Capital Controls and Monetary Policy Independence

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Abstract

International monetary policy trilemma – the tradeoff among exchange rate stability, monetary policy independence, and unrestricted capital mobility – imposes an important constraint for policy makers in an open economy. This paper investigates an aspect of the hypothesis that has received relatively less attention: whether a decrease in capital mobility through imposition of capital controls, while holding the degree of exchange rate stability constant, will enhance monetary independence.

Using a panel dataset covering 88 countries for the 1995-2010 period and system GMM estimation, we find that 1) capital controls help improve monetary policy independence; 2) the effectiveness of capital controls depends on the types of assets and the direction of flows they are imposed; and 3) the choice of exchange rate regime has important impact on the effectiveness of capital controls on monetary policy independence.

Keywords: Monetary Policy; Independence; Capital Controls; Exchange Rate Regime; GMM Estimation
JEL Classification: F21; F31; F42

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1. Introduction

According to the international monetary policy trilemma, policymakers simultaneously may achieve any two, but not all, of the following three goals, 1) exchange rate stability;2)unrestricted movement in international capital;and 3) monetary policy autonomy.The first goal, exchange rate stability,requires a fixed or heavily managed exchange rate regime. The second goal, free capital mobility, is usually associated with elimination of exchange controls on cross-border movement of international capital. The third goal, monetary policy autonomy isconceptual and thus difficult to define.Usually if a country can easily implement its own monetary policy without being forced to follow another country's monetary policy, it is considered to have a high level of monetary independence. One of the most popular measures of monetary independence is deviation of the domestic interest rate from the foreign or base rate.Aizenman et al (2008), Frankelet al(2004), and Shambaugh (2004) examine monetary independence using this metric.

Previous studies in the trilemmamostly focus on the relationship between the exchange rate regime and monetary policy independence.See, inter alia, di Giovanni and Schambaugh (2008), Bluedorn and Bowdler (2010), Frankelet al(2004), and Schambaugh (2004). Most studies assume high capital mobility especially when industrialized economies are under consideration. In this case, the trilemma is reduced to a simpler dilemma between exchange rate stability and monetary independence. For various reasons, however, the tradeoff between capital mobility and monetary independence– for instance, whether introducing more stringent capital controls will enhance monetary independence – has been limited to case studies. An important reason may be measurement of capital mobility. According to the International Monetary Fund (IMF), capital flows can be roughly categorized as portfolio flows (equity and bond), direct investment, and other financial flows. In addition, each main category can contain many subsets. This complexity of measurementmakes capital mobility more difficult to quantify than monetary independence and the exchange rate regime.

The purpose of this paperis to investigate whether capital control policies enhance monetary independence in the context of the trilemma.Given that capital flows can take many different forms, it is of great interest to understand whether the effectiveness of capital controls depends on the type of financial assets they are imposed and whether controls on capital inflows and outflows have different

effects. Instead of using an aggregate measure of capital controls as most existing studies do, wethus adopt a set of disaggregate capital control variables to measure the effectiveness of capital controls. In addition, based on this set of disaggregate capital control variables, we generate our own aggregate capital control variable, which is no longer a 0/1 dummy, but a variable taking into account the intensity of capital controls (see data section for more discussion). This aggregate measure can then be viewed as an improvement over the 0/1 dummy measure of capital controls. Furthermore, we also employ panel-data systemgeneralized method of moments (GMM) estimation − which can better address endogeneity issues − to analyze a panel annual dataset covering 88 countries during the 1995-2010period.

Main findings of this paper include1) capital controls help improve a country's monetary independence, which is consistent with the trilemma theory; 2) the effectiveness of capital controls depends on the type of assets and direction of flows they are imposed; 3) the choice of exchange rate regime hasimportant impact on the effectiveness of capital controls on monetary independence.

The remainder of the paper is as follows. Section 2 provides a brief review of literature in related fields. Section 3 describes the methodology and the dataset. Section 4 reports the main results. Section 5 reports the robustness of the results. Section 6 concludes.

2. Literature review

Free and unrestricted movement of international capital has both benefits and costs.Benefits of allowing a high level of international capital flows include consumptionsmoothing, improvement in domestic investment and growth potential. On the other hand, international capital flows may generate undesirable outcomes especially when they are large and sudden. Magudet al(2011)summarize four important side effects of capital flows in terms of "four fears". They are 1) fear of appreciation of the domestic currency; 2) fear of "hot money" or volatile short-term capital flows that could be very destructive to the real economy; 3) fear of large inflows, which can fuel asset price bubbles and encourage excessive risk taking by cash-rich domestic intermediaries; 4) fear of loss of monetary autonomy which may arise if huge capital flows weaken the flexibility of domestic monetary policy. These fears may rationalize the increasingly wider use of capital controls across countries. Even the IMFcomes to view capital controls more favorably than before.

This paper investigates empirical evidence regarding the fear of loss of monetary autonomy due to greater capital mobility. It can fit into two broad strands of literature: 1) the study of trilemma or tradeoffs among the three policy goals; and 2) the study of the effectiveness of capital controls.In the context of the trilemma, most studies pay attention to the relation between the exchange rate regime and monetary independence. Shambaugh (2004) investigates how fixed exchange rates affect monetary policy using the data of 155 countries over period 1973-2000. He finds that fixed exchange rates involve a loss of monetary policy autonomy. In particular, a country with fixed exchange rate regime has its nominal interest rate follow that of a base country more closely than a country which does not fix its exchange rate. Shambaugh (2004) also considers the effects of capital controls using IMF's binary(aggregate) dummy variables. He finds a positive effect of capital controls on monetary independence, although the coefficient estimates are statistically insignificant.

Frankelet al(2004)explore the impact of exchange rate regime on the sensitivity of local interest rates to international interest rates using 46 developing and industrialized economies during 1976–1996. They find that in the 1990s all exchange rate regimes exhibit high sensitivity of local interest rates to international onesin the long run even for countries with floating regimes. In the short run, however, interest rates of countries with more flexible regimes adjust more slowly to changes in international rates, implying some room for monetary independence. However, the paper does not explicitly consider the role of capital controls. Instead, it roughly distinguishes degree of world capital mobility by dividingthe whole sample into three sub-periods under the assumption that capital mobility is higher in the more recent period.

Bluedorn and Bowdler(2010) investigate the relationship between monetary independence and exchange rate regime by distinguishing monetary policy in base country (the US) into identified, unanticipated, and exogenous interest rate changes and study how different types of interest rate changes may affect home country's monetary policy. Yet, the paper fails to address the complexity of capital controls by using a single binary measure.

Unlike the above papers, some studies explicitly consider the framework of the trilemmain which all three aspects of the policy tradeoffs are explicitly taken into account. Using a panel of data from 22 countries between 1967 and 1992, Rose (1996)finds little evidence of an obvious tradeoff between fixed exchange rates, capital mobility, and monetary independent.However, as argued by Obstfeldet al(2005),

the measure of monetary independence in the paper is obtained from the monetary models of the exchange rate, which yields limited credibility whenidentifying monetary policy shocks.Aizenman et al(2010) construct a continuous index for each variable of the trilemma. They find that the weighted sum of the three indexes adds up to a constant, confirming the idea that a rise in one trilemma variable should be traded-off with a drop of the weighted sum of the other two. Interestingly, they use an index of financial openness measured in more diverse levels than a simple binary dummy variable to proxy the extent of a country's capital mobility. Obstfeld et al (2005) use an interwar (1919-1938) annual dataset from 16 countries to explicitly investigate the trilemma. The analysis of the interwar data finds strong support for the logic of the trilemma. A drawback of their dataset is a limited coverage of countries. The paper covers much less countries than the previous two papers. Also, the measurement of capital controls in the paper still suffers the same problem as does Shambaugh (2004). Miniane and Rogers (2007) examinethe trilemma using a structural vector autoregressive model. They deal with capitalcontrols by roughly splitting sample countries into high capital control group and low capital control group.

In sum, a common issue facing the above papers, except for Rose (1996), is that they typically use a coarse measure of capital controls. As a result, the empirical results provide little guidelineto policymakers on the effectiveness of different capital control policies. If the government decides to regulate capital flows, should it choose to impose restrictions on bondsor equities, or direct investment?Do restrictions on inflow or outflow make difference? These questions cannot be answeredfrom thepapers mentioned in the above. In addition, the coarse measure is only a dummy and does not account for intensity of capital controls. Another important problem of these papers is thatthey fail to address potential endogeneity and reverse causation issues.For instance, a country may choose to employ capital restrictions because it lacks monetary autonomy. A two-way causality between capital controls and monetary independence could undermine the legitimacy of conclusions made in these papers.

Another strand of literature considering the impact of capital controls on monetary policy deals withthe effectiveness of various capital control measures. Most studies in the field try to answer the

question of interest using individual-country case study. Often they consider very specific control policies and look at the "treatment effect" of these policies on the economy. Edison and Reinhart(2001), De Gregorio et al (2000), Kaplan and Rodrik(2002), Valdes-Prieto and Soto(1998), and many other studies provide evidence that capital controls positively affect monetary independence. Despite the interesting results, these studies are only limited to a small number of countries such as Malaysia and Chile. Only a small number of papers such as Montiel and Reinhart(1999) and Binici et al (2010) consider multiple countries while keeping a detailed measure of capital controls. Yet their research interest is the link between capital controls and the volume and composition of capital inflows and outflows.Although they consider a more specific set of capital control policies, they are silent about the effect of capital controls on monetary independence.

3. Data

Our annual panel dataset covers 88 countries for the 1995-2010period. (See Appendix for the list of countries.)Monetary independence is the ability of a country to setits own monetary policy for domestic purposes independentof external monetary influences. As monetary policy usually takes the form of interest rate targeting, an intuitive measure of monetary independence would be the difference of interest rate between the home country and the base country (or the rest of the world).Weemploy the methodology developed by Aizenman et al (2010) and define monetary independence for country i as follows:

$$MI = 1 - \frac{corr(r_i, r_b) + 1}{2}$$

Where$\mathrm{corr}(r_i, r_b)$ is measure the correlation of the monthly interest rates between the home country and the base country, denoted as b.Money market rates are used as the interest rate.[1]By construction, the maximum and minimum values are 1 and 0, respectively. A highervalue of the index means a lowercorrelation of interest rates and thus greater monetarypolicy independence.

[1] Base countries include the US, UK, Germany, France and a few other countries. See Shambaugh (2004) for detailed discussion.

For the measurement of capital controls, we follow themethodology developed by Schindler (2009). The original data source is from IMF's Annual Report on Exchange Arrangements and Exchange Restrictions (AREAER). Before 1995, AREAER reports each country's overall capital controls status using one single dummy; since 1995, the variable breaks down to many categories according to capital flows' asset type, ownership, or direction of flows.Using the information on capital controls from IMF'sAREAER forthe period from 1995 to 2005, Schindler (2009) first codes the restrictiveness of different types of capital controls at the level of individual transactions, and then takes average of these subindices to obtain more finely gradated asset or inflow/outflow specific indices.For example, equity transactions are classified into four types: residents buying or selling assets abroad, and nonresidents selling or buying domestic assets. Each of these basic transactions is coded as "1" if restrictions exist and "0" otherwise. Thus, an aggregate equity controls index would be the average of four binary variables and could thus take on five different values: 0, 0.25, 0.5, 0.75, or 1. The equity inflow and outflow indices, respectively, are the average of two underlying transaction variables, thus potentially assuming three values: 0, 0.5, or 1. We update the data to 2010.

For the measure ofexchange rate regime, we follow the binary classification of Klein and Shambaugh (2008). A fixed exchange rate regime ($Peg_{it} = 1$) is defined as a situation where, over the course of a calendar year, the month-endbilateral exchange rate with the base country stays within a 2% band; $Peg_{it} = 0$ otherwise. Klein and Shambaugh's study covers data up to 2004. This paper updates to 2010.

Monetary independence may be affected byother variables including inflation rate, trade openness, financial development, andrelative income. Inflation, especially when it is high, is a sign of loss of monetary control. Previous literature finds a negative correlation between inflation rate and indicators of central bank independence. See, inter alia, Alesina and Summers (1993) and Cukierman et al (1992). In other words, the central bank of a higher inflation country is more likely to have a lower degree of independence from domestic political pressure. The external degree of monetary independence – the subject of this study – is also likely to be lower if the country hopes to borrow the reputation of low inflation policy of the base country by tying its currency to that of the base country.

International trade is an important channel of transmission of external influences. Trade openness – defined as the ratio of the sum of imports and exports to GDP – is likely to be positively related to the extent of the country's exposure to foreign shocks including foreign monetary policy and the monetary policy linkage, which lowers monetary independence. (Shambaugh 2004) Financial development – proxied by the private credit/GDP ratio −is often associated with financial integration with the world financial market, which tends to expose the country to international financial market shocks. This suggests that financial development is likely to lower monetary independence.The effect of relative income on monetary independence is ambiguous. Ahigh-income country tends to be more open in trade and finance and therefore may interact with the above-mentioned factors. At the same time, a more advanced country is also likely to wish to exert its own monetary policy instead of being imposed by foreign policy decisions.

Data for inflation, trade openness, and relative income are obtained from Penn World Table 7.0; the measure of financial development is from World Development Indicators (WDI). Table 1 provides the summary statistics.Note that the trilemma variables range from 0 to 1 by construction. The mean of capital control variables is 0.36, suggesting that countries maintain some restrictions on capital flows but do not heavily rely on capital controls. The mean of exchange rate stability is 0.36, which implies that more than one thirdof the observations adopt a fixed exchange rate regime. Other variables including inflation, relative income, financial development, and trade openness have reasonable ranges. No obvious outliers are detectedin the dataset.

[Table 1 about here]

4. Methodology

The following regression equationis estimated to investigate the effectiveness of capital control policies on monetary independence in the context of the trilemma.

$$MI_{it} = \text{Constant} + \beta\ CC_{it} + \delta\ Peg_{it} + \ \gamma\ X_{it} + \ \epsilon_{it} \qquad (1)$$

MI_{it}isa country$i$'s level of monetary independence in year t ,CC_{it} is a vector of various capital control variables. In some regressions, we also employ an aggregatemeasure of capital controls instead. $Peg_{it}$is

a binary control variable, which measures a country's exchange rate regime. ($Peg_{it} = 1$ for a fixed exchange rate regime and 0 otherwise.) X_{it} is a group of control variables, including per capita income (relative to the US), trade openness, inflation rate and a measure of financial development.

Shambaugh (2004) uses a framework similar to Eq.(1). There are three notable differences between the his specification and ours. First, the measurement of monetary independence is different. He uses the interest rate differential between a country and its base country. This paper uses monetary independence developed by Aizenman et al (2010), which is based on the correlation of interest rates between the home and the base countries. Second, this paper uses a more disaggregated set of capital control variables based on the asset categories and types of flow, while Shambaugh (2004) uses a single aggregated capital control variable.

Third, we employs a more sophisticated econometric method of estimation than the basic ordinary least squares used by Shambaugh (2004) which may suffer from omitted variable biasesand endogeneity problems. Admittedly,it is very difficult to identify all possible explanatory variables for monetary independence. The explanatory variables that can be identified and included in the regression are limited and the omitted variable bias may be inevitable. For instance, a country's government can influence central bank's policy-making and further affect its monetary policy autonomy. Missing the proxy to measure a government's intervention may lead to an omitted variable bias. One could consider fixed effect panel regression,such as least-squares dummy variable (LSDV)regression.This apporach can remove some time-invariant individual fixed effect, largely mitigate the omitted variable bias, and provide less biased results. However, it cannot overcome the potential endogeneity problems that are highly proable in the estimation of Eq. (1). For instance, monetary independence and inflation may affect each other in both directions. A country could try to control inflation by following another country's monetary policy, which,in turn, implies that high inflation leads to low monetary independence. Another example is capital controls: a country may choose its polices including capital controls in order to achieve a certain level of monetary independence.These econometric issues can be

addressed with dynamic panel data system GMM estimation methodology pioneered by Arellano-Bond (1991), Arellano-Bover (1995), and Blundell-Bond (1998).[2][3]

5. Results

5.1 Preliminary Analyses

Table 2 lists correlations among capital restrictions on various types of assets. Most correlations are high, suggesting that a country imposing capital restriction on one asset type, say, equities, is likely to impose restriction on the other types as well, say, bonds and direct investment. Table 3 reports correlations among capital restrictions on the direction of flows. From the result, a country with controls on inflows is also likely to have controls on outflows.

[Table 2 and 3 about here]

5.2 Main Results

Table 4 reports the main results of the regression analysis estimated by panel-data system GMM that allows for fixed effects and addresses the endogeneity problems of explanatory variables. This paper uses the following specification for estimation.

$$MI_{it} = \alpha_i + \beta\ CC_{it} + \lambda CC_{it} * Peg_{it} + \ \gamma X_{it} + \ \epsilon_{it} \qquad (2)$$

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[2]System GMM estimation can be used to deal with a general model as follows:$y_{it} = \beta x_{it} + \ \epsilon_{it};\ \epsilon_{it} = \ \mu_i + \ \upsilon_{it};$ $E(\mu_{it}) = \ E(\upsilon_{it}) = E(\mu_{it}\upsilon_{it}) = 0$; where the disturbance term has two orthogonal components: the fixed effects, μ_i, and the idiosyncratic shocks, υ_{it}. The estimation addresses omitted variable bias by construction: system GMM uses data transformations such as first difference or "orthogonal deviations" for each individual to remove individual fixed effect. For instance, using first differences, $\Delta y_{it} = \beta \Delta x_{it} + \ \Delta \upsilon_{it}$. The individual fixed effect, μ_i, is removed from the model. Second, if some explanatory variables may be endogenous, the lagged values of these explanatory variables are used as instruments for estimation. In this way, potentialendogeneity problems can be mitigated. Moreover, Windmeijer (2005) devises a small-sample correction to improve the accuracy of the standard errors provided by the estimation, which makes the estimation more practical. Overall, system GMM estimation provides less biased results than general estimation methods such as pooled OLS or LSDV.

[3]To use GMM estimation, it is important to check the validity of moment conditions. Animportant advantage of system GMM is that it can use lagged values of explanatory variables as instruments to deal with potential endogeneity issues. However, it relies on the assumption that changes in the instrumenting variables ω_{it} are uncorrelated with the individual fixed effects: $E(\Delta\omega_{it}\mu_{it}) = 0$ for all *i* and *t*. If this holds, then $\Delta\omega_{i,t-1}$is a valid instrument for the endogenous variables in levels: $E\left(\Delta\omega_{i,t-1}\epsilon_{it}\right) = E\left(\Delta\omega_{i,t-1}\mu_{it}\right) + \ E\left(\omega_{i,t-1}\upsilon_{it}\right) - E(\omega_{i,t-2}\upsilon_{it}) = 0$. In the context of this paper, the estimation needs changes of inflation rate and capital controls to be orthogonal to the country fixed effect. This assumption holds since inflation stabilization and capital control policies are common tools for any countries.

wherei and t denote country and year. $\mathrm{MI_{it}}$is monetary independence as defined in equation (1). $\mathrm{CC_{it}}$is a vector of capital control variables. We consider three different levels of aggregate measurement for capital controls: (a) overall measure; (b) capital controls on three different types of capital flows as defined in Table 1 (equity + collective investment, bond + financial credit, and direct investment); (c) controls on inflows and outflows. Thus in (c), there are six different capital control dummy variables in the equation. Eq (2) also examines the effects of capital controls when they are used in combination with the fixed exchange rate regime. $\mathrm{X_{it}}$ is a group of control variables which are potential determinants of monetary independence, including the level of income, inflation, the exchange rate regime ($\mathrm{Peg_{it}} = 1$ for a fixed exchange rate), trade openness ("openc") as measured by the sum of exports and imports to GDP and the extent of financial development ("fin dvp"). The latter is definedas private credit to GDP ratio.

First, lagged values (up to 5 periods) instrument capital controls and inflation in order to mitigate potential endogeneity issues. Second, orthogonal deviations data transformation is used to accommodateunbalanced panels, because first difference amplifies gaps in unbalanced panels. For instance, if some y_{it} is missing, then neither Δy_{it}nor $\Delta y_{i,t+1}$can be constructed using first difference. Instead, orthogonal deviations let each observation subtract the average of all future available observations of a variable. It is computable for all observations except the last one, so it minimizes data loss. Third, two-step estimation and small sample correction are used to improve the accuracy and efficiency of the estimation.[4]

[Table 4 about here]

Regression (1) in Table 4 estimates the overall effect of capital controls, which is augmented from disaggregate capital control variables. It considers the intensity of capital controls, which is an advantage of our aggregate measure over the coarse 0/1 dummy measure used in previous studies. The estimation result suggests a positive effect of capital controls on monetary policy independence, although it is not statistically significant. This is probably due to the fact that, only in a fixed exchange

[4]Windmeijer (2005) aruges that the two-step efficient GMM, with small sample correction, performs better than one-step in estimating coefficients, with lower bias and standard errors.

rate regime, the tradeoff between capital controls and monetary independence is clear. The sample contains both floaters and fixers, so results from floaters may not show this tradeoff and thus weaken the overall results. Interaction terms between exchange rate regime and capital controls are useful to detect this tradeoff for fixers. The effects of control variablesare reported at the bottom of the table. Maintaining a fixed exchange rate lowers monetary independence since monetary policy is constrained to keep the exchange rate fixed. Inflation also significantly reduces monetary independence. This is in line with previous studies that there is a negative correlation between inflation rate and indicators of central bank independence. Financial development slightly negatively affects monetary independence as expected. Relative income and trade openness tend to have little effect. The six control variables are consistently signed across 6 different specifications reported in Table 4.Among the variables that have statistically significant effects, a fixed exchange rate regime reduces monetary independence. This is consistent with the trilemma and also withShambaugh(2004).

Interestingly, monetary independence is negatively is associated with both trade openness and financial development. Regarding the latter, to the extent that capital mobility typically advances along liberalization and development in the financial sector, this result is consistent with the trilemma as well. The negative effect of trade openness on monetary independence seems reasonable given that greater trade openness is associated with a smaller economy that tends to be exposed to more shocks of the external origin. See McKinnon (1963) for an early discussion about the linkage.

Regression (3) uses two capital control variables distinguishing capital inflow and outflow. Interestingly, controls on inflows significantly increase monetary independence, while controls on outflows tend to be less effective. One explanation is that controls on inflows is usually deliberately designed by policy makers to absorb desired capitals flows from international capital market, while controls on outflows are often last minute attempts by policy makers to prevent capital flight when the economy is in deep recession. Controls on inflows are usually well regulated, but controls on outflows may not be the case.

Regression (5)uses a disaggregate set of capital control variablesincluding restrictions on equityand collective investment flows, restrictions on bond and financial credit flows, and restrictions on direct

investment flows. Different types of capital flow restrictions seem to have differenteffectson monetary independence. In particular, restrictions on equity andcollective investment and those on direct investment flows seem to help improve a country's monetary independence.Yet restrictions on bond and financial credit flows would decrease a country's monetary independence. This is an interesting resultand requires further investigation.Nonetheless, the positive effects of restrictions on equity+collective investment and direct investment are quite significant, while the negative effect of restrictions on bond+financial credit is insignificant.

In the trilemma, the tradeoff between capital mobility and monetary independence depends on the exchange rate regime. In a floating exchange rate regime, when the interest rate is adjusted, the exchange rate is likely to move accordingly and thus potentially reduces the extent of cross-border capital flows. In this case, the tradeoff between capital mobility and monetary independence may not be important. However, in a fixed exchange rate regime, a country is more likely to forced to rely on capital controls in order to reduce the severity of international capital flows and gain monetary independence. The exchange rate regime will affect this tradeoff crucially. To capture this tradeoff, Regression (2), (4), and (6) add the interaction terms between the exchange rate regime and capital controls to Regression(1), (3), and (5), respectively. The coefficient of the interaction term in Regression (2) is positive and statistically significant. This supports that capital controls are more effective under a fixed exchange rate than under a floating. Regression (4) shows that the coefficient of interaction term is positive for capital inflows while it is negative for outflows. Regression (6) confirms the result in Regression (5) that restrictions on equity and collective investment and those on direct investment flows seem to be more effective than restrictions on bond and financial credit flows. However, no interaction term is statistically significant in regression (6).

Table 5 reports a selection of the validity tests for system GMM estimation developed by Hansen(1982)and Arellano and Bond(1991). The three tests are standard post-estimation tests that are used to test the validity of instruments used in estimation. The test for AR(2) is the Arellano-Bond test for autocorrelation among idiosyncratic disturbance terms. Existence of autocorrelation invalidates some or all lagged values as instruments. The test for validity of moment conditions is the Hansen test of over-

identification. System GMM can generate many moment conditions using lagged values as instruments, but it relies on the assumption that changes in the instruments are uncorrelated with the individual fixed effects. This test thus tests the joint validity of these moment conditions. The test for exogeneity of instrument subsets is the Difference-in-Hansen test of exogeneity of instrument subsets. It tests for the exogeneity of instruments used in the regression. A rejection of any of these tests may weaken the reliability of system GMM estimation. Reported in Table 5 are P-values which confirm the validityof instruments and the reliability of system GMM estimation.

6 Robustness check

Table 6 provides regression results using LSDV estimation. This estimation is commonly used to control for country fixed effects although it does not provide direct treatment to endogeneity issues. The results show that restrictions on capital flows statistically significantly affect monetary independence. All coefficients of capital control variables and control variables have the same signs as those of the GMM estimates. Clearly, result from LSDV estimation is highly consistent with system GMM estimation.

As an alternative measure of exchange rate regime, we consider the ERS(exchange rate stability) measure developed by Aizenman, Chinn, and Ito (2010) (ACI). It ranges from 0, the lowest exchange rate stability, to 1, the highest one and is based on annual standard deviations of the monthly exchange rate between the home country and the base country.[5]Table 7 reports the results obtained from using system GMM estimation along with the ACImeasure of *de facto* exchange rate stablility instead of the Klein and Shambaugh (2008)'s binary exchange rate regime classification used in Table 4. All coefficients of capital control variables and control variables have the same signs as those reported in Table 4.Interestingly, the coefficients on interaction terms tend to be more statistically significant. These

[5]ERS is defined as follows: $ERS = \frac{0.01}{0.01+stdev(\Delta log(exch-rate)}$. Thus, greater exchange rate flexibility reduces the measure. With no exchange rate changes, ERS = 1.

results reinforce the conclusion from Table 4 that the choice of exchange regime seems to have important impact on the effectiveness of capital controls on monetary independence.[6]

7. Conclusion

International monetary policy trilemma – the tradeoff among exchange rate stability, monetary independence, and unrestricted capital mobility – is an important constraint for policymakers in an open economy. This paper empirically investigates the validity of the proposition that, holding the degree of exchange rate stability constant, a decrease in capital mobility through an imposition of capital controls will enhance monetary independence. Using a panel dataset covering 88 countries for the 1995-2010 period and system GMM estimation, we find that there is some room for correctly chosen capital controls to enhance monetary independence. The effectiveness of capital controls appears to depend on the types of assets and the direction of flows they are imposed. Restrictions on equity, collective investment and direct investment seem to be more effective than those on bonds and financial credit. Restrictions on inflows appear to be more effective than those on outflows. In addition, a fixed exchange rate regime has negative impact on monetary independence as the trilemma suggests. The choice of exchange rate regime has important bearings on the effectiveness of capital controls on monetary independence. Capital controls are more effective under a fixed exchange rate than under a more flexible exchange rate regime.

[6] As part of robustness check, we also investigate whether capital controls affect monetary independence in a non-linear fashion. In particular, squared terms of capital control variables are added to the baseline model. The results (not reported) indicate that the non-linear terms are not significant in any specification, which suggests that the linearity assumption on the relation between capital control and monetary independence seems to be valid.

Table 1. Descriptive Statistics

Variable	Description	Obs	Mean	Std. Dev.	Min	Max
mi	Monetary independence	1382	0.387	0.220	0	0.967
Capital controls						
ka	Overall capital controls	1274	0.356	0.348	0	1
eqci	equity+collective investment	1456	0.348	0.362	0	1
bofc	bond+financial credit	1274	0.349	0.362	0	1
di	direct investment	1456	0.402	0.402	0	1
eqcii	equity+collective investment inflow	1456	0.297	0.358	0	1
eqcio	equity+collective investment outflow	1456	0.399	0.411	0	1
bofci	bond+financial credit inflow	1274	0.291	0.367	0	1
bofco	bond+financial credit outflow	1274	0.408	0.417	0	1
dii	direct investment inflow	1456	0.434	0.495	0	1
dio	direct investment outflow	1456	0.315	0.464	0	1
Control variables						
peg	exchange rate stability	1456	0.364	0.481	0	1
pi	inflation	1274	0.012	0.103	-0.610	0.569
openc	trade openness	1365	0.868	0.555	.132	4.534
fin_dvp	private credit/GDP	1414	0.637	0.534	0	3.194
y	relative income	1365	0.391	0.366	.0173	3.111

Note: Equity refers to shares and other securities, such as stocks; bond refers to bond and other securities; collective investment includes share certificates and registry entries or other evidence of securities investor interest in an institution for collective investment, such asmutual funds; financial credits includes credits other than commercial credits granted by all residents, including banks, to nonresidents, or vice versa; direct investment refers to investments for the purpose of establishing lasting investment economic relations both abroad by residents and domestically by nonresidents.

Table 2. Correlation between capital controls on different assets

	eqci	bofc	di
eqci	1		
bofc	0.877	1	
di	0.745	0.698	1

Table 3. Correlation between capital controls on direction of flows

	kai	kao
kai	1	
kao	0.832	1

Table 4. Panel-data system GMM estimation

Regression	(1)	(2)	(3)	(4)	(5)	(6)
ka	0.126	0.0415				
	(0.116)	(0.111)				
ka_peg		0.131*				
		(0.0745)				
kai			0.200*	0.0465		
			(0.118)	(0.0853)		
kao			-0.0543	0.0138		
			(0.0867)	(0.0726)		
kai_peg				0.339**		
				(0.133)		
kao_peg				-0.198*		
				(0.111)		
eqci					0.191	0.249*
					(0.122)	(0.147)
bofc					-0.114	-0.245*
					(0.0964)	(0.129)
di					0.105**	0.0488
					(0.0425)	(0.0668)
eqci_peg						-0.105
						(0.166)
bofc_peg						0.201
						(0.178)
di_peg						0.0778
						(0.122)
y	-0.0866	-0.101*	-0.0925*	-0.0937*	-0.0537	-0.0828
	(0.0572)	(0.0533)	(0.0489)	(0.0509)	(0.0416)	(0.0562)
pi	-0.108**	-0.134**	-0.107**	-0.129**	-0.138***	-0.103
	(0.0500)	(0.0566)	(0.0500)	(0.0530)	(0.0484)	(0.0619)
peg	-0.0888***	-0.117***	-0.0930***	-0.126***	-0.0989***	-0.155**
	(0.0296)	(0.0414)	(0.0295)	(0.0469)	(0.0307)	(0.0676)
openc	-0.0275	-0.0101	-0.00501	-0.00854	-0.00227	0.0180
	(0.0349)	(0.0389)	(0.00307)	(0.0321)	(0.0314)	(0.0334)
fin_dvp	-0.0731***	-0.0863***	-0.0781***	-0.0860***	-0.0892***	-0.0929**
	(0.0251)	(0.0299)	(0.0240)	(0.0278)	(0.0292)	(0.0391)
Constant	0.504***	0.526***	0.496***	0.507***	0.455***	0.494***
	(0.0563)	(0.0571)	(0.0497)	(0.0444)	(0.0516)	(0.0466)
Observations	1,070	1,070	1,070	1,070	985	985
# of nations	88	88	88	88	88	88

Table 5. Tests for validity of system GMM estimation

	(1)	(2)	(3)	(4)	(5)	(6)
A. Test for AR(2)	0.442	0.591	0.420	0.209	0.294	0.452
B. Test for validity of moment conditions	0.182	0.216	0.399	0.201	0.245	0.281
C. Test for exogeneity of instrument subsets	0.329	0.106	0.346	0.699	0.488	0.589

Table 6. Panel regression with country fixed effects

Regression	(1)	(2)	(3)	(4)	(5)	(6)
ka	0.0777**	0.0730**				
	(0.0339)	(0.0360)				
ka_peg		0.0184				
		(0.0378)				
kai			0.0592	0.0303		
			(0.0444)	(0.0483)		
kao			0.0202	0.0369		
			(0.0380)	(0.0406)		
kai_peg				0.111		
				(0.0719)		
kao_peg				-0.0826		
				(0.0622)		
eqci					0.192***	0.204***
					(0.0542)	(0.0566)
bofc					-0.150***	-0.139***
					(0.0430)	(0.0483)
di					0.0709**	0.0458
					(0.0276)	(0.0295)
eqci_peg						-0.0747
						(0.0901)
bofc_peg						-0.0362
						(0.0750)
di_peg						0.108*
						(0.0597)
y	0.0191	0.0184	0.0193	0.0222	0.0149	0.0233
	(0.0667)	(0.0666)	(0.0665)	(0.0649)	(0.0695)	(0.0660)
pi	-0.0625	-0.0621	-0.0617	-0.0607	-0.0372	-0.0381
	(0.0471)	(0.0471)	(0.0470)	(0.0472)	(0.0477)	(0.0473)
peg	-0.0347**	-0.0432*	-0.0353**	-0.0441*	-0.0366**	-0.0360
	(0.0159)	(0.0253)	(0.0158)	(0.0253)	(0.0173)	(0.0289)
openc	-0.0892***	-0.0892***	-0.0877***	-0.0880***	-0.0695**	-0.0698**
	(0.0317)	(0.0317)	(0.0320)	(0.0322)	(0.0326)	(0.0326)
fin_dvp	-0.0407	-0.0406	-0.0418	-0.0422	-0.0505*	-0.0547**
	(0.0273)	(0.00273)	(0.0274)	(0.0272)	(0.0280)	(0.0274)
Constant	0.560***	0.564***	0.553***	0.568***	0.532***	0.523***
	(0.0628)	(0.0638)	(0.0649)	(0.0664)	(0.0668)	(0.0678)
Observations	1,070	1,070	1,070	1,070	985	985
R-squared	0.459	0.459	0.459	0.460	0.488	0.490

Table 7. Panel-data system GMM estimation using ACI exchange rate stability

Regression	(1)	(2)	(3)	(4)	(5)	(6)
ka	0.133**	0.158***				
	(0.0610)	(0.0427)				
ka_ers		-0.00502				
		(0.0777)				
kai			0.194***	-0.0442**		
			(0.0451)	(0.0206)		
kao			-0.0463	0.159***		
			(0.0388)	(0.0181)		
kai_ers				0.373***		
				(0.0305)		
kao_ers				-0.374***		
				(0.0314)		
eqci					0.175***	0.199**
					(0.0451)	(0.0893)
bofc					-0.108***	-0.262**
					(0.0321)	(0.103)
di					0.121***	0.0637
					(0.0183)	(0.0424)
eqci_ers						-0.267**
						(0.109)
bofc_ers						0.388***
						(0.134)
di_ers						0.112
						(0.0750)
y	-0.000859**	-0.000857***	-0.000994***	-0.00105***	-0.000648***	-0.000912***
	(0.000354)	(0.000272)	(0.000289)	(0.000120)	(0.000230)	(0.000273)
pi	-0.0889***	-0.0933***	-0.0771***	-0.0854***	-0.0994***	-0.0785**
	(0.0300)	(0.0212)	(0.0247)	(0.00955)	(0.0173)	(0.0334)
ers	-0.147***	-0.128***	-0.150***	-0.108***	-0.168***	-0.237***
	(0.0315)	(0.0459)	(0.0223)	(0.0223)	(0.0232)	(0.0649)
openc	-0.000243	-0.000147	1.35e-07	7.39e-05	8.58e-05	0.000167
	(0.000207)	(0.000177)	(0.000179)	(5.66e-05)	(0.000161)	(0.000216)
fin_dvp	-0.000831***	-0.000941***	-0.000891***	-0.000964***	-0.00103***	-0.00109***
	(0.000175)	(0.000144)	(0.000156)	(7.66e-05)	(0.000140)	(0.000204)
Constant	0.557***	0.541***	0.557***	0.537***	0.517***	0.591***
	(0.0365)	(0.0275)	(0.0316)	(0.0124)	(0.0220)	(0.0359)
Observations	1,070	1,070	1,070	1,070	985	985
# of nations	88	88	88	88	88	88

Appendix Table: List of countries in the dataset

Low income	Middle income		High income
Bangladesh	Angola	Panama	Australia
Burkina Faso	Argentina	Paraguay	Austria
Cote d'Ivoire	Bolivia	Peru	Bahrain
Ghana	Brazil	Philippines	Belgium
India	Bulgaria	Romania	Brunei Darussalam
Kenya	Chile	Russia	Canada
Kyrgyz Republic	China	South Africa	Cyprus
Pakistan	Costa Rica	Sri Lanka	Denmark
Tanzania	Czech Republic	Swaziland	Finland
Togo	Dominican Republic	Thailand	France
Uganda	Ecuador	Tunisia	Germany
Uzbekistan	Egypt	Turkey	Greece
Yemen, Republic of	El Salvador	Uruguay	Hong Kong
Zambia	Georgia	Venezuela	Iceland
	Guatemala		Ireland
	Hungary		Israel
	Indonesia		Italy
	Jamaica		Japan
	Kazakhstan		Korea
	Latvia		Kuwait
	Lebanon		Malta
	Malaysia		Netherlands
	Mauritius		New Zealand
	Mexico		Norway
	Moldova		Portugal
	Morocco		Qatar
	Nicaragua		Saudi Arabia
	Oman		Singapore
			Slovenia
			Spain
			Sweden
			Switzerland
			United Arab Emirates
			United Kingdom

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