# CENTRAL BANK INDEPENDENCE AND FINANCIAL INSTABILITY

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**Abstract**
The issue of how bank regulation and supervision affect financial instability is very important, since ensuring financial soundness is a major goal of bank regulators. Greater independence from external pressure should mean that central banks are less politically constrained in acting to prevent financial distress, which should allow them to act earlier and more decisively before a crisis erupts. We estimate the relation between Central Bank Independence and financial instability. We use a dynamic heterogenous panel model between 1985 and 2005 with a large set of control variables. We find a significant negative relation between CBI and financial instability, which is mostly due to political independence.

Keywords: Financial instability, Central Bank Independence, dynamic heterogeneous panel.

JEL code:

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## 1. Introduction

Many central banks have obtained a responsibility for financial stability in addition to their price stability mandate (Das *et al*., 2004). Financial stability refers to the smooth functioning of the various components of the financial system, i.e., financial institutions, markets, and payments, settlement, and clearing systems (Čihák, 2007; Oosterloo and De Haan, 2004).

There is a voluminous literature suggesting that central bank independence (CBI) may be instrumental in realizing the price stability objective of monetary policy (Klomp and De Haan, 2007 and Meade and Crow, 2007). It has also been argued that CBI may foster financial stability. Greater independence from outside political pressures should mean that the central bank is less constrained in preventing financial distress, which should allow the bank to act earlier and more decisively before a crisis erupts. Also, more independence may give the central bank a wider latitude in managing a systemic crisis (Čihák, 2007).[1] Indeed, there is some evidence suggesting that CBI is positively related to financial stability (see Garcia Herrero and Del Rio, 2003 and Čihák, 2007).

In this paper we re-examine the effect of CBI on financial stability using a dynamic heterogeneous model. We use this kind of model as estimators that have been used in previous studies (like fixed and random effects, IV or GMM) are based on the assumption that the data can be pooled. This assumption may be questioned if the sample of countries is quite heterogeneous (cf. Pesaran *et al*., 1999).[2] In this paper we therefore use the Pooled Mean Group (PMG) estimator, which controls for panel heterogeneity. Another innovation of the paper is that we introduce an alternative indicator of financial instability that is based on a factor analysis of various indictors. This variables

[1] However, as pointed out by Čihák (2007), the relationship between central bank independence and financial stability may not be straightforward as central banks have incomplete control over policy outcomes in the area of financial stability. Unlike price stability, financial stability is rarely within the sole purview of the central bank, and it is usually shared with other agencies, including the ministry of finance, and often also a separate supervisory agency and a deposit protection fund.

[2] Bouwman *et al*. (2005) have shown that the impact of CBI on inflation is not homogenous across countries.

includes not only instability in the banking sector, but also instability in other parts of the financial system.

We use the data on Central Bank Independence from a recent world-wide survey by Arnone *et al.* (2007). Compared to previous research, they offer a very wide dataset, comprising for a about 70 central banks, for the late 1980s and 2003. The Central Bank Independence indices are based on the methodology proposed by Grilli *et al.* (1991). This methodology distinguish between political autonomy (i.e.,ability of the central bank to select the objectives of monetary policy) and economic autonomy (i.e., ability of the central bank to select its instruments).

We conclude that there exist a significant negative relation between CBI and financial instability. If we split CBI in political and economic independence, the results indicate that this negative relation is primarily caused by political rather than by economic independence.

The remainder of this paper is structured as follows. The next section gives a description of the methodology and data used. Section 3 shows our results on the relation between CBI and financial instability. The final section discusses our results and concludes.

## 2. Methodology and data

### 2.1 Financial instability indicator

In the analyses of Garcia Herrero and Del Rio (2003) and Čihák (2007) financial instability is proxied by the occurrence of banking crises. Demirgüç-Kunt and Detragiache (1998) identify a crisis when at least one of the following conditions holds: 1) the ratio of non-performing assets to total assets in the banking system exceeds 10 percent; 2) the cost of the rescue operation is at least 2 percent of GDP; 3) Banking sector problems result in a large-scale nationalization of banks; 4) Extensive bank runs take place or emergency measures.

There are however a number of drawbacks to use banking crisis as an indicator of financial instability. First, it identifies crises only when they are severe enough to trigger market events. In contrast, crises successfully contained by prompt and corrective policies are neglected. Second, the identification of the exact timing of crises is rather subjective and its accuracy has been questioned (Caprio and Klingebiel, 1996). Third, it only takes banking crises into account, therefore neglecting instability in other parts of the financial system. Finally, this indicator is dichotomous while financial instability is not.

As an alternative, we therefore constructed a continuous financial instability indicator by using factor analysis on a number of financial instability indicators. Factor analysis is a statistical data reduction technique used to explain variability among observed random variables in terms of fewer unobserved random variables called factors. The observed variables are modeled as linear combinations of the factors, plus "error" terms. The eigenvalue for a given factor measures the variance in all the variables which is accounted for by that factor. If a factor has a low eigenvalue, then it may be ignored. Other factors are more important in explaining the variances in the set of variables under consideration.

There is no ”best” criterion for dropping the least important factors. The so-called Kaiser criterion drops all factors with eigenvalues below one. The Cattell scree test is a graphical method in which the eigenvalues are plotted on the vertical axis and the factors on the horizontal axis. The test suggests to select the number of factors that corresponds to the place of the curve where the smooth decrease of eigenvalues appears to level off to the right of the plot[3].

The data we used are commonly used financial stability indicators by various Central Banks (cf. ECB, FED), and that are available widely over the period 1980 to 2005[4]. The first set of variables indicate changes in the balance sheet of the banking system. Larges changes in liquidity indicators of the banking system are indicators of

[3] The appendix includes an extensive statistical description of the factor analysis methodology.
[4] Oosterloo *et al.* (2006) gives a review on the commonly reported indicators on financial instability by Central Banks.

financial crises. We also include two direct (dichotomous) measures of banking crises. The first is the indicator described above of Demirgüç-Kunt and Detragiache (1998). The other banking crisis indicator is taken from Caprio and Klingebiel (2003) and updated by Honohan and Laeven (2005). This indicator is based on the actual or incipient bank runs or failures leading to suspend the internal convertibility of liabilities or forcing the government to intervene replacing a significant share of the banks' capital. An innovation compared to the indicator of Demirgüç-Kunt and Detragiache (1998) is that the latter distinguish between systematic and non-systematic banking crises. Second, we include data on changes in risk in return. Changes in these indicators indicate that risk of the financial market increase or decrease and thereby the instability of the financial sector. Finally we use variables on the monetary authorities. Large changes in the foreign assets or the money supply may indicate that there is a liquidity problem in the financial market.

For some of the 75 countries we use, some indicators are not available for all years. We have less than 10 percent missing observations. In order not to lose valuable information, we applied the EM algorithm of Dempster, Laird and Rubin (1977) to compute the missing observations. The EM algorithm was suggested by Dempster, Laird and Rubin (1977) to solve maximum likelihood problems with missing data. It is an iterative method, the expectation step involves forming a log-likelihood function for the latent data as if they were observed and taking its expectation, while in the maximization step the resulting expected log-likelihood is maximized. The correlations between the different indicators are not perfect, they vary between 0.21 and 0.73. Therefore, we consider the different indicators of financial instability as imperfect measures of this concept.

The next step is retaining the right number of factors to represent financial instability. First, the Kaiser rule which states that all factors with a eigenvalue larger than one should be retained indentified more than six factors. However in this case, this is probably a so-called Heywood case where some solutions of the unique variances of the indicators are smaller than zero. If instead the scree plot criteria is used, financial instability can be represented as a one dimensional construct. This is shown in Figure 1.

The one factor model is highly significant, the p-value of the the goodness-of-fit test is 0.001. The results indicate that the one-factor model is appropriate to represent financial instability.

[INSERT FIGURE 1 ABOUT HERE]

Table 1 presents the correlation of the various indicators with the one factor model and the variance of the indicators explained by the two factors. The one factor model can explain about 80 percent of the change in credit to the private sector, but less than 5 percent of the change in share price index. In total about sixty percent of the variance is explained by the one factor, while fourty percent of the total variance is unique, meaning that this part is unexplained.

[INSERT TABLE 1 ABOUT HERE]

**2.3 Model and data**

By using traditional pooled estimators (fixed and random effects, IV or GMM) the question remains if the data is suitable to pool into a homogenous panel regression. For panel data studies with large *N* and *T*, assuming homogeneity of the slope coefficients is quite often rejected. With the so-called Mean Group estimator we can estimate separate equations for each country and examine the distribution of the estimated coefficients across groups. This produces consistent estimates of the average of the parameters in heterogeneous panels provided that group specific parameters are independently distributed and the regressors are exogenous. However, it has also been shown that MG estimates will be inefficient if parameters are the same across groups, i.e., if the long-run slope homogeneity restriction holds (Pesaran *et al*., 1999). In this case, Pesaran *et al*. (1999) propose a maximum likelihood-based ‘‘pooled mean group’’ (PMG) estimator which combines pooling and averaging of the individual regression coefficients. This estimator allows the intercepts short-run coefficients and error variances to differ freely across groups, but the long-run coefficients are constrained to be the same. Not imposing equality of short-run slope coefficients also allows the dynamic specification, e.g. the number of lags included to differ across groups. The PMG estimates the error equation of the autoregressive distributed lag (ARDL) representation. The model we estimate is based on an unbalanced panel between 1985 and 2005. The model is given as follows

$$fi_{i,t} = \alpha_j + \gamma fi_{i,t-1} + \beta_i X_{i,t} + \mu CBI_{i,t} + \varepsilon_{i,t} \qquad (1)$$

Where $fi_{i,t,}$ is the financial instability indicator in country $i$ at time $t$, $X_{i,t}$ is a vector of control variables containing mostly variables used by Demirgüç-Kunt and Detragiache (1998)[5], $CBI_{i,t}$ is the Central Bank Independence indicator by Arnone *et al.* (2007). Because we have the CBI indicator only two point in the time, we decided to assign the years 1985 to 1995 with the value of the end of the 80s and we assign the value taken from 2003 to the years 1996 to 2005[6]. The last term $\varepsilon_i$ is an error term. Note that the intercept term $\alpha_j$ may differ from country to country. Assume that all of these variables are I(1) and cointegrated. For notational convenience we derive the equations here with one lag in the dependent and explanatory variables for all countries. In the actual estimation procedures we allow the lags to differ between series and between the dependent and explanatory variables. The error correction equilibrium representation is derived as follows.

$$\Delta fi_i = \alpha_j + (1-\lambda) fi_{i,t} + \beta_i X_{i,t} + \phi_i \Delta X_{i,t} + \mu CBI_{i,t} + \theta \Delta CBI_{i,t} + \varepsilon_{i,t} \qquad (2)$$

This error correction equation implies the following long-run estimation

[5] In the appendix is a detailed description of the data used.
[6] We have tested also various other divisions of years, but the results throughout the paper remain the same.

$$fi_{i,t} = \alpha_j + \frac{\beta_i}{1-\lambda} X_{i,t} + \frac{\mu}{1-\lambda} CBI_{i,t} + \varepsilon_{i,t} \qquad (3)$$

We test for long-run homogeneity using a joint Hausman test based on the null of equivalence between the PMG and MG estimation. If we reject the null (obtain a probability value of less than 0.05), we reject homogeneity of our cross section's long run coefficients. An alternative to the Hausman test is the likelihood ratio test for short-run or long run parameter heterogeneity and has homogeneity as the null hypothesis.

Next, we formulate our baseline model. This has been done with the specific-to-general approach of the PMG model whereby we stepwise add the variable with the lowest p-value at a ten percent level. Recent work by Lutkepohl (2007) shows that this method is the leading approach used for modelling multiple time series. It has theoretical and practical advantages in particular if cointegrated variables are involved. In fact, a bottom-up approach to multiple time series analysis that starts from analyzing individual variables or small groups of variables and uses the results from that analysis to construct a larger overall model has a long tradition (see, e.g., Zellner and Palm, 1974; Wallis, 1977; Zellner and Palm 2004).

The control variables are mostly based on the variables suggested by Demirgüç-Kunt and Detragiache (1998). First, we use the growth rate of the real GDP to capture adverse macroeconomic shocks. Theory predicts that adverse shocks affecting the whole economy will increase s systemic banking or financial crisis. This happens because negative shocks to the whole economy affect the solvency of borrowers. Since financial institutions cannot perfectly diversify their lending risk in an economy that is in general distress, their balance sheet worsens subsequently.

We include the change of the real exchange rate to test the hypothesis that financial market problems are the results of excessive exposure to foreign exchange risk. An unexpected change of domestic currency might cause problems if domestic banks borrow in foreign currency and lend in domestic currency. Goldstein, Kaminsky and Reinhart (2000) find that overvaluation of real exchange rate is the best leading indicator of financial crises.

A shock in short-term interest rates is likely to cause financial system problems because financial institutions cannot adjust their returns on assets quickly enough to compensate the increased cost of deposits. Inflation is an approximate for nominal shocks. It is likely to be associated with macroeconomic mismanagement that affects the whole economy. Fiscal surplus reflects the resources that the government has at its disposal to deal with the financial problems. A country with an unsound financial position tends to postpone the measures required to strengthen the financial sector. The passivity and inaction are usually justified on the grounds that there is no room for more government expenditure. It is expected that a country with sound finances would have the perceived capacity to rectify the problems on time. Besides, sound fiscal position is an important precondition for a successful financial liberalization (McKinnon, 1993).

Next, we include a liberalization dummy to capture the extent to which financial liberalization has progressed. Improperly implemented financial liberalization is likely to cause financial system problems. This is because banks are allowed more opportunities for risk-taking in a liberalized financial market (Kaminsky and Reinhart, 1991).

Furthermore, countries lacking a sound legal system and governance might have more financial system problems due to corruption or inefficient enforcement of law, low degree of regulation and government ineffectiveness. Explicit deposits insurance influences financial instability in two opposite ways. On one hand, bank runs are less likely to occur when deposits are insured against the risk of bank insolvency. On the other hand, a deposit insurance motivates banks to engage in overly risk-taking investments if the insurance scheme is under-priced and the premiums fail to fully reflect the risk of bank portfolios.

Additonal to Demirguc-Kunt and Detragiache (1998) we also add a variable to check if globalization affects financial instability. This effect can be positive as well as negative. It depends on the correlation with the foreign financial shocks. If the correlation is positive, then globalization will increase financial instability, but when the correlation is negative, then globalization can have a smoothing effect on the financial markets. We also include shocks to terms of trade to control for foreign shocks on financial instability. Large capital inflows and capital flight, particularly in the case of emerging countries, probably affect the stability of the financial sector as well.

Finally, we turn to variables that describes some characteristics of the monetary policy conducted by the Central Bank. The impact of the monetary policy design on financial stability is related to the debated question of the relation between price stability and financial stability. The economic literature is divided as to whether there are synergies or a trade-off between them. If synergies existed between the two objectives it would seem safe to argue that the same monetary policy design which helps achieve price also fosters financial stability. However, if there is a trade-off, it would be much harder to establish an *a-priori* on the impact of price stability on financial stability

Among the arguments for a trade-off, Mishkin (1996) argues that high level of interest rates, necessary to control inflation, negatively affect banks' balance sheets and firms' net financial worth, especially if they attract capital inflows. This is because capital inflows contribute to over-borrowing and increase credit risk, and may lead to currency mismatches if foreign capital flows are converted into domestic-currency denominated loans. Cukierman (1992) states that the inflation control may require fast and substantial increases in interest rates, which banks cannot pass as quickly to their assets as to their liabilities. This increases interest rate mismatches and, thus, market risk. Another type of trade-off stems from too low inflation or deflation, which reduces banks' profit margins and, by damaging borrowers (and not lenders as inflation) increases the amount of non performing loans in banks' balance sheets.

Among the arguments for synergies between price and financial stability, Schwartz (1995), states that credibly maintained prices provide the economy with an environment of predictable interest rates, leading to a lower risk of interest rate mismatches, minimizing the inflation risk premium in long-term interest rates and, thus, contributing to financial soundness. From this strong view of synergies, where price stability is practically considered a sufficient condition for financial stability, some more cautious supporters of the "synergies" view argue that price stability is a necessary condition for financial stability but not a sufficient one (Padoa-Schioppa, 2002; Issing 2003).

Some central banks aim at price stability together with other –in principle non-compatible– objectives. One additional policy objective often mentioned is financial instability. The financial supervision regimes vary significantly from country to country. A review of the financial supervision architectures indicates a trend toward a gradual concentration of supervisory powers, especially in Europe. A number of countries have assigned the task of supervising the entire financial system to a single authority different and independent from the central bank other countries have assigned the financial stability objective to the Central Bank (Masciandaro, 2004). An survey from the Bank of England examines to which exent Central Banks are responsible for the financial sector supervision in the 80s. Another survey by Masciandaro (2004) examines to which institution is responsible monitoring the banking sector, insurance sector and the security sector. We combine these two surveys in a dummy variable to test if financial instability is lower if the Central Bank has an explicit mandate of financial supervision.

When compared with the central bank objectives, the reasons why the choice of the monetary policy strategy can affect financial stability are less clear-cut. Perhaps the most debated case is the exchange-rate based strategy. Domaç and Martinez Peria (2000) find that fixed exchange rate regimes, and implicitly an exchange rate-based monetary strategy, are preferred to reduce the likelihood of banking crises among developing countries. However, Eichengreen and Rose (1998) argues that whether fixed or floating exchange rate regimes reduce the probability of banking crises depends on the source of disturbances. If the threat to the stability of the banking system comes from outside, there is a case for exchange rate flexibility (which may translate into a monetary or inflation targeting in terms of the monetary policy strategy). Instead, if the threat comes from inside (i.e., erratic monetary policies at home), an exchange rate anchor is a better strategy. Finally, Eichengreen and Arteta (2000) also find mixed results. In sum, there is hardly any *a priori* on which strategy can better contribute to financial stability.

# 3 Empirical results

### 3.1 Regression results

In addition to the PMG and MG we also report the dynamic fixed effects (DFE) to facilitate comparison. Results will vary quite substantially across methodologies given that the MG procedure is the least restrictive, and thus potentially inefficient. The DFE allows for individual intercepts to vary across countries, and is similar to the GMM procedure.

For all estimations we use a three stage estimation procedure. In the first stage, we determine the optimal number of lags for each series chosen by the Schwarz Bayesian information Criterium (SBC). All results are robust for alternative selection criteria like Akaike's Information Criterium (AIC) and the Hanna-Quinn Information Criteria (HQ). For the vast majority of the countries, specifications with no lagged dependent variables are rejected at conventional levels of statistical significance, indicating that dynamics is important and so that the static fixed effects method is clearly inadequate to for the task at hand. In the second stage, we search for a suitable initial value of the coefficients. In the final stage we use a Newton-Raphson optimization algorithm to maximize the likelihood function.

Our baseline results of the specific-to-general are shown in table 1. The result of the PMG estimator appears substantially different from those using the DFE estimators regarding the size of coefficients. However, the PMG result is fairly similar to the result using the MG. This is encouraging because the two estimators use different methods to estimate the model while the coefficients from both estimations, unlike the DFE, are based on long-run effects. Compared to the results using the MG estimator, the PMG results improve the precision of estimations. This outcome is expected given that the MG estimators are known to be inefficient due to a low degree of freedom. Comparison of the MG and PMG results indicates that imposing long-run homogeneity reduces the standard errors of the long-run coefficients, but changes little the estimates. The Hausman test and the likelihood ratio statistic, which suggests sample countries can be pooled to provide common long-term coefficients, confirms this.

When we look at the economic control variables we see that a high GDP growth significantly decreases financial instability[7]. This result confirms that real shocks to the economy have been a major source of systemic financial system problems. This confirms the results by Demirguc-Kunt and Detragiache (1998) but contradicts the results by Cihak (2007) which did not found a significant relation. Next, we find that changes in the exchange and financial market liberalization significantly increase financial instability. Finally, the results confirm the theory that high values of governance, measured by the rule of law variable of the International Country Risk Guide, tend to significantly reduce financial instability[8].

[INSERT TABLE 2 ABOUT HERE]

In table 2 we first add the Central Bank Independence variable. The results clearly indicate a significant negative effect on financial instability . If we split independence in the next columns in economic and political independence, than the results indicate that political independence is more important than economic independence[9]. This result confirms the conclusion of Čihák (2007) which founds a negative effect on the probability of a banking crises, but contradicts Garcia Herrero and Del Rio (2003) which did not found a significant result.

### 3.2 Robustness of the evidence

As a first robustness check we include the monetary policy and central bank variables mentioned above. In column 3 of table 3 we add a dummy variable to control for Cen-

[7] The short-run parameter estimation along with the individual country MG results are available from the authors on request.
[8] We also test the governance hypothesis with the other variables from the ICRG: government effectiveness, bureaucratic quality, government instability, corruption and democratic accountability.
[9] The results stay the same if we include economic and political independence separately.

tral Banks focusing on price-stability. We find a negative significant effect of the dummy variable, which means that banks that has price stability as a main objective also makes the financial system less instable.

The results on the monetary policy strategy in next three columns show that there are no significant differences in Central Banks that use the exchange rate, inflation or the money growth as strategy object on financial instability. Next we find that when a Central Bank has a explicit mandate of financial stability, it has also lower financial instability.

In all cases mentioned above, the Central Bank Independence variables stays significant negative, while the variable on price-stability becomes insignificant in the last specification, if we also include the financial stability mandate variable.

[INSERT TABLE 3 ABOUT HERE]

Problem till now is that although the joint Hausman test indicates that the PMG is the appropriate estimation technique, the individual Hausman test on homogeneity of the political variables indicate that they vary across countries. Therefore we estimate the model with only a lagged dependent variable and the Central Bank variables from the last specification of Table 2. Now the mean group (MG) model is the appropriate model. The former joint Hausman test is probably dominated by the impact of the economic variables and the lack of degrees of freedom due to inclusion of many control variables. The results in Table 4 still indicate that CBI matter and give rise to the idea that the impact of independence differ across countries. Also it supports a popular view among political scientists that political variables are more heterogenous across countries then economic variables. This combined with the PMG results above indicates that there, at least in the short-run, is heterogeneity present. This means that the DFE/GMM is not the right method to estimate this kind of models. The magnitude of the CBI variable is higher compared to Table 2, but this is probably cause by an omitted variable bias.

[INSERT TABEL 4 ABOUT HERE]

It could be argued that one individual country could significantly affect the estimated parameters, even when the Hausman tests and/or the likelihood test on homogenity do not reject the hypothesis of common long-run coefficients. A sensitivity analysis was thus performed on our preferred specification  in order to assess the robustness of the results to variation of country coverage. We re-estimated  te last regression of Table 2 with the bootstrap method. In this method, we replicate the regressions 1,000 times by estimating it with a changing sample of countries of 40 percent of the total sample. The purpose of this procedure is to examine the stability of the regressions by checking on sample sensitivity. Table 4 shows the bootstrap results for the Central Bank Independence variables of the regressions. The results show the same pattern than the basic regressions, meaning that the relation between Central Bank Independence and financial instability, although there is heterogeneity, relative stable across country.

If we have a closer look at developing and developed countries we find that Central Bank Independence has a higher impact in developed countries. This means that Central Bank Independence is better in explaining financial instability if it is not to large. These results are shown in the Table 4.

Finally, because there could be an measurement error in the factor analysis on financial instability, we also re-estimated the regressions with only the standard deviation of the credit as a share of GDP as an indicator of financial instability. The results in the second part of Table 4 show the same pattern then before. The results of Central Bank Independence are also significant if we use the alternative indicator of financial instability. So, to sum up we find in the various sensitivity test, the results remain the same as with our baseline result.

## Conclusion

Many central banks have obtained a responsibility for financial stability in addition to their price stability mandate (Das *et al*., 2004). Financial stability refers to the smooth functioning of the various components of the financial system, i.e., financial institutions, markets, and payments, settlement, and clearing systems (Čihák, 2007; Oosterloo and De Haan, 2004).

It has been argued that CBI may foster financial stability. Greater independence from outside political pressures should mean that the central bank is less constrained in preventing financial distress, which should allow the bank to act earlier and more decisively before a crisis erupts. Also, more independence may give the central bank a wider latitude in managing a systemic crisis (Čihák, 2007).

In this paper we re-examine the effect of CBI on financial stability between 1985 to 2005 using a dynamic heterogeneous model. We introduce an alternative indicator of financial instability that is based on a factor analysis of various indictors. This variables includes not only instability in the banking sector, but also instability in other parts of the financial system.

We conclude that there exist a significant negative relation between CBI and financial instability. If we split CBI in political and economic independence, the results indicate that this negative relation is primarily caused by political rather than by economic independence. This results still hold if we use a number of sensitivity test.

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## Data references

| Variable | Definition | Source |
|---|---|---|
| Central Bank Independence | Measure of political and/or economic independence of the Central bank | Arnone *et al.* (2007) |
| Economic growth | Growth rate of real GDP per capita | IMF (2006) and Worldbank (2006) |
| Terms of trade shock | Standard deviation of terms of trade. | IMF (2006) and Worldbank (2006) |
| Exchange rate change | change real exchange rate | IMF (2006) and Worldbank (2006) |
| Real intrest rate | Real interest rate is the lending interest rate adjusted for inflation as measured by the GDP deflator. | IMF (2006) and Worldbank (2006) |
| Inflation | GDP deflator | IMF (2006) and Worldbank (2006) |
| Government deficit | Surplus or deficit of the governance balance as ratio to GDP | IMF (2006) and Worldbank (2006) |
| M2/reserves ratio | M2 comprise the sum of currency outside banks, demand deposits other than those of the central government, and the time, savings, and foreign currency deposits of resident sectors other than the central government. This as a ratio to the bank reserves | IMF (2006) and Worldbank (2006) |
| Domestic credit | financial resources provided to the private sector, such as through loans, purchases of nonequity securities, and trade credits and other accounts receivable, that establish a claim for repayment. For some countries these claims include credit to public enterprises. Measured as a share of GDP | IMF (2006) and Worldbank (2006) |
| Bank reserves | Bank capital to assets is the ratio of bank capital and reserves to total assets. | IMF (2006) and Worldbank (2006) |
| Credit growth | Growth of the domestic credit | IMF (2006) and Worldbank (2006) |
| Deposit insurance | dummy which takes the value 1 for countries where there is an explicit deposit insurance system | Demirgürç-Kunt and Sabaci (2002 |
| Net financial flow | Financial inflow mines outflow as percentage of GDP | IMF (2006) and Worldbank (2006) |
| Globalization | KOF Globalization index | Dreher (2006) |
| Liberalization | Dummy variable if the financial markets are liberalizated | Mehrez and Kaufmann (2000), Demirgüç-Kunt and Detragiache (1998), Kaminsky and Schmukler (2002) and Williamson and Mahar (1998) |
| Central Bank strategy | these three variables (Exchange rate target, Money target and Inflation target) are dummies that equal one during periods in which targets for these variables were used | Mahadeva and Sterne (2000), Reinhart and Rogoff (2002), Kuttner and Posen (2001), Berg, Borensztein and Mauro (2002) and Carare and Stone (2003) |
| Price stability focus | measures to what extent statutory objectives do provide the central bank with a clear focus on price stability following the approach of Cukierman et al. (1992) | Cukierman, Webb and Neyapti (1992), Mahadeva and Sterne (2000) and. Cukierman, Miller and Neyapti (2002). |

| | | |
|---|---|---|
| Financial suppervision | a dummy which  which stems from a survey conducted by the IMF i where all member countries where asked to inform of which institution was responsible for banking regulation and supervision in their respective countries. | Tuya and Zamalloa (1994) and Masciandaro (2004). |
| Financial instability | EFA on a number of the standard deviation of a number financial variables (see appendix) | Own calculation |
| Governance | Rule of law | International Country Risk Guide (2004) |

## APPENDIX 1: factor analysis financial instability

### A1. Method

To determine whether indicators of financial system instability have a multidimensional character, a so-called Explanatory Factor Analysis (EFA) is employed. The first step in this analysis is to check whether the data used is suitable for an EFA using the Kaiser-Meyer-Olkin measure of sampling adequacy testing whether the partial correlation among variables is low. A test statistic higher than 0.6 indicates that the data is suitable for an EFA. An alternative test is Bartlett's test of sphericity, that checks whether the correlation matrix is an identity matrix in which case the factor model is inappropriate. In all cases examined in this paper, both tests indicated that an EFA can be done.

The objective of an EFA is to identify what different indicators of a latent variable (like human capital) have in common and to separate common factors from specific factors. Following Wansbeek and Meijer (2000) and Lattin *et al.* (2003), the EFA model can be written as:

$$x_i = \Delta\xi_i + \varepsilon_i \qquad (1)$$

Where $x_i$ is a vector containing the $M$ indicators for observation i, i = 1…$k$ (in our case the various indicators of human capital and several dimensions of the political regime), $\Delta$ is a vector of factor loadings of order $M \times k$, and $\xi$ is a vector of latent variables with mean zero and positive define covariance. The random error term $\varepsilon$ is assumed to be uncorrelated with the latent variables.[10] Under these assumptions, the covariance matrix of $x_i$ is:

$$\Xi = \Delta\Phi\Delta' + \Omega \qquad (2)$$

Where $\Xi$ is the parameterised covariance matrix and can be decomposed in the covariance matrix of the factors $\Phi$ and the diagonal covariance matrix of error terms $\Omega$. The model is estimated with the Maximum Likelihood (ML) method. By assuming that the factors and the disturbance term are normally distributed, it follows that the indicators are normally distributed. The log-likelihood function can be written as:

[10] $E(\varepsilon) = 0$ and $E(\zeta\varepsilon') = 0$.

$$ln\, L = ln\left|\Xi\right| + tr\left[S\Xi^{-1}\right] \tag{3}$$

Where $S$ represents the sample covariance matrix. Minimizing this fit function means choosing the values for the unknown parameters that lead to the implied covariance matrix as close as possible to the sample covariance matrix .

The next step is to decide on the number of factors to represent human capital or political institutions on the basis of the scree plot, which plots the number of factors against the eigenvalues of the covariance matrix of the indicators. In general, there are two ways of interpreting the graph. According to Kaiser's Rule, only factors with an eigenvalue exceeding unity should be retained. An alternative way is to look for an 'elbow' in the scree plot, i.e., the point after which the remaining factors decline in approximately a linear fashion, and to retain only the factors above the elbow.

After deciding on the number of factors, it is possible that the factors of the (standardized) solution of the model are difficult to interpret. In that case, we can rotate the factor loadings, yielding a solution that may be easier to interpret because the matrix has a simpler structure. Ideally, each indicator is correlated with as few factors as possible. The rotation technique that we use to interpret the factors is the Oblimin rotation, which allows for correlation among the factors and minimizes the correlation of the columns of the factor loadings matrix. As a result, a typical indicator will have high factor loadings on one factor, while it has low loadings on the other factors.

All indicators receive factor scores for the various dimensions (factors) identified. These factor scores are used to come up with the so-called Bartlett predictor, i.e., the best linear unbiased predictor of the factor scores:

$$\hat{\xi}_i = \Phi\Delta'\theta^{-1}x_i \tag{4}$$

Table 1: Factor analysis

| | Factor | Variance explained |
|---|---|---|
| **Banking system** | | |
| Change in bank liabilities to asset ratio | 0.201 | 0.04 |
| Change in bank reserves to asset ratio | 0.407 | 0.17 |
| Changes in capital to asset ratio | 0.095 | 0.01 |
| Change in share of domestic credit by banks | 0.312 | 0.10 |
| Credit to the private sector to GDP | 0.897 | 0.80 |
| Banking crises indicator I - Demirgüç-Kunt and Detragiache | 0.698 | 0.49 |
| Banking crises indicator II - Honohan and Klingebiel | 0.512 | 0.26 |
| **Risk and return** | | |
| Change in real interest rate | 0.132 | 0.02 |
| Change in intrest rate spread | 0.475 | 0.23 |
| Change in risk premium | 0.212 | 0.04 |
| Change in bank discount rate | 0.487 | 0.24 |
| Change share price index | 0.089 | 0.01 |
| Change government bond yield | 0.401 | 0.16 |
| **Monetary authorities** | | |
| Change of money and quasi money (M2) as % of GDP | 0.412 | 0.17 |
| Change net foreign assets to GDP | 0.212 | 0.04 |
| h-squared | 0.595 | |
| Goodness of fit p-value | 0.001 | |
| Kaiser-Meyer-Olkin | 0.701 | |
| Barlett test of spericity p-value | 0.000 | |

Figure 1: Scree plot

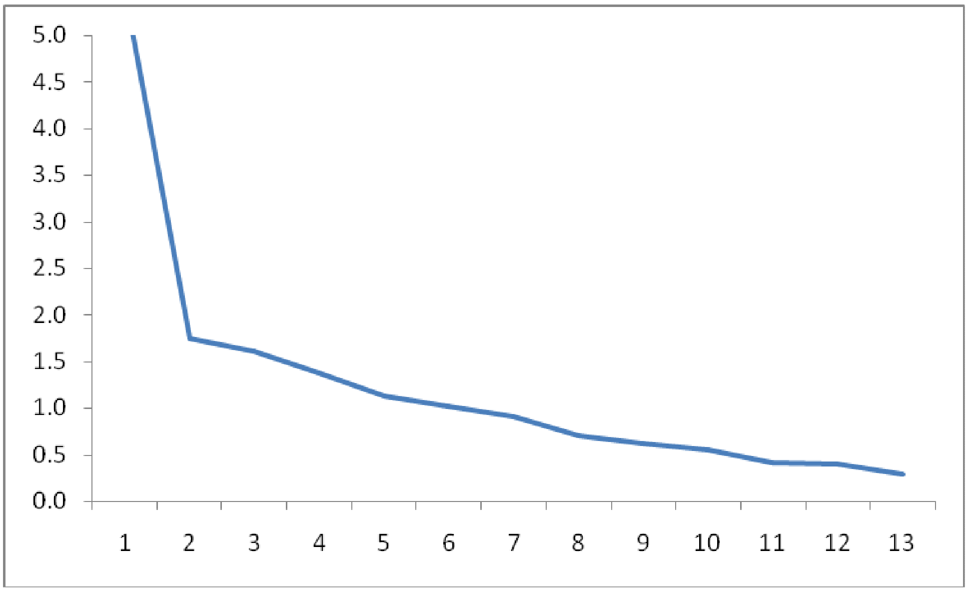

Table 2: Baseline regression

| Explanatory Variables | | MG (1) | PMG (2) | DFE (3) |
|---|---|---|---|---|
| **Economic variables** | | | | |
| Financial instability volatility lagged | | 0.300 | 0.312 | 0.461 |
| | | [1.42] | [1.96] | [2.81] |
| Economic growth | - | -1.761 | -2.375 | -2.383 |
| | | [-3.56] | [-4.01] | [-4.53] |
| Exchange rate change | + | 0.720 | 0.908 | 1.335 |
| | | [1.69] | [2.07] | [2.72] |
| Financial market liberalization | + | 1.248 | 1.314 | 1.424 |
| | | [1.62] | [2.01] | [1.50] |
| Terms of trade shocks | + | 0.627 | 0.812 | 0.331 |
| | | [2.46] | [2.84] | [4.33] |
| Rule of law | - | -0.871 | -1.014 | -1.261 |
| | | [-2.81] | [-3.14] | [-2.82] |
| Number of countries | | 75 | | 75 |
| Number of observations | | 1215 | | 1215 |
| Hausman test p-value | | 0.23 | | na |
| Likelikelihood ratio test p-value | | 0.21 | | na |

*t-values between brackets*

Table 3: Central Bank regression

| Explanatory Variables | | PMG (1) | PMG (2) | PMG (3) | PMG (4) | PMG (5) | PMG (6) |
|---|---|---|---|---|---|---|---|
| **Economic variables** | | | | | | | |
| Financial instability volatility lagged | | 0.192 | 0.338 | 0.374 | 0.119 | 0.125 | 0.403 |
| | | [2.06] | [2.16] | [1.94] | [2.25] | [2.12] | [1.41] |
| Economic growth | - | -3.116 | -2.616 | -3.027 | -2.355 | -1.142 | -1.848 |
| | | [-4.49] | [-3.28] | [-3.66] | [-4.13] | [-5.05] | [-3.28] |
| Exchange rate change | + | 0.457 | 0.484 | 0.870 | 0.864 | 0.350 | 0.589 |
| | | [1.52] | [1.68] | [1.88] | [1.32] | [1.37] | [1.73] |
| Financial market liberalization | + | 1.565 | 0.708 | 1.345 | 1.589 | 1.025 | 1.635 |
| | | [2.13] | [1.41] | [1.83] | [2.31] | [1.95] | [2.33] |
| Terms of trade shock | + | 0.282 | 0.529 | 0.587 | 0.398 | 0.134 | 0.176 |
| | | [3.61] | [2.57] | [2.81] | [2.12] | [1.85] | [3.14] |
| Rule of law | - | -0.601 | -0.845 | -0.735 | -0.793 | -0.598 | -0.768 |
| | | [-2.82] | [-2.50] | [-2.83] | [-2.12] | [-2.09] | [-2.13] |
| **Central Bank variables** | | | | | | | |
| Central Bank Independence | - | -2.912 | | -1.962 | -1.251 | -1.626 | -1.879 |
| | | [-3.17] | | [-3.05] | [-2.94] | [-2.83] | [-2.70] |
| Economic independence | - | | -1.201 | | | | |
| | | | [-1.24] | | | | |
| Political independence | - | | -2.876 | | | | |
| | | | [-3.87] | | | | |
| Central bank focus upon price stability | - | | | -1.754 | | | -0.981 |
| | | | | [-1.98] | | | [-1.42] |
| Exchange rate target strategy | | | | | -1.812 | | |
| | | | | | [-1.52] | | |
| Money growth target strategy | | | | | -0.982 | | |
| | | | | | [-1.01] | | |
| Inflation target strategy | | | | | -1.100 | | |
| | | | | | [-1.26] | | |
| Central Bank supervision of financial system | - | | | | | -0.943 | -0.712 |
| | | | | | | [-2.19] | [-2.01] |
| Number of countries | | 61 | 61 | 59 | 57 | 56 | 56 |
| Number of observations | | 922 | 922 | 892 | 862 | 847 | 847 |
| Hausman test p-value | | 0.24 | 0.28 | 0.24 | 0.30 | 0.24 | 0.25 |
| Likelikelihood ratio test p-value | | 0.27 | 0.31 | 0.27 | 0.35 | 0.27 | 0.36 |

*t-values between brackets*

Table 4: Robustness analysis

| | Single variable | | Developing countries | | Developed countries | | Bootstrap | Alternative |
|---|---|---|---|---|---|---|---|---|
| | MG | PMG | MG | PMG | MG | PMG | PMG | PMG |
| Central bank focus upon price stability | -1.079 | -1.086 | -1.232 | -1.604 | -0.690 | -0.879 | -0.981 | -1.957 |
| | [-1.52] | [-1.85] | [-1.18] | [-1.43] | [-1.19] | [-1.47] | [-1.57] | [-1.44] |
| Central Bank supervision of financial system | -0.745 | -1.015 | -1.227 | -1.240 | -0.474 | -0.529 | -0.712 | -1.308 |
| | [-1.87] | [-2.31] | [-2.53] | [-2.68] | [-2.27] | [-2.57] | [-2.59] | [-2.53] |
| Central Bank Independence | -3.226 | -3.602 | -3.759 | -4.749 | -1.827 | -2.488 | -1.879 | -6.281 |
| | [-3.23] | [-3.93] | [-2.62] | [-2.87] | [-2.87] | [-3.00] | [-2.79] | [-2.81] |
| Hausman test | | 0.03 | | 0.37 | | 0.18 | | 0.31 |

*t-values between brackets*