652	Ghana[EMG, *]
328	Grenada
258	Guatemala
656	Guinea
654	Guinea-Bissau
336	Guyana*
263	Haiti
268	Honduras*
532	Hong Kong, China[EMG, *]
944	Hungary[EMG, *]
534	India[EMG, *]
536	Indonesia[EMG, *]
429	Iran, Islamic Rep.
436	Israel[EMG, *]
343	Jamaica[EMG, *]
439	Jordan[EMG, *]
916	Kazakhstan*
664	Kenya[EMG, *]
542	Korea, Rep. [EMG, *]
443	Kuwait*
917	Kyrgyz Republic*
544	Lao PDR
941	Latvia*
446	Lebanon*
666	Lesotho
668	Liberia
946	Lithuania[EMG, *]
674	Madagascar
676	Malawi
548	Malaysia[EMG, *]
556	Maldives
678	Mali
682	Mauritania
684	Mauritius[EMG, *]
273	Mexico[EMG, *]
868	Micronesia, Fed. Sts.
921	Moldova
948	Mongolia
686	Morocco[EMG, *]
688	Mozambique*
518	Myanmar
728	Namibia
558	Nepal*
353	Netherlands Antilles
278	Nicaragua
692	Niger[EMG]
694	Nigeria
449	Oman
564	Pakistan[EMG]
283	Panama
853	Papua New Guinea
288	Paraguay*
293	Peru[EMG, *]
566	Philippines[EMG, *]
964	Poland[EMG, *]
453	Qatar
968	Romania*
922	Russian Federation[EMG, *]
714	Rwanda
716	Sao Tome & Principe
862	Samoa
456	Saudi Arabia
722	Senegal
718	Seychelles
724	Sierra Leone
576	Singapore[EMG, *]
936	Slovak Republic[EMG, *]
961	Slovenia[EMG, *]
813	Solomon Islands
199	South Africa[EMG, *]
524	Sri Lanka[EMG, *]
361	St. Kitts and Nevis
362	St. Lucia
364	St. Vincent and the Grenadines
366	Suriname
734	Swaziland
463	Syrian Arab Republic
923	Tajikistan
738	Tanzania
578	Thailand[EMG, *]
742	Togo
866	Tonga
369	Trinidad and Tobago[EMG]
744	Tunisia[EMG, *]
186	Turkey[EMG, *]
746	Uganda*
926	Ukraine*
298	Uruguay
846	Vanuatu
299	Venezuela, RB[EMG]
582	Vietnam
474	Yemen, Rep.
754	Zambia*
698	Zimbabwe[EMG]

Notes: These countries are included in the sample for the first-step estimation. Countries with "*" are the ones included in the second-step estimation. "EMG" indicates "emerging market countries (footnote 26).

Appendix 3: Macroprudential Policy Index

Variable	Variable Name	Definition
Broad-based capital tools (CAPITAL)		
DP	Time-Varying/Dynamic Loan-Loss Provisioning	Dummy for the use of a policy that requires banks to hold more loan-loss provisions during upturns
CTC	General Countercyclical Capital Buffer/Requirement	Dummy for the use of a policy that requires banks to hold more capital during upturns
SIFI	Capital Surcharges on Systematically Important Financial Institutions	Dummy for the use of a policy that requires Systematically Important Financial Institutions to hold a higher capital level than other financial institutions
INTER	Limits on Interbank Exposures	Dummy for the use of a policy that limits the fraction of liabilities held by the banking sector
Sectoral capital and asset-side tools (ASSET)		
LTV_CAP	Loan-to-Value Ratio	Dummy for the use of LTV measures used as a strict cap on new loans as opposed to a loose guideline or merely an announcement of risk weights
DTI	Debt-to-Income Ratio	Dummy for the use of a policy that constrains household indebtedness by enforcing or encouraging a limit
LEV	Leverage Ratio	Dummy for the use of a policy that limits banks from exceeding a fixed minimum leverage ratio
CONC	Concentration Limits	Dummy for the use of a policy that limits the fraction of assets held by a limited number of borrowers
Liquidity-related tools (LIQUIDITY)		
FC	Limits on Foreign Currency Loans	Dummy for the use of a policy that reduces vulnerability to foreign-currency risks
RR_REV	FX and/or Countercyclical Reserve Requirements	RR is a policy that limits credit growth. It can also be targeted to limit foreign-currency credit growth. RR_REV is a subset of RR that restricts to reserve requirements which i) imposes a specific wedge on foreign currency deposits or are adjusted countercyclically
CG	Limits on Domestic Currency Loans	Dummy for a policy that limits credit growth
TAX	Levy/Tax on Financial Institution	Dummy for taxes on the revenue of financial institutions
MPI	Macroprudential Policy Index (0 – 12)	LTV_CAP+DTI+DP+CTC+LEV+SIFI+INTER+CONC+FC+RR_REV+CG+TAX
BORROWER	Borrower-targeted instruments (0 – 2)	LTV_CAP+DTI
FINANCIAL	Financial Institution-targeted instruments (0 – 10)	DP+CTC+LEV+SIFI+INTER+CONC+FC+RR_REV+CG+TAX

Source: Table 1 of Cerutti, et al. (2017b), IMF-FSB-BIS (2016).

Table 1: Summary Statistics of MPI

	Minimum	Mean	Median	Maximum	Standard Deviation
Full Sample	0	1.76	1.00	8.00	1.54
IDC	0	1.21	1.00	5.00	1.29
LDC	0	1.87	2.00	8.00	1.57
EMG	0	2.23	2.00	8.00	2.23

Table 2: Factors Affecting the Estimated Financial Sensitivity, 1998-2014

	LDC (1)	EMG (2)
Exch. Rate Stability	-0.016	-0.070
	(0.263)	(0.335)
Financial Openness	0.386	0.493
	(0.212)*	(0.239)**
IR Holding	0.167	0.135
	(0.611)	(0.846)
CA balance (%)	-0.318	-1.140
	(0.829)	(1.348)
Gross debt (%)	0.107	0.182
	(0.121)	(0.138)
Inflation Vol.	2.443	0.938
	(1.431)*	(1.594)
Trade Comp.	-1.897	-1.318
	(0.896)**	(1.048)
Trade demand	2.365	1.265
	(1.093)**	(1.080)
Bank Lending	0.324	0.347
	(0.619)	(0.582)
Fin. Dev.	0.755	0.638
	(0.447)*	(0.526)
Currency crisis	1.091	0.075
	(0.275)***	(0.284)
Banking crisis	-0.208	-0.024
	(0.229)	(0.253)
Macro-prudential	**-0.039**	**-0.029**
	(0.044)	**(0.044)**
N	851	532
Adj. R2	0.05	0.01
# of countries	61	35

Notes: The estimations are conducted with the robust regression method due to the existence of outliers. * p<0.1; ** p<0.05; *** p<0.01. The second estimation is conducted for the estimates $\hat{\gamma}_{it}^{C}$ from the first-step estimation. Time fixed effects for the three-year panels and the constant are also included, though their estimates are not reported.

Table 3: The Effects of Disaggregated MPI, LDC vs. EMG

***Dependent Variable*: Estimated Financial Sensitivity through Policy Interest Rates between CEs and PHs**						
	LDC	LDC	LDC	EMG	EMG	EMG
	(1)	(2)	(3)	(4)	(5)	(6)
Borrower-targeted	-0.084		-0.063	-0.077		-0.069
MPI	(0.119)		(0.124)	(0.108)		(0.121)
Financial Institution- targeted		-0.041	-0.031		-0.027	-0.012
MPI		(0.053)	(0.056)		(0.059)	(0.065)

Notes. The estimations are conducted with the robust regression method due to the existence of outliers. * p<0.1; ** p<0.05; *** p<0.01. The second estimation is conducted for the estimates $\hat{\gamma}_{it}^{C}$ from the first-step estimation. However, this table only reports the estimates on the borrower- or financial institution-targeted macroprudential policy index, though the same set of controls variables as reported in Table 2 are included, including time fixed effects and the constant.

Table 4: Factors Affecting the Estimated Financial Sensitivity When CEs' Monetary Policy Is "Loose"

	LDC	EMG
	(1)	(2)
Exch. Rate Stability	0.080	-0.247
	(0.361)	(0.475)
Financial Openness	0.097	-0.009
	(0.280)	(0.324)
IR Holding	-0.107	0.216
	(0.741)	(1.056)
CA balance (%)	0.031	-0.989
	(1.046)	(1.736)
Gross debt (%)	0.067	-0.007
	(0.157)	(0.187)
Inflation Vol.	5.976	6.094
	(2.450)**	(4.242)
Trade Comp.	-0.639	-0.234
	(1.191)	(1.407)
Trade demand	0.863	0.056
	(1.463)	(1.530)
Bank Lending	0.565	0.819
	(0.690)	(0.662)
Fin. Dev.	0.219	-0.487
	(0.570)	(0.712)
Currency crisis	0.792	0.318
	(0.384)**	(0.375)
Banking crisis	-0.085	-0.081
	(0.289)	(0.342)
Macro-prudential	**-0.104**	**-0.055**
	(0.057)*	**(0.060)**
N	471	288
Adj. R2	0.04	0.01
# of countries	61	35

Notes: The estimations are conducted with the robust regression method due to the existence of outliers. * p<0.1; ** p<0.05; *** p<0.01. The second estimation is conducted for the estimates $\hat{\gamma}_{it}^{C}$ from the first-step estimation. Time fixed effects for the three-year panels and the constant are also included, though their estimates are not reported.

Table 5: The Effects of Disaggregated MPI, Borrower-targeted vs. Financial Institution (Lender)-targeted, "Loose Time"

Dependent Variable: Estimated Measure of Financial Sensitivity through Policy Interest Rates between CEs and PHs						
	LDC	LDC	LDC	EMG	EMG	EMG
	(1)	(2)	(3)	(4)	(5)	(6)
Borrower-targeted	-0.111		-0.017	-0.184		-0.180
MPI	(0.158)		(0.167)	(0.151)		(0.171)
Financial Institution- targeted		-0.136	-0.134		-0.041	-0.004
MPI		(0.070)*	(0.073)*		(0.079)	(0.090)

Notes. The estimations are conducted with the robust regression method due to the existence of outliers. * p<0.1; ** p<0.05; *** p<0.01. The second is conducted for the estimates $\hat{\gamma}_{it}^{C}$ from the first-step estimation. However, this table only reports the estimates on the borrower- or/and financial institution-targeted macroprudential policy index. The same set of controls variables as reported in Table 4 are included in the estimation, including time fixed effects and the constant.

Table 6: The Effects of Disaggregated MPI, Capital-, Asset-, and Liquidity-based, "Loose Time"

Dependent Variable: Estimated Measure of Financial Sensitivity through Policy Interest Rates between CEs and PHs				
	(1)	(2)	(3)	(4)
Capital-based MPI	-0.082			-0.094
	(0.391)			(0.168)
Asset-based MPI		-0.085		0.043
		(0.111)		(0.125)
Liquidity-based MPI			-0.323	-0.322
			(0.127)**	(0.138)**

Notes. The estimations are conducted with the robust regression method due to the existence of outliers. * p<0.1; ** p<0.05; *** p<0.01. The second estimation is conducted for the estimates $\hat{\gamma}_{it}^{C}$ from the first-step estimation. However, this table only reports the estimates on the capital-based, asset-based, or/and liquidity-based macroprudential policy index. The same set of controls variables as reported in Table 4 are included in the estimation, including time fixed effects and the constant.

Table 7: Current Account Surplus Countries vs. Current Account Deficit Countries

	LDC		EMG	
	CA Surplus	CA Deficit	CA Surplus	CA Deficit
	(1)	(2)	(3)	(4)
Macroprudential Policy Index	-0.051	-0.220	0.009	-0.264
	(0.071)	(0.110)**	(0.072)	(0.113)**
N	181	289	132	156
Adj. R2	0.07	0.36	0.20	0.06
# of countries	48	54	32	30

Table 8: Countries with High IR vs. Those with Low IR

	LDC		EMG	
	High IR	Low IR	High IR	Low IR
	(1)	(2)	(3)	(4)
Macroprudential Policy Index	-0.060	-0.168	0.036	-0.272
	(0.072)	(0.109)	(0.074)	(0.129)**
N	268	203	154	135
Adj. R2	0.00	0.13	-0.01	0.06
# of countries	43	38	23	22

Table 9: Financially Open Countries vs. Financially Closed Countries

	LDC		EMG	
	Open	Close	Open	Close
	(1)	(2)	(3)	(4)
Macroprudential Policy Index	-0.111	-0.146	-0.104	-0.044
	(0.082)	(0.089)*	(0.106)	(0.083)
N	237	234	144	143
Adj. R2	-0.01	0.12	-0.05	0.04
# of countries	33	34	19	20

Table 10: Portfolio Inflow Growing vs. Capital Inflow Contracting

	LDC		EMG	
	K-inflow Expanding	K-inflow Contracting	K-inflow Expanding	K-inflow Contracting
	(1)	(2)	(3)	(4)
Macroprudential Policy Index	-0.214	0.092	-0.145	0.090
	(0.091)**	(0.116)	(0.102)	(0.106)
N	230	198	150	130
Adj. R2	0.06	0.45	-0.02	0.03
# of countries	47	46	28	28

Table 11: Credit Growing vs. Credit Contracting

	LDC		EMG	
	High Credit Expansion	Low Credit Expansion	High Credit Expansion	Low Credit Expansion
	(1)	(2)	(3)	(4)
Macroprudential Policy Index	-0.259	-0.027	-0.155	-0.044
	(0.087)***	(0.089)	(0.092)*	(0.109)
N	210	261	122	167
Adj. R2	0.19	-0.02	0.12	-0.01
# of countries	51	57	29	33

Figure 1 (a): MPI by Income Groups

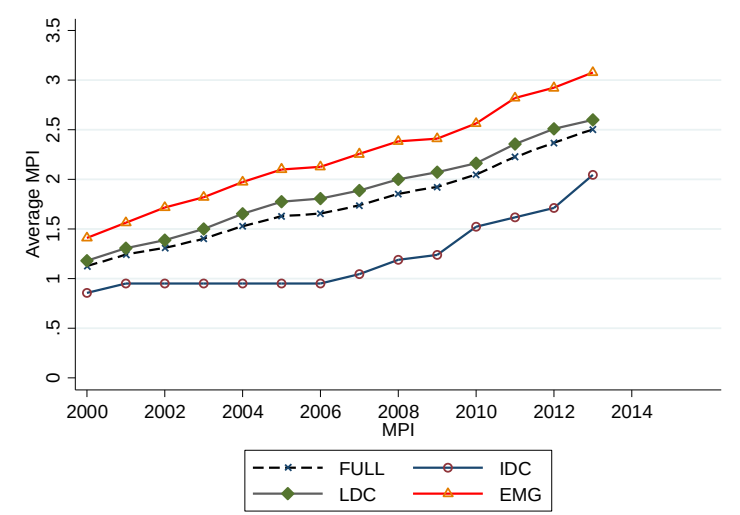


Figure 1 (b): MPI by Regions

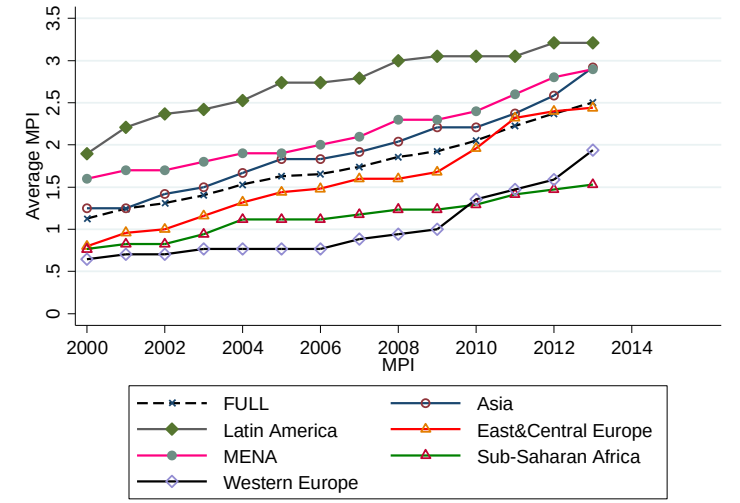


Figure 2: *BORROWER* and *FINANCIAL* by Income Groups

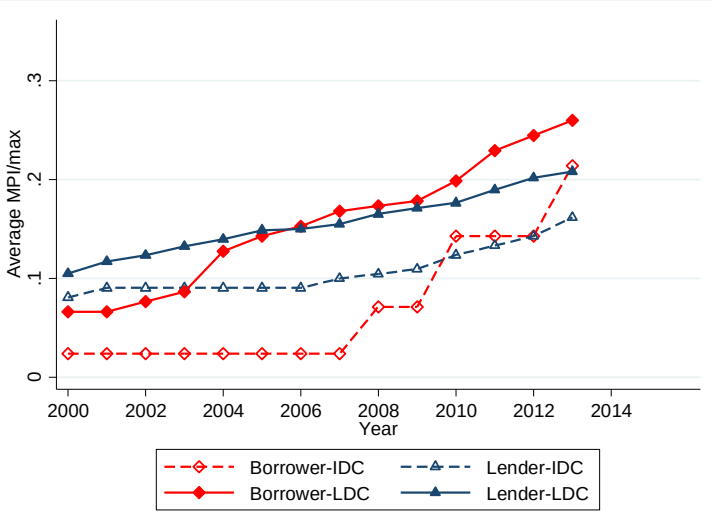


Figure 3: *CAPITAL*, *ASSET*, and *LIQUIDITY* by Income Groups

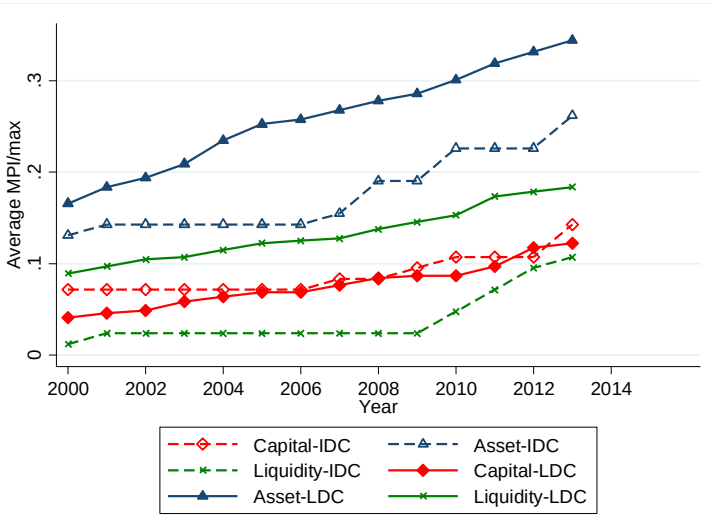
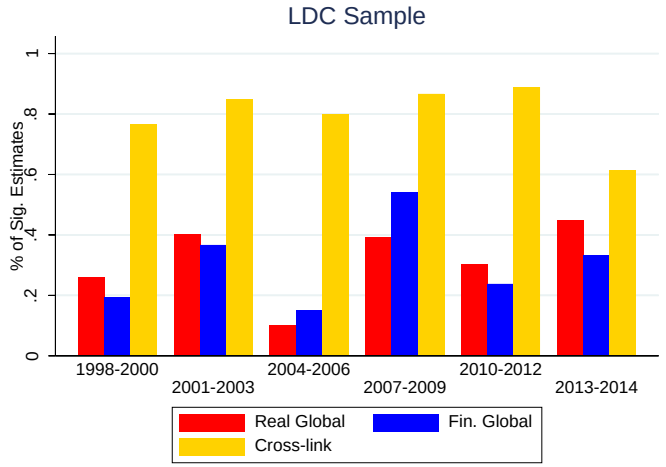


Figure 4: Proportion of Significant F-Tests

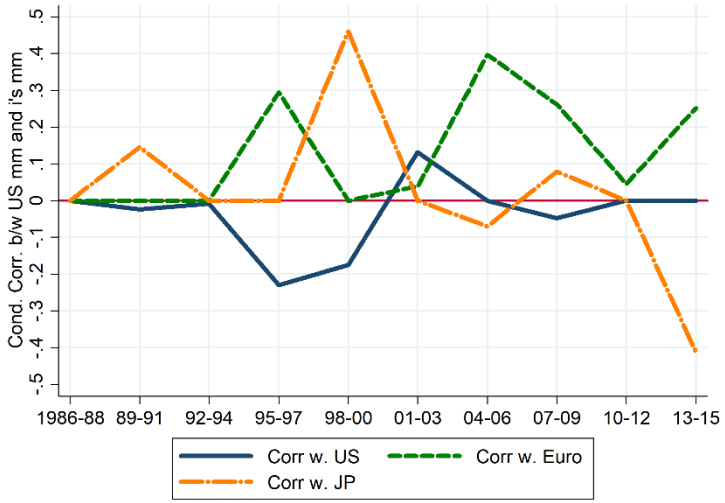
CE: Policy Interest Rate → PH: Policy Interest Rate



Note: illustrates the proportion of countries for which the joint significance tests are found to be statistically significant (with the *p*-value less than 5%) for the real global and financial global groups, and vector X^C of the center economies' policy interest rates.

Figure 5: Summary Statistics of the Estimated Gammas

(a) Median of the Gammas



(b) Standard Deviations of the Estimated Gammas

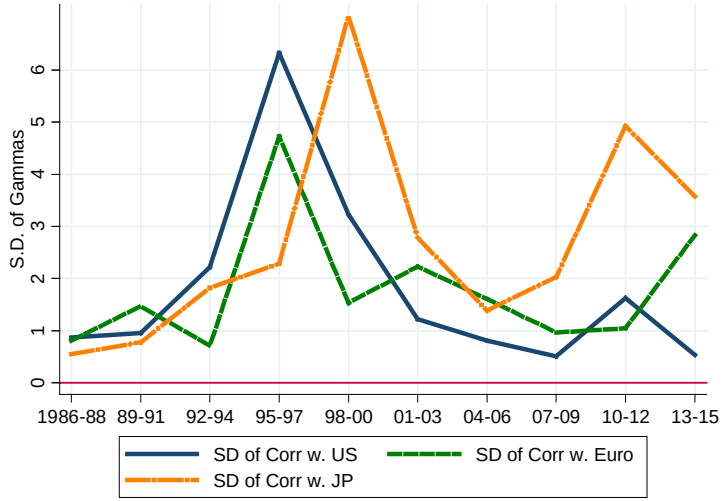


Figure 6: Shadow Policy Interest Rates of the CEs

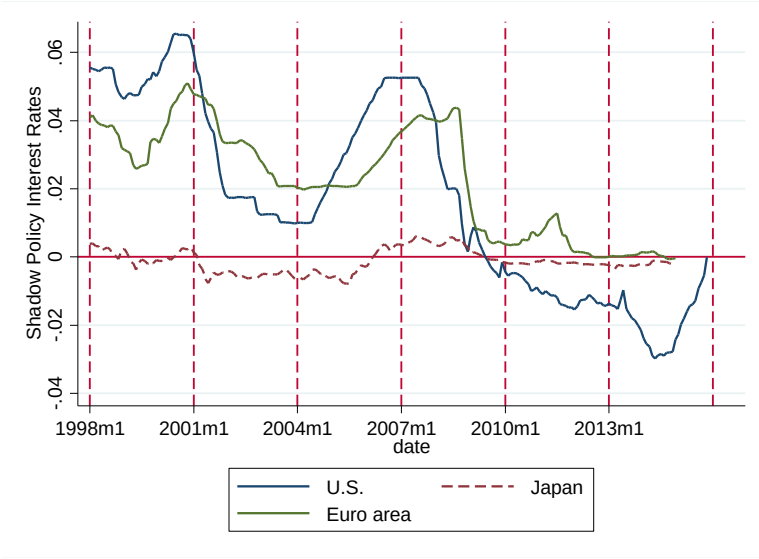
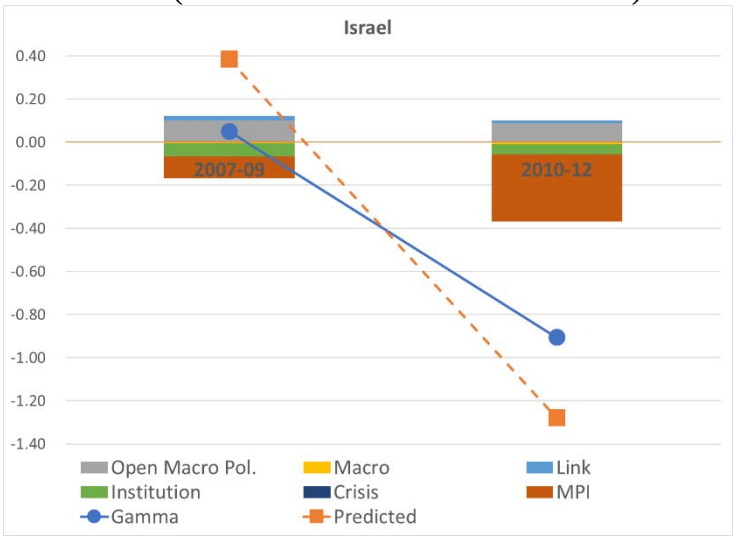
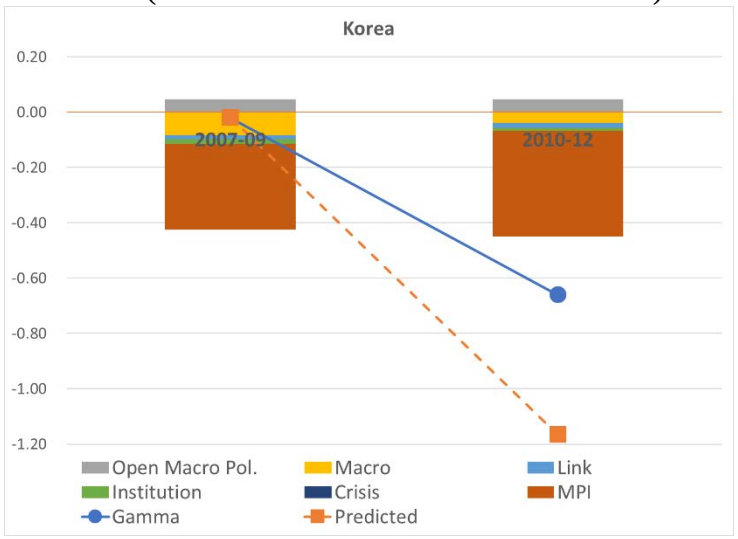


Figure 7: Estimated Contributions to the Gamma

Israel (MPI: 1 in 2007-09 → 3 in 2010-12)



Korea (MPI: 1.7 in 2007-09 → 3.0 in 2010-12)



Turkey (MPI: 2.3 in 2007-09 → 4.7 in 2010-12)