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Understanding the relationship between financial development and monetary policy

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ABSTRACT

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Abstract

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1 Introduction

One of the roles of monetary policy (MP) is to set short-term interest rates in order to influence prices and/or output. When short-term interest rates change, agents modify their consumption and investment patterns depending on how borrowing and lending rates, credit availability, market liquidity and asset prices are affected by the monetary policy stance.

There is still debate regarding the fundamental mechanism behind the effectiveness of monetary policy. At the theoretical level, the *monetary* approach stresses the liquidity channel: an increase in monetary supply reduces interest rates, which in turn affects private spending. An alternative approach stresses a *credit* channel. According to this view, the change in monetary conditions affects not only the "price of liquidity" (short-term interest rate), but also the conditions at which credit is allocated among the agents in the economy (external finance premium).

An important part of the empirical literature on monetary policy effectiveness (MPE) is concerned with the predominance of one channel over the other. However, since both channels operate through the financial system, the degree of financial development (FD) appears crucial in explaining MPE. For example, as the financial system develops, the relative power of one channel as MP transmitter could change. In fact, it seems to be the case that the credit channel is more relevant in emerging or underdeveloped countries -with poor financial systems-, whereas as the economy develops the monetary channel takes a more preeminent role in the transmission of MP (see Kamin et al., 1998). Additionally, it is a well-established fact that credit aggregates take longer to be impacted than interest rates, asset prices and exchange rates.

The increased attention devoted recently to the credit channel has generated a strand of literature on the interplay between MP and financial intermediaries. This literature has examined both how MP directly affects financial intermediaries –and, more generally, firms– by impacting their balance-sheets (Chatelain et al., 2003; Gertler and Gilchrist, 1994; Kashyap and Stein, 1995; Kashyap et al., 1993; Oliner and Rudebusch, 1996, among others) and how financial intermediaries intervene in the transmission channel through credit conditions (Freixas and Holthausen, 2006; Kashyap and Stein, 2000; Bolton and Freixas, 2006; Stein, 1998; Thakor, 1996; Van den Heuvel, 2000, among others).

Despite this intensified interest in the analysis of specific effects and channels of monetary policy actions and despite the increase relevance of this literature in the light of the recent financial crisis and credit crunch, an in-depth study of the relationship between FD and MPE is still lacking, even though the issue has been raised in several forums.[1] This may be in part due to the lack of accepted empirical measures of MPE but also to the limited cross-country evidence available. Data series for emerging or less developed countries -that therefore have less developed financial sectors- tend to be short or have numerous missing values, thus impeding meaningful analyses.

This last point is especially important from a policy point of view. Given that financial markets of emerging countries are in their developmental stages, a better understanding of how this development affects the workings of monetary policy would be key for policymakers

[1] An example is the *Conference on Financial Innovation and Monetary Transmission* held at the Federal Reserve Bank of New York (see the FRBNY Economic Policy Review of May 2002).

and investors alike. Some studies have tried to analyze the workings of MP in emerging markets in a country-case basis (see Kamin et al., 1998 or Loayza and Schmidt-Hebbel, 2002) but no study has attempted a cross-country comparative analysis of MPE or drawn conclusions that could be generalized or serve as guidance for future research and policy.

We attempt to fill this need of a systematic study by carrying out an empirical analysis of the relationship between financial sector development and MPE using information from more than sixty countries. This set of countries includes developed, emerging and non-developed economies. We first calculate summary measures of both FD and MPE. We use cluster analysis in order to classify the different countries into homogeneous groups, which allows us to offer some comments regarding stages of development and macroeconomic performance. We then estimate a set of dynamic panels that test the significance of relationships between the indicators of FD, the MPE measures and some additional macroeconomic variables. Given that this is, to our knowledge, the first systematic study of this issue, we keep our analysis at a general level and try to offer a set of stylized facts that could serve as future guidelines for researchers, policymakers and international investors.

We do not have strong priors about what general relationships will be uncovered by our analysis. On the one hand, it could be that a more developed financial sector would reduce MPE, the reason being that as financial innovation proceeds, the new set of instruments allows private agents to insure themselves against unexpected monetary shocks, thus reducing the volatility of their expenditure patterns. On the other hand, in a poorly developed financial system characterized by lack of competition and a small number of financial intermediaries, there exists inertia on interest rate formation and it may be difficult for credit to expand rapidly if banks are undercapitalized. Therefore, as changes in monetary conditions will take longer to affect borrowing and lending rates or the amount of credit, MP could be less effective or its impact might come after a longer time lag.

The paper is organized as follows. In Section 2 we review the measures used in the literature for both FD and MPE, and explain how we have constructed our measures for the two concepts. We also present some additional variables that will control for macroeconomic heterogeneity. Section 3 contains the main analysis which relates MPE to the level of FD and to the other macroeconomic variables by using a cluster analysis and a dynamic panel data approach. Section 4 concludes by putting together the results of the analysis in the form of a set of uncovered stylized facts and by commenting on limitations of the analysis and future priorities for research.

2 Measuring the variables of interest

We describe now the measures of financial development and monetary policy effectiveness that we have developed. In order to understand these choices, we briefly review how the previous literature has measured each concept.

2.1 Financial Development

Since the seminal paper by King and Levine (1993), different measures of FD have been proposed. In Table 1 we present a summary of the most relevant contributions and the

variables used. The paper by Beck et al. (2000) is especially relevant, since it presents a new database of indicators of financial development and structure across countries and over time. The database incorporates twenty two different indicators that measure the size, activity and efficiency of financial intermediaries and markets. The study is a major improvement with respect to the existing literature since it presents systematic data on most indicators for a large set of countries.

[Insert Table 1 here]

In this paper we use the database in Beck et al. (2000) and collect yearly data on the different indicators for the period 1980:2007. This allows us to include a large number of countries with information on a sufficient number of indicators. Given data restrictions, we discarded some indicators for which availability was very limited.[2] The final database contains a total of fifteen indicators of FD, arguably too many for a manageable analysis and discussion.[3] The challenge is indeed to find a more compact and manageable number of indicators that are both operational and informative. We decided to summarize the fifteen indicators with comprehensive "summary measures" coming from a principal components analysis. The methodology of principal components finds combinations of a set of variables that explain most of the variance/covariance of the original variables. These *components* are obtained from the characteristic vectors of the covariance or correlation matrices. There are as many components as original variables but, by taking the characteristic vectors associated with the highest eigenvalues, one is able to capture most of the variation present in the data with only a few measures.[4]

These measures, which are linear combinations of the original variables, may not have a clear interpretation. Factor analysis can then be used to find an interpretation for the new variables, by rotating the identified components in order to associate more closely the original variables to each component. The rotated components -factors- can be interpreted in terms of which original variables are highly related to each of them.[5]

The fifteen indicators selected were available -for at least some of the years in the sample-

[2] This is a standard problem when dealing with emerging or less developed economies.

[3] Table 2 contains the final list of indicators that were included in the analysis.

[4] Principal components has been successfully used, for example, by Beck and Levine (2002) in a similar context.

[5] The usual factor analysis setup represents the observed variables y_j, $j = 1...K$ for individuals $i = 1...N$ as being generated from linear combinations of the J common unobserved factors F_{ji} and K specific factors s_{ki}:

$$\begin{aligned} y_{1i} &= \alpha_{11}F_{1i} + ... + \alpha_{J1}F_{Ji} + s_{1i} \\ &... \\ y_{Ki} &= \alpha_{1K}F_{1i} + ... + \alpha_{JK}F_{Ji} + s_{Ki} \end{aligned}$$

The coefficients α_j are called the *factor loadings*. These loadings are normalized, so ideally we would like to have coefficients close to one and close to zero which would allow for interpretation of the factors. The amount of variance of the variable y_j explained by the common factors F_1 to F_J is called the *commonality* and the amount of variance unexplained -and therefore explained by the specific factor s_j- is called the *specificity*. Manuals on multivariate analysis contain more thorough descriptions of the methodologies. See, for example, Rencher (2002) or Anderson (2003).

for a total of 84 countries.[6] We performed factor analysis on the country-year observations of the indicators and decided to keep the first three components, which account for 59%, 20% and 10% of the total variation respectively (i.e. 89% of the total variation). The remaining twelve components had a much lower explanatory power. We then rotated the components through a VARIMAX rotation and found the loadings that each variable had in the three factors. Table 2 shows the loadings of the fifteen observed indicators. Loadings with high absolute value have been highlighted in bold.[7]

[Insert Table 2]

The results suggest a nice interpretation of the three factors. The first factor can be interpreted as the "overall size and depth of the *financial intermediaries* sector". Notice that the variables with high loadings reflect the relative size of financial assets to GDP or measure costs of the functioning of the financial intermediaries: variables with positive loadings are positively related to the size and efficiency of the financial sector whereas the two variables with negative loading are negatively related. The second factor can be thought of as reflecting the "level of *activity in the stock market*", or maybe the *volatility of the stock market*. The third factor is associated with the *relative size of the Central Bank*. All three factors are quite easy to understand and appealing from the point of view of finding a few relevant composite measures of FD. We believe that the identification of these three factors and the simplification of the problem of measuring financial depth are by themselves nice contributions of this preliminary analysis.

A simple correlation analysis between the three factors shows that the financial intermediaries factor and the central bank factor have a significantly high correlation (0.6), whereas the stock market factor seems to be less related to the other two. This can be seen in two figures that we include for illustration purposes. Figures 1 and 2 depict the values of the three FD factors for a selected set of countries.[8] The overall picture that the figures provide of the cross-country financial development is quite intuitive and, in general, it aligns with the

[6] The list of countries included in this analysis and estimates of the three factor scores for each country can be obtained from the authors.

[7] We also analyzed four and five factors, but we show the results of the three factor case. On the one hand, the three factors can be given a very natural interpretation after rotation, whereas this was not the case for the other cases: estimation of the four *factor* case had problems of convergence which prevented us from applying explicit statistical tests. In the five-factor case one of the factors did not load with a high coefficient on any of the indicators and, therefore, it could not be easily interpreted and was likely the consequence of over-fitting.

[8] Selection of the countries included in Figures 1 to 6 has been done on the basis of readability of the graphs, while at the same time keeping those countries that would have enough data available for the subsequent analysis. As it can be seen, the selected subset contains most of the OECD and a few developing countries. Abbreviations for the countries in all figures are: ARG: Argentina; AUS: Australia; BAH: Bahamas; BAN: Bangladesh; BAR: Barbados; BEL: Belarus; BHR: Bahrein; CAN: Canada; COL: Colombia; CZE: Czech Republic; ECU: Ecuador; EGY: Egypt; FIN: Finland; FRA: France; GER: Germany; GRE: Greece; HUN: Hungary; IND: India; IRE: Ireland; ITA: Italy; JAP: Japan; JOR: Jordan; KEN: Kenya; KOR: South Korea; LAT: Latvia; LIT: Lithuania; MAL: Malaysia; MAW: Malawi; MEX: Mexico; MOR: Morocco; NET: The Netherlands; NEW: New Zealand; NOR: Norway; PAK: Pakistan; PER: Peru; PHI: Philippines; POL: Poland; POR: Portugal; ROM: Romania; RUS: Russia; SEN: Senegal; SIN: Singapore; SLO: Slovak Republic; SOU: South Africa; SPA: Spain; SWE: Sweden; SWI: Switzerland; THA: Thailand; TRI: Trinidad and Tobago; TUR: Turkey; UK: United Kingdom; URU: Uruguay; US; United States; ZIM: Zimbabwe.

common wisdom. However, it should be noted that most of the financial development indicators are measures relative to the overall size of the economy, therefore for certain countries -such as the US or Japan- the value of the factor may deserve a second thought.

[Insert Figures 1 and 2]

2.2 Monetary Policy Effectiveness

A second step in our analysis is the measurement of MP effectiveness. The literature has dealt with this issue mostly through the use of VAR analysis (see Bagliano and Favero, 1998; Bagliano et al., 1999; and Christiano et al., 1999, 2005) or through structural macroeconometric models (see Boivin and Giannoni, 2006; or Fair, 2005). Following this literature, we construct several measures based on VAR models that include information on output, prices and a monetary policy instrument. The results of the VAR are used to compute the time it takes for changes in the monetary instrument to impact output significantly and the intensity of the impact. Our discussion in this subsection follows the setup in Christiano et al. (1999, 2005), adapting the analysis so it can be used for a wide range of countries.

Let us first define a reduced-form VAR:

$$Y_t = \Gamma_1 Y_{t-1} + ...\Gamma_k Y_{t-k} + e_t \tag{1}$$

where Y_t is divided into three blocks with a specific ordering:[9] $Y_t = \begin{pmatrix} Y_{1t} \\ mpi_t \\ Y_{2t} \end{pmatrix}$. The first block, Y_{1t}, is the set of variables that influence the decisions of the Central Bank (CB) but are not contemporaneously affected by the MP instrument (MPI). The second block, mpi_t, is the specific MPI used by the CB, which responds to current values of the variables in Y_{1t}. Finally, Y_{2t} is a set of variables that are contemporaneously affected by the MPI and that enter the CB's decision only with a lag. Therefore, we assume that the CB follows a MP rule such as:

$$mpi_t = f(Y_{1t}) + g(mpi_{t-1} + ... + mpi_{t-4} + Y_{1t-1} + ... + Y_{1t-4} + Y_{2t-1} + ... + Y_{2t-4}) + e_{mpi,t} \tag{2}$$

where $f(\cdot)$ and $g(\cdot)$ are (linear) functions and the number of lags (four, since we use quarterly data) have already been specified. Variables in Y_{1t} only respond to their own lags and to lags of mpi_t and Y_{2t}. Variables in Y_{2t} respond to contemporaneous Y_{1t} and mpi_t, and to lags of all variables.

A large number of variables are included in both Y_{1t} and Y_{2t} in the original references.[10] Because of data limitations, we have included an output gap measure –HP-detrended–, the inflation rate and the long-term interest rate in Y_{1t}. For the MPI, we have tried two

[9] The order is irrelevant for the estimation of the VAR coefficients, but it is key for the subsequent identification of the structural shocks.

[10] Specifically, in Christiano et al. (2005) Y_{1t} contains real GDP, real consumption, the GDP deflator, real investment, real wages and a measure of labor productivity. The second block, Y_{2t}, contains real profits, growth in a monetary aggregate and a measure of the real prices of stocks. Finally, mpi_t is a short-term interest rate, even though they alternatively use, as we do, a measure of reserves.

alternative specifications. Given the lack of uniform short-term interest rate measures, we use monetary aggregates. For our first specification, we use the growth in money and focus on the direct impact of money growth on output, inflation and interest rates. For the second specification, we use growth in narrow money as the MPI (using the reserves measure available in the *International Financial Statistics,* IFS, database of the IMF) and include the growth in the monetary aggregate as a variable in Y_{2t}.[11]

After OLS estimation of the reduced-form VAR in (1) with $k = 4$, we identify the structural shocks in a "block-Cholesky" fashion.[12] We assume that inflation does not respond contemporaneously to the other variables; the output gap responds to inflation; the long-term rate responds to both inflation and the output gap; finally, the MPI (money growth or reserves growth) responds to the previous three variables. In the five-variable VAR, with reserve growth as the MPI, money growth is assumed to respond contemporaneously to reserve growth. Given this ordering of the variables, the structural shocks can be identified and the impulse response functions (IRFs) of the different variables to shocks in the MPI are calculated. These IRFs constitute the traditional characterization of the response to MP.

We have collected data for as large a set of countries as possible. We placed special effort on ensuring that the final set overlapped with those for which we could effectively measure financial development. For coherence, we opted not to combine different data sources, and used only data available in the IFS. As a result, we ended up with data for a total of sixty six countries. For each country we collected quarterly data on five variables: an output measure (either *log[GDP volume]* or *log[industrial production]*), a measure of inflation (CPI-based), the long-term interest rate available in the database, a monetary aggregate and a measure of narrow money.

The measures of MP effectiveness used are summarized in Table 3.[13] These measures attempt to capture the lag through which the MPI affects output, the size of this impact and the length of the impact. The VARs can be estimated by simple OLS. We then find the impulse response functions (IRF) to structural shocks by using the Cholesky ordering described above. From these IRFs of output to the MPI we compute:

- The cumulative impact after four quarters, as a measure of the size of the impact (*mp1* and *mp2*, in the 4- and 5-variable VARs respectively).

- The time at which the peak of the IRF occurs, as a measure of the time that MP takes to affect output (*lag1* and *lag2*).

- The time at which the *cumulative* IRF peaks, as a measure of the length of the impact (*cumlag1* and *cumlag2*).

Finally, we attempt to ascertain whether monetary contractions have a different impact than monetary expansions. Some papers have argued that if the credit channel is important, then monetary expansions may not be effective if the financial system is underdeveloped and cannot expand credit fast enough (see, for example, Carranza et al., 2006). In order to identify this asymmetry, we estimate augmented versions of the VAR's in (1) that include a

[11] The variables included (inflation rates, interest rates, money growth, gaps from detrended output) are stationary so we estimate the VARs in levels.

[12] See Hamilton (1994) for a review of this identification scheme.

[13] The list of countries, number of available observations for the final analysis -the period for which the different series overlap- and the measures used for output and the interest rate can be obtained from the authors. Results of the country-by-country VARs are omitted.

set of terms that identify monetary contractions. Thus, the equation for any variable k in the augmented VAR looks like:

$$\begin{aligned} y_{kt} &= a_0 + \boldsymbol{\gamma}_k' \left[Y_{t-1}' \;\; Y_{t-2}' \;\; Y_{t-3}' \;\; Y_{t-4}' \right]' + ... \\ &\quad ... + \gamma_{k1}^{mc} \left[\Delta mpi_{t-1} \right]^- + \gamma_{k2}^{mc} \left[\Delta mpi_{t-2} \right]^- + \gamma_{k3}^{mc} \left[\Delta mpi_{t-3} \right]^- + \gamma_{k4}^{mc} \left[\Delta mpi_{t-4} \right]^- + e_{kt} \end{aligned} \tag{3}$$

where $\boldsymbol{\gamma}_k$ is the $(4K \times 1)$ vector of coefficients for the regular lagged terms of the K variables and $[\Delta mpi_{t-i}]^-$ are lagged terms that take value zero for monetary expansions and the value of the change in the *mpi* for monetary contractions. Therefore the coefficients γ_k^{mc} measure the differential effects of lagged changes in the *mpi* when these changes correspond to contractionary policies. The binary variables (*asim1* and *asim2*) are then derived: if the p-value of the F-test for joint significance of the coefficients of the asymmetric terms is less than 5%, the *asim1* or *asim2* variables take value 1, and 0 otherwise.

[Insert Table 3 here]

We follow a recursive procedure in order to obtain a time series of annual values of the MPE measures, which will then be used along with the annual data on FD and other macroeconomic variables in the final panel. The VARs are run for each country using at least thirty six observations (nine years of quarterly data). The MPE measures are then computed and assigned to year t, where t is the year of the last observation used in the first estimation of the VAR. We then add another four quarters of data to the VAR, reestimate it and compute the MPE measures for the following year, and so on.

We do not comment on the results of the MPE measures for the separate countries. Some stylized facts that provide the first relevant insights of the analysis can, however, be pointed out. Figures 3 to 6 show the values of the MPE measures (averages for all the years for which they are calculated) for a selected set of countries. First, there is evidence that the lag at which MP impacts output tends to be smaller in developed countries than in less developed economies. Second, there is some evidence that the final cumulative impact of MP is less intense in the more developed countries (note that the more developed economies tend to be in the middle range of the axes). Third, for the less developed countries in the sample, MP seems to be very short-lasting and, in most cases, even ineffective (note the countries for which *mp1*, the variable in the Y-axis, is negative in Figures 3 and 4).

[Insert Figures 3 to 6 here]

2.3 Additional Macroeconomic Variables

In addition to the FD and MPE, we have collected data for a set of alternative macroeconomic variables from the World Bank Development Indicators Database and another alternative source. The variables are listed and briefly described in Table 4. They characterize the heterogeneity of the different countries and serve as controls for the relationships between our main concepts of interest. Data are annual and span the same range that our measures of FD and MPE. Of special interest is the set of three binary indicators that capture the exchange rate regime (fixed, intermediate and floating). The data for the regimes come from

Levy-Yeyati and Sturzenegger (2003), who focus on the actual behavior of the currency and not on the regime officially announced.

[Insert Table 4 here]

3 The Relationship between Monetary Policy and Financial Development

We now discuss the results of the analysis of the relationship between MPE measures and FD. We have employed two different methodologies in an effort to detect significant regularities. We start classifying the world economies in terms of their characteristics and continue studying the relationship between MPE measures and FD by estimating a set of dynamic panels.

3.1 Classifying the World Economies

We perform a preliminary analysis by grouping the countries in terms of their characteristics using clustering techniques. Non-hierarchical cluster analysis is a methodology designed to find groupings of individuals based on their similarities along a set of characteristics. In our case, these characteristics will be the macroeconomic variables, FD factors and the MPE measures. A measure of dissimilarity between individuals is defined, and the different individuals are assigned to a pre-specified number of groups (clusters). The outcome is a set of clusters that contain those individuals that are similar –their values in the characteristics are similar– but are different from individuals in the other clusters –the cluster means of the characteristics are dissimilar across clusters.

We have performed a non-hierarchical cluster analysis using our full set of variables. Given that the number of clusters has to be defined beforehand and considering that we had complete data (the overlap of countries for which both FD and MPE measures are available) on fifty three countries, we tried four, five and six clusters. The results tend to be quite consistent and the output of the five and six-cluster procedures simply implies the splitting of one of the groups found in the four-cluster run. The resulting clusters were in any case comparable, so we only show in Table 5 the four-cluster result for the broadest set of countries.[14] Table 5a contains the sample averages of the variables and the group averages. The last columns present an analysis of variance test that detects significant differences in means across the identified groups.[15] The cluster members are identified in Table 5b. In this table, we offer two snapshots of the clusters, corresponding to the 1990s (data used correspond to 1986-1995) and the 2000s (1996-2005), using decade long averages of the variables. This procedure allows us to study the evolution of the grouping while showing how some countries move from one cluster to another as development occurs. The results in Table 5a correspond to the most recent decade, which contains the highest number of countries.

[Insert Table 5 here]

[14] Again, the full set of results is available upon request.

[15] See, for example, Kanji (1999) for the specifics of the test, which is quite standard.

Focusing on the results for 1996-2005, the grouping of countries into four clusters is quite intuitive. Two clusters are composed of high-income developed economies, while the other two contain emerging and less developed economies. The first cluster includes emerging economies and the least developed countries in the sample. Notice the low gross national income (GNI) per capita. Countries such as Bangladesh, Jordan, India and Indonesia are included in this group.[16] These countries present quite volatile rates of GDP growth and gross fixed capital formation (GFCF). Even though GDP growth rates are high, GFCF rates are not, and GFCF represents the lowest percentage of GDP of all groups. The ratio of services/GDP for this group is also the smallest: these countries seem to be still in early stages of development and investment has not taken off. Their financial systems are the least developed, with Central Banks that tend to be small relative to the economy. Moreover, inflation is high and quite volatile.

The second group corresponds to emerging economies with a higher level of income than the first one. Latin American and Eastern European countries are included in this group. These countries have the highest average rates of GDP or GFCF growth, services/GDP ratios that are increasing and high rates of GFCF/GDP. These are all signs of development in the process. Notice also the volatility of GDP growth, GCFC growth and inflation, although inflation levels are much smaller than in the first group.

The third group is a group of Developed Economies, but in the low-income end. It contains economies like Australia, New Zealand, Portugal, Italy and Spain. Their income per capita is smaller than those of the fourth group, and have experienced higher and more volatile rates of growth of GDP and GFCF. They are investing more heavily than the high-income countries. Their financial systems are less developed, but the Central Bank is of comparatively similar size. These economies have mostly fixed exchange rates (due to the inclusion of several euro-economies).

The last group identified contains most Northern and Western European countries, Japan and the USA. The group members have the highest per capita income. For these countries, GDP growth and GFCF growth have been low and quite stable, and inflation rates have also been low and stable. Their financial systems and stock markets are the most developed, and the relative size of the Central Bank is large, but smaller than that of the previous group. Again, exchange rate regimes tend to be fixed in this group, mostly because of the eurozone countries included.

As it can be seen, the countries are clustered by income levels, but significant differences in the degree of development of their financial systems and size of their Central Banks are present. The picture is not so clear as to the MPE measures, since only one of the measures is significantly different across groups: the least developed countries present much more evidence of asymmetric effects of MP, an argument that supports the idea that less developed financial systems lead to different impacts of monetary expansions and contractions. Of the other MPEs, it has to be noted that lags in effectiveness tend to be higher in less developed economies and that the impact of MP in those economies is sometimes negative. Even though the differences across groups are not statistically significant, the result is noticeable in the

[16] Note that data for the poorest countries in the world are generally not available. Therefore, this LD group, which contains some solid emerging countries, has to be understood as the one that contains the least developed countries, i.e. those with the lowest income, of the *final sample*.

group means.

3.2 Monetary Policy Effectiveness and Financial Development

We finally estimate a set of dynamic panels where we try to relate some of the MPE measures to FD, while at the same time controling for macroeconomic heterogeneity.[17] Our panels take the form:

$$MPE_{it} = \beta_1 FD_{1,it} + \beta_2 FD_{2,it} + \beta_3 FD_{3,it} + \boldsymbol{\beta}' \mathbf{z}_{it} + \rho MPE_{it-1} + e_{it}$$

where MPE_{it} is the specific MPE measure for country i in year t, $FD_{j,it}$ is the value of FD factor j for country i in year t, $\mathbf{z}_{it}$ is the vector of controls and e_{it} is a zero mean iid error. We use Arellano and Bond's GMM estimator for the panels where the MPE measure is a continuous variable.[18] For the *asim1* and *asim2* variables, however, we use a simple logit panel, where no lagged dependent variable is included. The panels are unbalanced, since the time periods available for the different countries are quite different. In any case, we end up having generally more than 400 country-year observations, with more than forty countries used in each panel. Table 6 shows the results of the panels for the different MPE measures, where three different specifications have been estimated for each measure: one where $\mathbf{z}_{it}$ is not included, one in which $\mathbf{z}_{it}$ contains GDP growth, GFCF growth and inflation as controls (other macro variables ended up not being significant), and a final one where exchange rate regime variables are also included.

[Insert Table 6 here]

Regarding the first MPE measure (*mp1*), there seems to be some evidence that the bigger the size of the Central Bank is, the more effective the MP is, even though the effect loses its significance for our third specification. This positive effect seems to be also the case with respect to GFCF: the bigger the size of GFCF, the more effective the MP seems to be. Both results make sense, but the second deserves a brief comment: more investment implies a bigger possibility that the MP acts through that variable, which gives support to the existence of a credit channel.

With respect to the second measure (*lag1*), the results for our third specification show that the bigger the Central Bank, the smaller the time at which the maximum of the impulse response function takes place, i.e. lags in the impact of changes in monetary aggregates are smaller. An additional result obtained from this panel is that when the size of the financial intermediaries is big, the lag is also somewhat bigger. This result also seems intuitive even though it may not be very exciting from the policy standpoint.

For our third measure we obtain that the bigger the Central Bank, the bigger the MPE measured as (*cumlag1*). This result is consistent with the one obtained for our second measure, *lag1*. The results also show that the bigger and more active the stock market is, the bigger the MPE. Both results are robust and are maintained through the three different

[17] For the sake of brevity, we only include a few of the MPE measures, those in the 4-VAR system. A battery of other panels are available from the authors.

[18] Other papers that have used dynamic panels in similar settings are Candelon and Beine (2009), Gavin and Kamin (2009), Bosker (2003) or the papers in Baltagi (2000).

specifications. An additional result obtained, even though not very intutitive, is that the higher the inflation rate, the higher the total impact of the monetary policy. The only explanation we can come up with is that the result could be due to reverse causality.

Finally, the results obtained for our fourth measure (*asim1*) seem unclear. On the one hand, there seems to be some evidence that the higher the size and depth of the financial development, the bigger the asymmetry. But this result is not generaly robust. A similar result occurs with respect to the size of the Central Bank: larger Central Banks seem to be associated with a higher probability of asymmetric effects. Finally, an additional result arises for the first time in the analysis: it seems to be the case that if the exchange rate is fixed, there is more asymmetry, which in turn means the MP is more effective.

4 Conclusion

We have done the first cross-country study of which we are aware of the relationship between financial development and the effectiveness of monetary policy. This type of analysis is plagued with difficulties that arise both from the lack of data for a number of countries and from the lack of uniform measures of these two economic concepts. We have used a number of methodologies to obtain a few meaningful composite measures of financial development and several VAR-based measures of the effectiveness of monetary policy actions. We consider this to be the first main contribution of our analysis.

Regarding the relationship between FD and MPE, we did not have strong priors on the results to be expected. Indeed, sound theoretical arguments can be raised to rationalize both a positive and a negative relationship. Our results reveal themselves as quite interesting since they show empirical regularities that, so far, had not been uncovered. The main findings can be summarized in the following points:

• The degree of financial development can be successfully measured by three composite factors: "overall size and depth of the financial intermediaries sector", "level of activity in the stock market" and relative size of the Central Bank.

• Monetary policy seems to have a larger cumulative impact when the financial system is less developed. This impact, however, takes longer time to appear than in more developed financial systems. This result needs further investigation, though.

• Lags in the impact of changes in monetary aggregates are larger in countries with a smaller Central Bank, although the effect on this lag of the overall financial system is unclear.

• Activity/volatility in the stock market is positively related to the length of the impact of monetary policy: where the stock market is less active/volatile, the cumulative effect of money expansions/contractions is larger and lasts for a longer time.

• The size of the Central Bank is positively related to the effectiveness of the MP (large impact and larger length of impact) and negatively related to the lags.

• The exchange rate regime and other macro variables do not seem to offer any regularities, although this may be a consequence of the numerous countries included in the sample that have fixed regimes (countries from the Euro-area).

The above results are, in any case, tentative and subject to reexamination in the light of a more complete theoretical framework and when better data become available. They identify several exciting avenues for future research on the relationship between economic policies

and the stage of development of emerging economies. First, it is of high priority to invest in data availability and compatibility among datasets: most of the limitations of our analyses stem from the lack of consistent measures for a broad set of countries. Second, a deeper look at the channels of monetary transmission in a theoretical model that includes the degree of financial development could give a more solid direction to the next steps to be taken in empirical studies. Third, the issue of monetary policy asymmetry has been researched very little but our results suggest that there is quite a bit of room for significant contributions in the subject, both from the theoretical and empirical viewpoints.

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Figure 1: Financial Intermediaries vs. Stock Market Factors

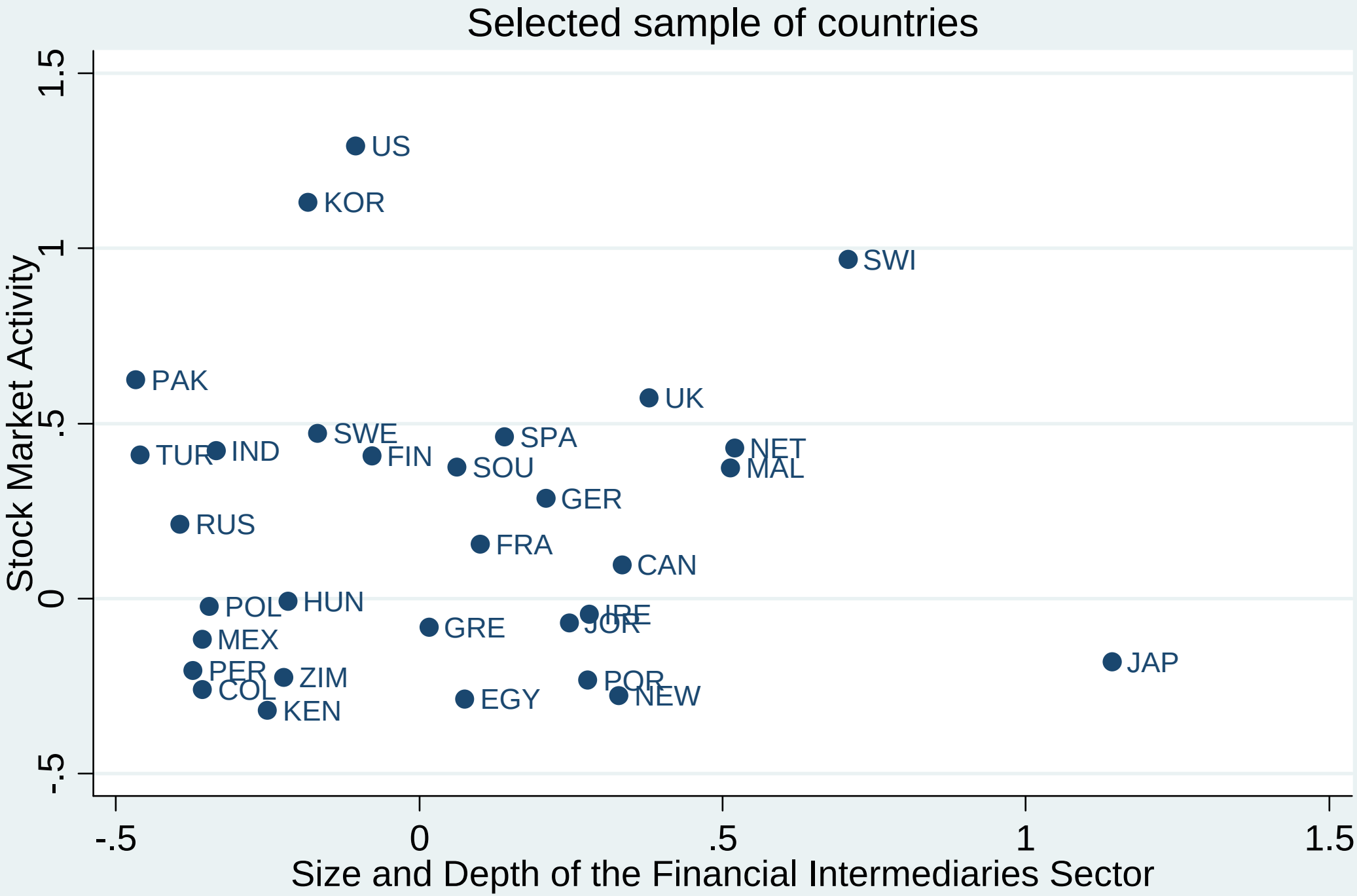

Figure 2: Financial Intermediaries vs. Central Bank Factors

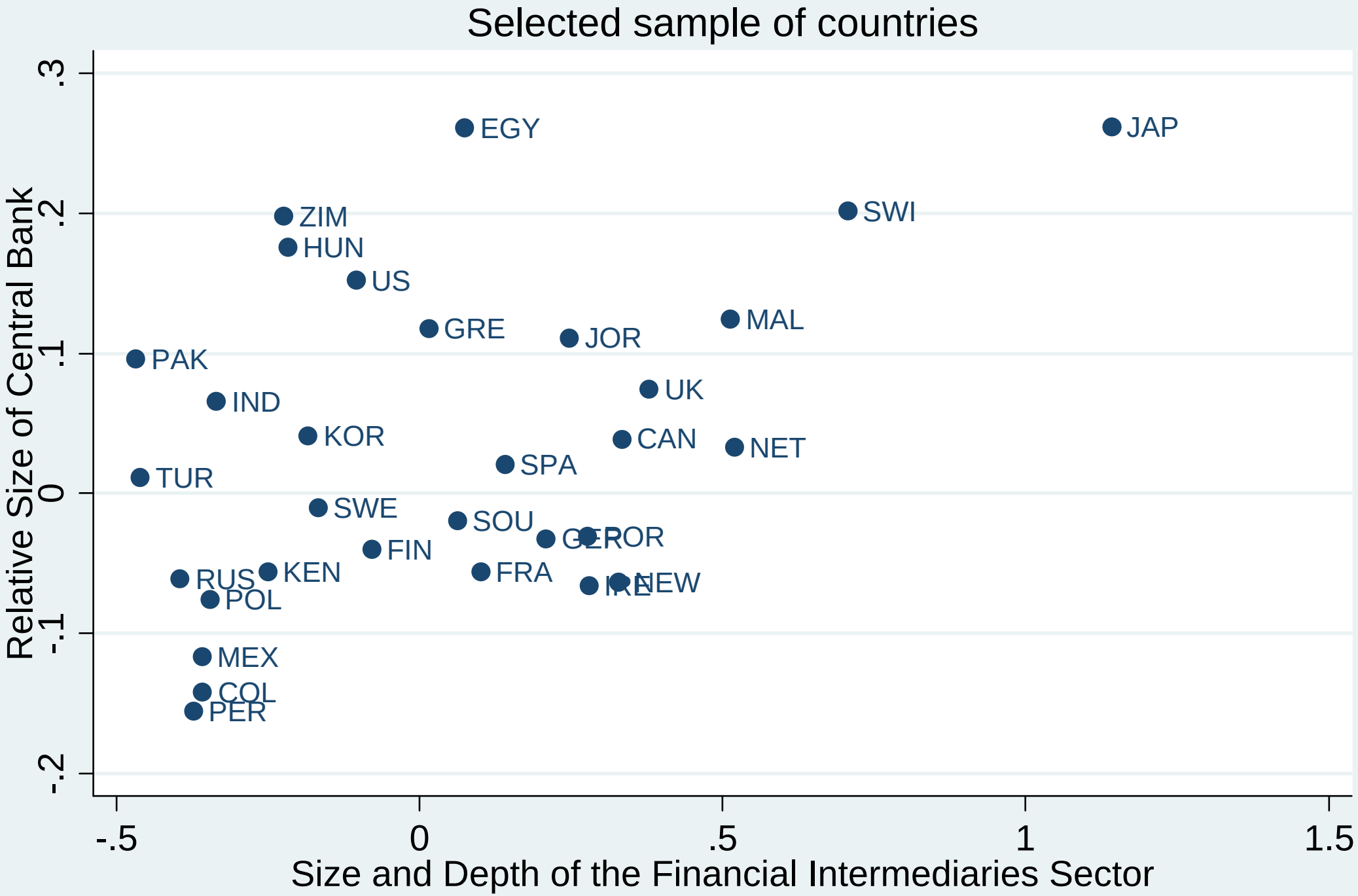

Figure 3: Lag vs. Effectiveness of Money Expansions

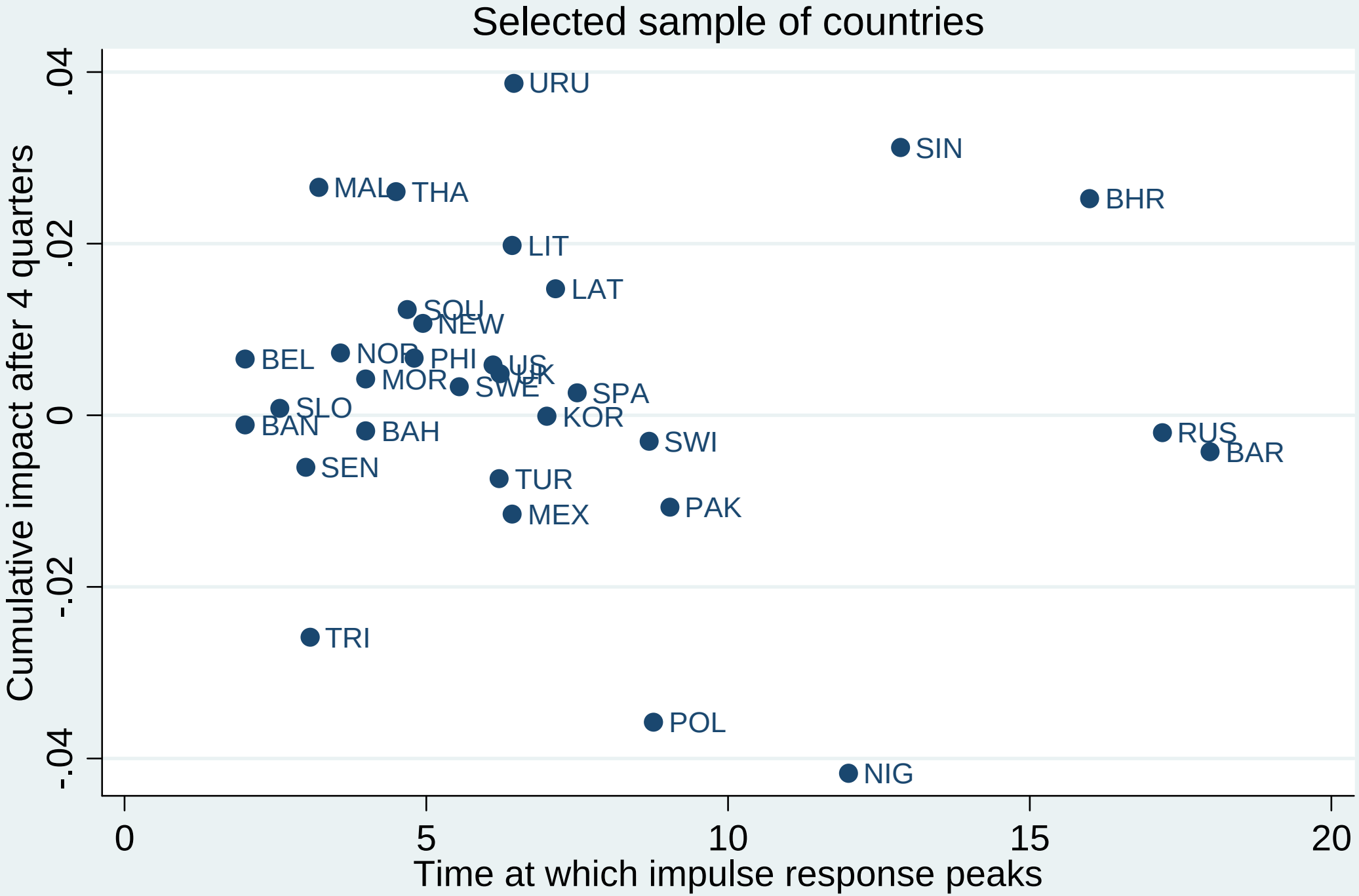

Figure 4: Effectiveness vs. Length of Impact of Money Expansio

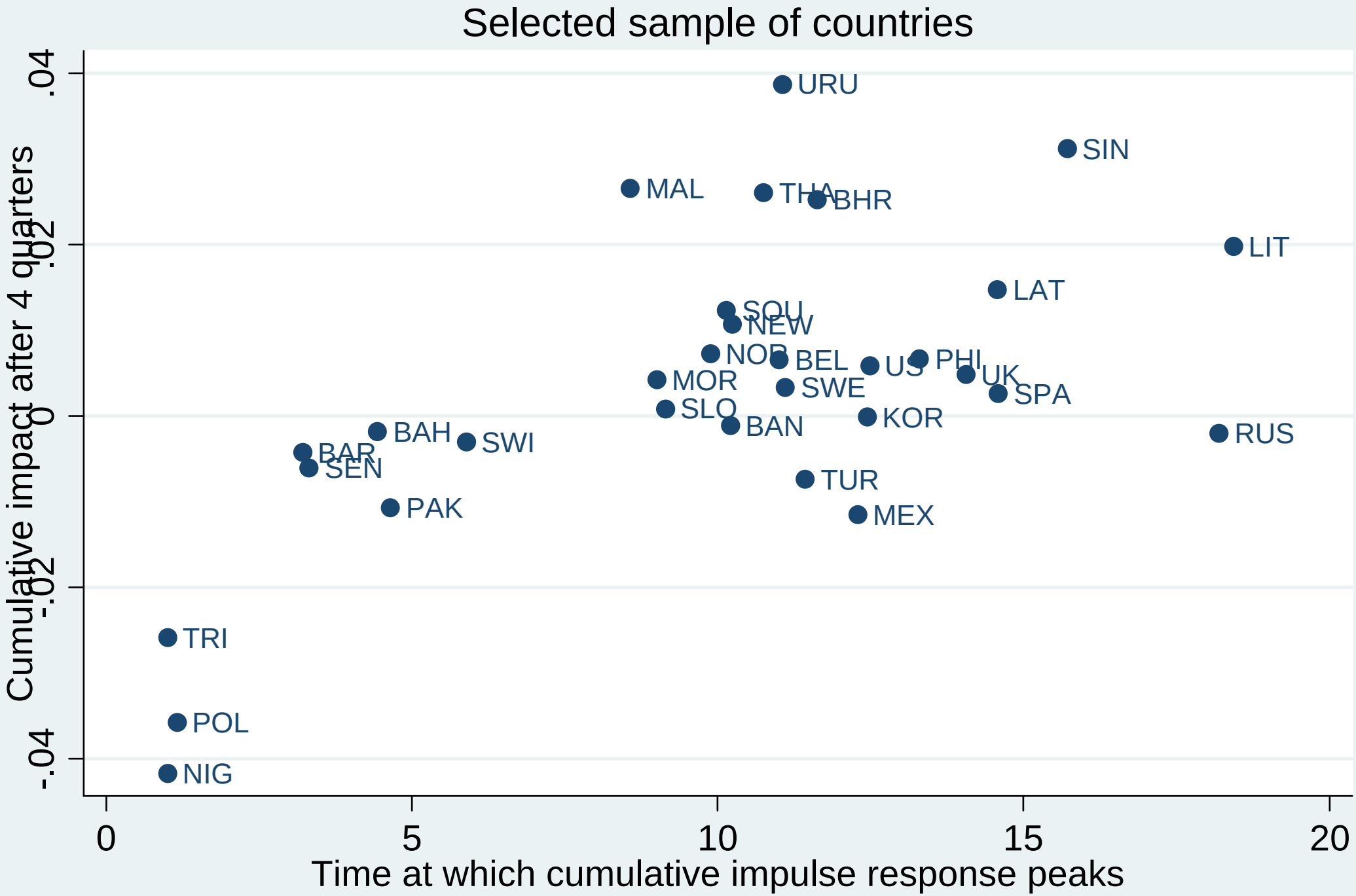

Figure 5: Lag vs. Effectiveness of Reserve Expansions

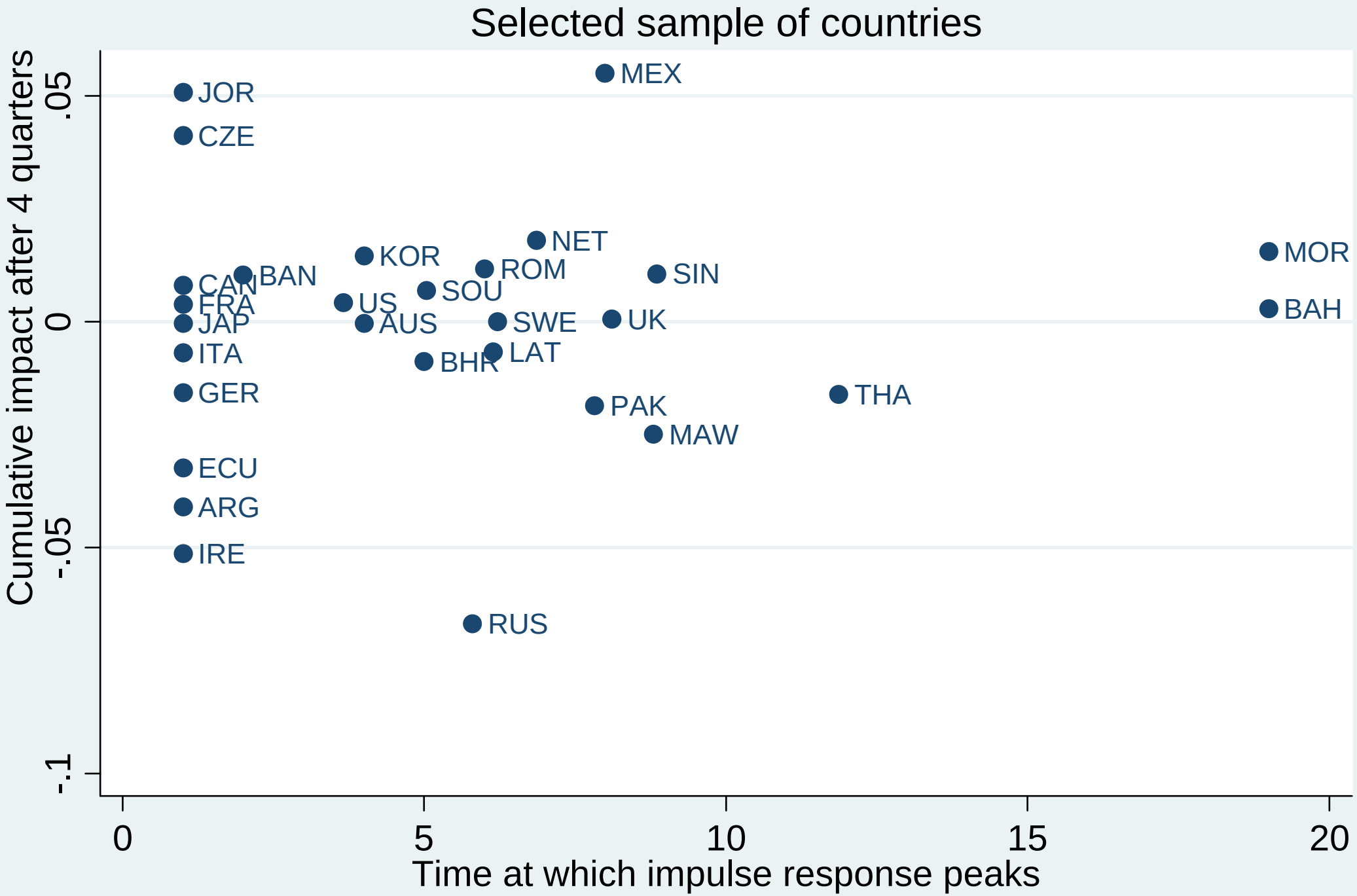

Figure 6: Effectiveness vs. Length of Impact of Reserve Expansions

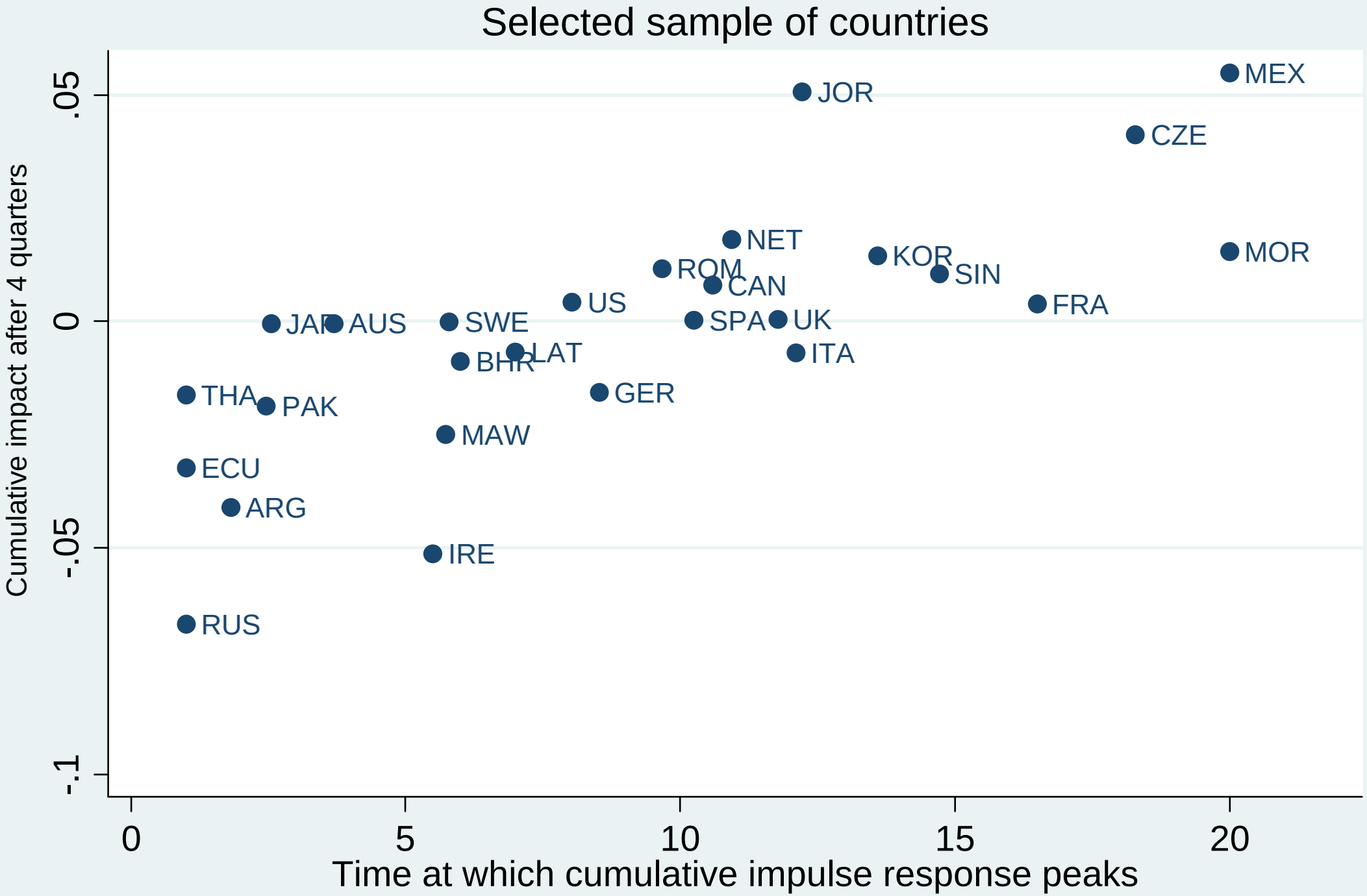

Table 1: Measures of financial development used in the literature

Reference	Indicators
King, R.G. and R. Levine (1993)	1) Size of financial intermediary sector: "Financial Depth" 1.1) Liquid Liabilities / GDP 1.2) Deposit money bank domestic assets / (DMBDA+Central Bank assets) 2) Domestic Asset Distribution 2.1) Claims on nonfinancial private sector / total domestic credit not to banks) 2.2) Claims on nonfinancial private sector / GDP
Arestis, P. and P.O. Demetriades (1997)	1) Stock Market Development 1.1) Stock Market Capitalisation Ratio: Stock Market Value / GDP 1.2) Stock Market Volatility: standard deviation of changes in stock market prices 2) Size of financial intermediary sector: 2.1) M2/GDP 2.2) Domestic bank credit/NominalGDP
Rajan, R.G. and L. Zingales (1998)	1) Capitalization Ratio: (Domestic Credit + Stock market Capitalization) / GDP 2) Accounting Standards (CIFAR)
Luintel, K.B. and M. Khan (1999)	1) Total deposit liabilities of deposit banks / Nominal GDP 2) Real Interest rate
Khan, M.S. and A.S. Senhadji (2000)	1) Domestic credit to private sector / GDP 2) 1 + stock market capitalization / GDP 3) 2 + (private and public bond market capitalization / GDP) 4) Stock Market capitalization
Al-Yousif, Y.K. (2002)	1) Currency / M1 2) M2 / Nominal GDP
Levine, R., N. Loayza and T. Beck (2000)	1) Liquid Liabilities / GDP. 2) Deposit money bank domestic assets / (DMBDA+Central Bank domestic assets) 3) Private Credit / GDP 4) Bank Assets / GDP 5) Bank Credit / GDP 6) Accounting 7) Other measures on legal characteristics and risk, expropriation, corruption, etc…
Von Furstenberg, G.M. and M. Fratiani (1996)	1) "Quantity-Based" Indicators 1.1) Ratios of liquid liabilities to GDP (M3 or even M4) 1.2) Earning assets of deposit money banks / total domestic credit 1.3) Proportion of credit allocated to private enterprises 2) "Price-Based" Indicators: 2.1) Spread in lending and borrowing real rates (banking system)
Beck, T. and R. Levine (2002)	1) Log(Private Credit/GDP*Value traded in the stock market/GDP) 2) Log(Private Credit+Market Capitalization)
Beck, T., A. Demirgüç-Kunt and R. Levine (2000)	1) Central Bank assets to total financial assets 2) Deposit Money Bank Assets to total financial assets 3) Other Financial Instituions Assets to total financial assets 4) Deposit money bank to Central Bank assets 5) Liquid liabilities to GDP 6) Central Bank Assets to GDP 7) Deposit Money Bank Assets to GDP 8) Other Financial Institutions Assets to GDP 9) Private credit by deposit money banks to GDP 10) Private credit by deposit money baks and other fin. Inst. to GDP 11) Bank deposits 12) Financial system deposits 13) Concentration 14) Overhead costs 15) Net interest margin 16) Life insurance penetration 17) Non-life insurance penetration 18) Stock market capitalization to GDP 19) Stock market total value traded to GDP 20) Stockmarket turnover ratio 21) Private bond market capitalization to GDP 22) Public bond market capitalization to GDP

Table 2: Factor loadings of final set of indicators and percentage of variance explained
First three components VARIMAX Rotation

Indicator of Financial Development	Factor loadings			Variance Explained	
	1st factor	2nd factor	3rd factor	Common	Specific
Deposit money bank vs. central bank assets	0.293	0.096	**-0.821**	0.769	0.231
Central Bank Assets to GDP	0.011	-0.069	**0.99**	0.999	0.001
Deposit Money Bank Assets to GDP	**0.91**	0.152	-0.193	0.999	0.001
Private credit by deposit money banks to GDP	**0.881**	0.191	-0.264	0.999	0.001
Private credit by deposit money banks and other financial institutions to GDP	**0.792**	0.308	-0.237	0.779	0.221
Bank deposits	**0.957**	0.052	-0.036	0.999	0.001
Financial system deposits	**0.954**	0.071	-0.02	0.999	0.001
Overhead Costs	-0.492	-0.064	0.021	0.247	0.753
Net Interest Margin	**-0.528**	-0.114	0.121	0.306	0.694
Concentration	**0.063**	-0.06	-0.045	0.01	0.99
Life insurance penetration	**0.522**	0.351	-0.203	0.437	0.563
Non-life insurance penetration	0.481	0.243	-0.334	0.402	0.598
Stock market capitalization to GDP	**0.526**	0.563	-0.108	0.999	0.001
Stock market total value traded to GDP	0.332	**0.892**	-0.095	0.999	0.001
Stockmarket turnover ratio	0.064	**0.84**	-0.089	0.999	0.001

Table 3: Measures of Monetary Policy Effectiveness

VAR specification	Measure	Measure Description
4-variable VAR Money growth as MPI	mp1 lag1 cumlag1 asim1	Impulse response: cumulative effect of structural shock to MPI on output after 4 quarters Time at which maximum of the impulse response function occurs Time at which maximum of the cumulative impulse response function occurs Asymmetric terms in VAR statistically significant
5-variable VAR Reserves growth as MPI	mp2 lag2 cumlag2 asim2	Impulse response: cumulative effect of structural shock to MPI on output after 4 quarters Time at which maximum of the impulse response function occurs Time at which maximum of the cumulative impulse response function occurs Asymmetric terms in VAR statistically significant

Table 4: Other Macroeconomic Variables

	Measure	Source	Code in WDI database
Income level	1 to 4 score[a]	From World Bank classification	
South Asia	0/1 indicator	From World Bank classification	
Europe & Central Asia	0/1 indicator	From World Bank classification	
East Asia & Pacific	0/1 indicator	From World Bank classification	
Latin America & Caribbean	0/1 indicator	From World Bank classification	
Middle East & North Africa	0/1 indicator	From World Bank classification	
Western Europe & North America	0/1 indicator	From World Bank classification	
Sub-Saharan Africa	0/1 indicator	From World Bank classification	
Central government debt	% of GDP	World Bank WDI Database	GB.DOD.TOTL.GD.ZS
GDP growth (annual %)	Average %	World Bank WDI Database	NY.GDP.MKTP.KD.ZG
	Std. Dev.	World Bank WDI Database	
GNI per capita, Atlas method	US$	World Bank WDI Database	NY.GNP.PCAP.CD
Gross fixed capital formation (GFCF)	% of GDP	World Bank WDI Database	NE.GDI.FTOT.ZS
GFCF (annual % growth)	Average %	World Bank WDI Database	NE.GDI.FTOT.KD.ZG
	Std. Dev.	World Bank WDI Database	
Inflation, GDP deflator (annual %)	Average %	World Bank WDI Database	NY.GDP.DEFL.KD.ZG
	Std. Dev.	World Bank WDI Database	
Services, etc., value added	% of GDP	World Bank WDI Database	NV.SRV.TETC.ZS
Exchange rate regime	Three 0/1 indicators[c]	Levy-Yeyati and Sturzenegger (2003), updated	

Standard deviations correspond to the previous five-year period

[a] Low income=1; Lower middle income=2; Upper middle income=3; High income=4

[b] Less indebted=1; Moderately indebted=2; Severely indebted=3

Table 5a: Cluster Analysis - Statistics

Data used correspond to the averages of all variables throughout the period 1996-2005. A total of 53 countries had all required information.
Means of the variables for full sample and for the four clusters are presented, along with a test of significance of the difference across clusters.

	Means of the Variables					Significance of differences in means across clusters		
	Full Sample	Centroids of the Clusters						
		Group 1	Group2	Group3	Group4		Stat.	Level
Size and Depth of Financial Intermediaries	**0.0015**	**-0.1884**	**-0.1763**	**0.2113**	**0.2444**	***	8.6617	0%
Stock Market activity	0.1189	0.0606	-0.0542	0.2127	0.3232		1.9776	13%
Relative Size of the Central Bank	0.0106	-0.0169	-0.0502	0.0269	0.0217		1.7346	17%
Income level	**3.1509**	**1.7500**	**3.0000**	**4.0000**	**4.0000**	***	155.81	0%
South Asia	**0.0755**	**0.2500**	**0.0000**	**0.1250**	**0.0000**	**	2.9955	4%
Europe & Central Asia	**0.2075**	**0.1667**	**0.5000**	**0.0000**	**0.0000**	***	6.7549	0%
East Asia & Pacific	0.1509	0.2500	0.1111	0.2500	0.0667		0.8376	48%
Latin America & Caribbean	**0.1509**	**0.1667**	**0.3333**	**0.0000**	**0.0000**	**	3.2449	3%
Middle East & North Africa	0.0189	0.0833	0.0000	0.0000	0.0000		1.1487	34%
Western Europe & North America	**0.3585**	**0.0000**	**0.0000**	**0.6250**	**0.9333**	***	54.556	0%
Sub-Saharan Africa	0.0377	0.0833	0.0556	0.0000	0.0000		0.5566	65%
Fixed Exchange Rate Regime	**0.4803**	**0.1713**	**0.4612**	**0.6667**	**0.6509**	**	3.7716	2%
Intermediate Exchange Rate Regime	**0.1656**	**0.3241**	**0.1658**	**0.0556**	**0.0972**	**	3.4831	2%
Flexible Exchange Rate Regime	0.3541	0.5046	0.3730	0.2778	0.2519		1.0914	36%
Services to GDP ratio	**62.2915**	**54.1274**	**59.9475**	**68.1637**	**68.5035**	***	12.377	0%
Inflation rate	**6.3640**	**11.2685**	**8.4934**	**2.5411**	**1.9239**	**	3.6147	2%
GFCF growth	5.0221	3.5899	6.6584	4.9360	4.2503		1.963	13%
GFCF % over GDP	21.7302	20.7637	22.9366	23.4026	20.1640	*	2.4645	7%
GNI per capita	**14038**	**1636**	**5537**	**19016**	**31506**	***	202.6	0%
GDP growth	**3.7303**	**3.8902**	**4.4883**	**3.3935**	**2.8726**	**	3.4672	2%
Standard deviation of GDP growth	**2.6030**	**2.9601**	**3.7759**	**1.7020**	**1.3906**	***	13.256	0%
Standard deviation of GFCF growth	**8.6904**	**9.0608**	**12.9519**	**5.4567**	**5.0050**	***	13.917	0%
Standard deviation of inflation rate	16.3228	24.9105	29.8897	1.3406	1.1630		2.0842	11%
mp1	-0.1630	0.1109	-0.5577	0.0041	0.0025		0.7287	54%
lag1	5.8810	6.4370	6.2750	5.5625	5.1333		0.5591	64%
cumlag1	9.1391	10.7812	8.3056	10.0125	8.3600		0.6808	57%
asim1	0.2181	0.2222	0.3579	0.1396	0.0889		1.9756	13%
mp4	-1.3172	-0.0075	-3.8797	0.0042	0.0051		0.6332	60%
lag2	3.3010	4.1093	3.6833	3.3083	2.1917		1.1656	33%
cumlag2	10.0625	10.7028	10.2692	7.8667	10.4733		0.4091	75%
asim2	**0.3524**	**0.6037**	**0.4417**	**0.1854**	**0.1333**	***	4.8261	1%

Table 5b: Cluster Members - 4 clusters

1986-1995				1996-2005			
EE - LDHI	**EE (2)**	**DE (1)**	**DE (2)**	**EE - LDHI**	**EE (2)**	**DE (1)**	**DE (2)**
Chile	Barbados	Australia	Austria	Bangladesh	Argentina	Australia	Austria
India	Greece	Italy	Belgium	Ecuador	Barbados	Canada	Belgium
Malaysia	Korea, Rep.	New Zealand	Canada	India	Botswana	Greece	Denmark
Pakistan	Portugal	Spain	Denmark	Indonesia	Chile	Italy	Finland
Poland		United Kingdom	Finland	Jordan	Croatia	New Zealand	France
South Africa			France	Pakistan	Czech Republic	Portugal	Germany
Trinidad and Tobago			Germany	Peru	Estonia	Singapore	Iceland
Uruguay			Japan	Philippines	Hungary	Spain	Ireland
			Netherlands	Romania	Korea, Rep.		Japan
			Norway	Russian Federation	Latvia		Netherlands
			Sweden	South Africa	Lithuania		Norway
			Switzerland	Thailand	Malaysia		Sweden
			United States		Mexico		Switzerland
					Poland		United Kingdom
					Slovak Republic		United States
					Trinidad and Tobago		
					Turkey		
					Uruguay		

DE: Developed Economies
EE: Emerging Economies
LDHI: Less-Developed High-Income Economies

Table 6: Panel estimates of measures of Monetary Policy Effectiveness

t-stats in second row. MPEt-1 is the lagged dependent variable. *, ** and *** denote significant at the 10%, 5% and 1% levels respectively. Panels for MP1, Lag1 and Cumlag1 are dynamic panels estimated using Arellano-Bond's GMM method. The panel for Asim1 is a logit panel with no lagged dependent variable included.

	MP1			Lag1			Cumlag1			Asim1		
Size and Depth of Fin. Interm.	-0.760	-0.930	-0.990	-0.240	-0.210	1.860	1.060	1.080	1.280	1.570	2.590	6.910
	-0.9	-1.05	-0.8	-0.3	-0.2	1.77*	0.8	0.7	0.7	1.2	1.72*	2.98***
Stock Market Activity	0.820	1.030	0.670	-0.080	-0.230	-0.770	1.760	2.020	2.810	0.740	0.630	0.480
	1.46	1.74*	0.87	-0.14	-0.38	-1.26	1.80*	1.98**	2.32**	0.92	0.75	0.45
Size of the Central Bank	6.490	8.200	6.150	-3.090	-3.320	-7.240	13.300	14.480	19.140	9.540	9.130	8.690
	2.04**	2.45**	1.41	-0.91	-0.91	-2.02**	2.40**	2.55***	2.84***	2.20**	1.97**	1.42
GDP growth		-0.070	-0.060		0.040	-0.030		0.100	0.090		-0.020	-0.250
		-0.87	-0.56		0.45	-0.42		0.75	0.54		-0.23	-1.75*
GFCF growth		0.060	0.060		-0.010	0.010		-0.060	-0.060		-0.010	0.020
		2.59***	1.90*		-0.34	0.33		-1.61	-1.22		-0.20	0.63
Inflation		0.020	0.010		-0.004	0.010		0.070	0.120		0.004	-0.040
		1.12	0.52		-0.21	0.35		1.92*	2.69***		0.15	-1.09
Fixed Exchange Rate			-0.190			0.550			-0.210			1.540
			-0.33			1.16			-0.22			1.85*
Flexible Exchange Rate			-0.300			0.350			-0.080			1.470
			-0.49			0.75			-0.08			1.69*
MPEt-1	0.510	0.500	0.430	0.200	0.220	0.003	0.230	0.200	0.090			
	13.99****	13.39***	9.51***	5.07***	4.96***	0.08	4.46***	3.64***	1.42			
sum(Ti)	431	401	302	428	398	299	431	401	302	531	488	383
N	50	47	44	50	47	44	50	47	44	56	51	49