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MASTER'S FINAL WORK

DISSERTATION

CENTRAL BANK INDEPENDENCE AND STOCK MARKET RETURNS

PEDRO MIGUEL MENDES ROSA COSTA

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SUPERVISOR:

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ABSTRACT

Central bank independence is regarded by both literature and policymakers as essential for achieving stability in inflation and long term welfare in modern economies, and it is usually supported by the idea that it accomplishes such stability without harming other variables in the economy. Until very recently, the literature studies of its effect on several macroeconomic variables have neglected the analysis of stock market returns. Using a set of 21 developed countries, we calculate the respective yearly stock returns using the MSCI indices, quoted in US Dollars, and test if it is possible to trace an impact caused by the levels of independence of the countries' central banks. Our analysis spans for a period of 20 years and the results lead us to conclude that the free lunch hypothesis behind central bank independence cannot be rejected when its impact is studied on stock market returns.

KEYWORDS

Central bank independence; stock market returns; panel analysis; developed economies.

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1. INTRODUCTION

Central banks have an unprecedented role in today's developed and emerging economies. Even though they have existed since the 17th century and they were since then responsible for the issuance of coin, it was in the last 75 years that central banks extended their scope to a pivotal role in the economy and in the financial determinants of all developed and developing economies. Following the thoughts of Goodhart (2011), we can divide the evolution of central banks into three eras of consensual practices: the Victorian era, from 1840 to 1914, the era of government control from the 1930s to the 1960s and the "triumph of the markets" from the 1980s until the most recent financial crisis that ultimately led to an economic and ultimately sovereign crisis in the very heart of the European Union. The Great Recession has shed the light on the awareness that the measures and policies that were working until now are not enough to contain the imperfections of the economy and the contagion perils of a global financial world.

In Europe, the introduction of a common currency led to the creation of the European Central Bank (ECB), thus centralizing the monetary policies in one central bank. Countries lost their monetary independence but their national central banks are part of the European System of Central Banks, being co-responsible for the monetary determinants of the Euroarea, responsible for financial and banking supervision, and also for the active participators in the ECB broad strategy and developments altogether with the other Euro national central banks (European Central Bank, 2015). At first sight, given that the main trend of focus for developed economies is price stability and because Euro countries lost their monetary independence, central bank independence (hereafter

CBI) may appear to be a dead subject to any country under the wing of the ECB. However, national central banks still play a key role in (1) the global strategy of the monetary union and (2) the financial developments of its own country. Studies on central bank independence are still being developed for such countries, measuring for instance how detached the central bank is from political influence (*i.e.*, if the central bank operates as a public independent institution or if it is only a powerful extent of the government and its policies) or how good is the intervention in the monetary and financial systems of the country. Moreover, given the fact that we may be headed towards full statutory convergence of the central banks, as it may be suggested in most recent indexes — Dincer and Eichengreen (2014) present updated measures of independence of the central banks, with equal values to all Euroarea countries — the countries' central banks still have individual responsibilities. Furthermore, literature has thoroughly tested CBI versus inflation and some studies have expanded this view and tried to complete the current knowledge by exploring other macroeconomic variables, such as GDP (gross domestic product) growth, but market performance has been one of the neglected variables.

The present work aims to respond to the apparent negligence of this very variable when analysing central bank independence. Only two papers, developed very recently, have approached this subject directly, finding a positive relationship between CBI and stock market returns. We will develop the work developed by the authors in further sections. Our purpose here is not to evaluate if CBI is a valid argument in the control of inflation nor if there are more important monetary policies that allow for price stability and long term growth; instead, we try to ascertain the validity of the 'free lunch' idea

developed by CBI defendants — that independence of the monetary authority is a condition to achieve price stability and has no other costs for the economies.

The following sections are structured as follows. Section 2 develops a review of the literature, both in the definition of central bank independence and the empirical discoveries in the field. Section 3 exposes the methodology to be used, explaining the data sources, the variables and our econometrical approach. We present our results in Section 4 and in Section 5 we summarise our main findings and make some suggestions for future research.

2. LITERATURE REVIEW

2.1. DEFINING CENTRAL BANK INDEPENDENCE

The first definition of central bank independence was suggested by Rogoff (1985) in his exposition of the theory of appointing a conservative central banker that does not seek to maximize short term welfare (namely by providing immediate employment) but instead aims for an emphasis in inflation control as a solution for long term welfare both in monetary and economic output terms. This proposal has set the basis of CBI, even if independence does not necessarily mean conservatism (Hayo & Hefeker, 2001). Each work on CBI uses a certain definition of independence, a concept that depends on the measurement analysing several dimensions and attributing subjective weights to laws and policies. Common sense leads us to believe that such institutions cannot be completely independent from the state organ that owns it; they can at best be autonomous, as defended by Siklos (2008). However, the term “independent” has been regularly used, rather than “autonomous”, and it is also the one we use here.

Understanding the concept is a vital step towards measuring and evaluating the effective independence of central banks and then extract conclusions from it. For instance, Anorne, Laurens, and Segalotto (2006a) constructed a recent CBI index by answering to questions such as: "Who appoints the governor of the central bank and what is the length of the governor's term?", "How is the governor's office related to the government's offices?", "Who formulates monetary policy?", "Does the bank provide credit to the government? Does it participate in public debt issuances?". This example illustrates that it is important to understand which characteristics are considered by the literature to reach the definition and measure of central bank independence, given that not all authors agree completely on which features to consider and how to consider them.

Following the work developed by Rogoff (1985), Bade and Parkin (1988) considered three statutes for their measure of independence: (i) the relationship between the central bank and the government in the formulation of the monetary policy; (ii) the procedures for the appointment and dismissal of the central bank governor; (iii) the financial and budgetary relations between the central bank and the government. We can see that there is an evaluation of CBI through the policymaking and financial spheres. Cukierman, Webb, and Neyapti (1992) (their index is also known as CWN) measured CBI using the legal standards, i.e., the legal bindings of the central bank and its governor, and some informal indicators of actual independence. For the legal part this index considers sixteen features, grouped in four main clusters: (i) the nomination, dismissal and term of the central bank governor; (ii) the economic and monetary policy formulation and undertaking; (iii) the objectives of the central bank; and (iv) the limitations in terms of lending to the public sector. The authors went beyond legal

grounds in their analysis because actual independence can differ from what is demanded or instructed by law as considered by Cukierman (1992); as a consequence, they have also considered some other aspects such as the governors' turnover rate (with a higher rate meaning a lesser tenure for the governor than the executive mandate), financial independence and effective priority given to price stability, the latter being achieved through questionnaires. Neyapti (2001) added to this measure the features of financial independence, supervision role and emergency credit. Neumann (1991) also identified several features needed to consider a central bank as independent, regarding the lending to the public sector, the independence of instructions from the government, full autonomy in the control of the exchange rates policies, individual independence of the governor and the board of the institution and the central bank's very statutes. Grilli, Masciandaro, Tabellini, Malinvaud, and Pagano (1991) (which CBI index is known as GMT) had also set the grounds and put in motion the concrete studies on central bank independence as a vital part of public institutions studies on debt and deficits with an acclaimed work, in which they develop an extensive analysis on 18 OECD (Organisation for Economic Cooperation and Development) countries with a staggering data set of political and monetary institutions' features, including the identification of two main characteristics of the central banks: political independence and economic independence. The first is identified as the ability and autonomy, verified in practice, to pursue the target of low inflation which not only increases credibility but also increased points of actual CBI; the second regards the autonomy of the central bank in choosing the instruments of monetary policy and in what measure can the government exercise influence in the processes and amounts of lending by the central bank to the executive

— the greater the influence, the lower the economic independence. Of course the measures are more complex than what we describe here, but because of space limitations we will not develop them further as their mentioning aims only to give an idea of the concept used by the authors and throughout the literature. Furthermore, CBI can also be defined by taking into consideration two dimensions: *de jure* and *de facto*. This is the conception used by Siklos (2008), whose argument is based on the idea that independence of the monetary authority must be measured using a multidimensional set of features that may not be common to all countries, that essentially is divided in the economic laws that aim to pursuit price stability (the *de jure* dimension) and the use of conservative measures that ensure long term low inflation (the *de facto* dimension).

2.2. THE IMPORTANCE OF CENTRAL BANK INDEPENDENCE

It is hard to find one single reason for the interest shown by the literature in central banks' independence. The first studies coincided with the preparation period of the Maastricht Treaty, to be signed in 1992, (and the idea of a unified Europe) and the interest in understanding the differences in the effect of politics in macroeconomic development and stability — namely the great inflation control by the Bundesbank compared with other major central banks — especially in monetary and gross product variables. Regarding the commitment with a monetary target as developed by Rogoff (1985). Debelle and Fischer (1994) argue that the interest shown in turning developed central banks in more independent institutions came from the success of the Bundesbank and the West German economy since the 1950's, the development of the academic literature on the inflationary bias of discretionary policymaking and the

empirical results that the literature had found regarding CBI, especially price stability and the free lunch idea.

Bade and Parkin (1988) study appears to be the first development of testing directly the relationship between CBI and inflation; with a set of 12 industrialised countries for the period 1972-1986, they used three areas of the statutes of the central banks to verify that greater CBI in policy making and governor nomination terms leads to lower levels of inflation. The investigation of the monetary behaviour and public budgets differences was the pillar of Grilli et al. (1991) important work in the pursuit of finding solid empirical explanations for the variance of macroeconomic performance by OECD industrialised countries, which share similarities and are interconnected with each other; the article focused on the importance of central banks in the constraints and incentives to the economies as a part of policymaking, concluding that greater CBI leads to a good inflation control with no major costs in other macroeconomic variables and the (then to be formed) independent design European Central Bank from national governments and the European Commission would be sufficient to insulate the monetary objectives of the ECB from the different fiscal problems of many European countries. Adding to this idea, Neumann (1991) argues that central bank independence appears to be the necessary condition for the citizens and society to have complete trust and positive expectation of the aimed stability of prices. The same reasoning behind the GMT Index was in the paper developed by Cukierman, Kalaitzidakis, and Summers (1993) in which the effect of central bank independence was studied regarding economic growth, private investment and real interest rates using a set of 70 countries and concluding that CBI has a positive effect on developing countries' economic growth, with no effect on developed countries.

For Alesina and Summers (1993), central bank independence may carry a positive contribute to real economic development given its greater political freedom that helps to promote stability and predictability, which is reflected in smaller economic shocks and lesser risk in interest rates, and such stability is only beneficial to the economy even if it is just on the prices dimension. However, they could not find any conclusive evidence in the relationship between real GDP and CBI. Many other authors have been studying the relationship between CBI and several macroeconomic variables (de Haan & Kooi, 2000 and Berger, de Haan & Eijffinger, 2001 present comprehensive surveys) and almost all conclude that indeed greater independence leads to better control on inflation rates, which consequently leads to better macroeconomic performance for the medium and long terms. Again, despite the mix of results and conclusions from the academia, the foundation for the independence of central banks lies on the 'free lunch' concept that holds at least for developed countries. According to this idea, even if a relationship of cause-effect cannot be established between CBI and good monetary behaviour, the fact is that on average more independent countries tend to achieve lower and stable inflation, less repercussions with the change of economic cycles and better fiscal and financial stability (Arnone, Laurens, & Segalotto, 2006b). Furthermore few studies have been able to identify a negative impact from CBI on the several macroeconomic variables under study.

On a contrary perspective regarding the true importance of CBI, Hayo and Hefeker (2002) developed a survey on the theoretical grounds of the concept of independence, targeting the fact that CBI is an endogenous variable when we are analysing inflation. They conclude that the independence of the monetary authority is

not a necessary nor sufficient condition to achieve price stability because the relationship between these two variables is not causation but correlation and the suggestion is made on the relevance of many other tools such as exchange rate agreements or inflation-targeting goals. In Europe, for instance, the implementation of the European System of Central Banks has led to a greater degree of independence but that can be understood as a consequence of (i) the inflation-targeting implemented in the Euroarea, (ii) the creation of a single central bank legally isolated from political pressure, and (iii) the prohibition of direct credit from the central bank to the public sectors (Arnone et al., 2006a). To counter argue, it is possible that an idea of balance between CBI and conservativeness is the right way to achieve stable levels of inflation, as argued by de Haan, Masciandaro, and Quintyn (2008). Siklos (2008) also found evidence of the relationship between his definition of CBI — already mentioned here — and inflation, concluding that the mix of features that define CBI cannot be equally applied to all economies. To answer to the problems of endogeneity, Jácome and Vázquez (2005) take into consideration several legal indicators of independence, control for a set of relevant variables but fail to come up with a robust empirical conclusion regarding CBI and inflation. Furthermore Crowe and Meade (2008) apply first differences in the study of the CBI effect in inflation and end up concluding the same negative relationship between the variables, in spite of arguing that the evolution of the independence of the monetary institutions in the several countries under study is coincident with both economic development and price stability. More recently and using an updated CBI index, Arnone and Romelli (2013) confirmed that changes in legal independence of central banks clearly have an impact on the dynamics of inflation rates.

With this analysis we can see that even though there is a mix of studies and conclusions on the several macroeconomic variables under study, it is clear that stock market performance has been neglected until recently. As a result, little is known about the relationship or the effects of CBI on stock prices or financial markets returns. This paper focuses on the continued study of the "free lunch" theory that is supported by past studies on CBI and therefore it tries to verify if there is any relationship on market returns, it aims to further address the factors that are influenced when making a central bank as independent.

The first direct approach on CBI and stock market returns was made by Förch and Sunde (2012), using a sample of emerging countries. They identified the returns as SMR_{it}[1]. 27 economies were considered with a period from 1988 until 2007 and the analysis was made using the indexes developed by Cukierman (1992), Cukierman et al. (1992) and Arnone et al. (2007), which is an update on the previous two, normalising the values for CBI using 12 dimensions of the economic and political independent indexes from 0 to 1. The empirical tests were made in two different ways, using: (i) an equality non-parametric test with a null hypothesis stating that the change in CBI is irrelevant in stock market returns and (ii) a multivariate linear regression using a effects panel analysis[2]. For the panel data analysis, several dummies are considered in order to test specific aspects and CBI is used as a whole and divided in economic and political

[1] To measure stock returns, the authors use $\mathrm{SMR_{it}} = \frac{\mathrm{MSCI_{it}} - \mathrm{MSCI_{it-1}}}{\mathrm{MSCI_{it-1}}}$, where SMR_{it} is the return for a given period *t* (in months) using the 27 MSCI Emerging Stock Index countries (*i*).

[2] The authors use the equation $\mathrm{SMR_{it}} = \mathrm{Const} + \beta \mathrm{CBI_{it}} + \gamma \mathrm{X_{t-1}} + \varepsilon_{it}$. CBI_{it} is the CBI level for the country *i* and period t, the main explanatory variable. X is a vector that includes the lagged values of the dependent variable, SMR_{it-1}, the returns on the MSCI World Index, the GDP per capita growth and also the terms of trade, trade openness, foreign direct investment, interest rate spread and inflation.

independence. The non-parametric tests show evidence for a positive effect of CBI in the one month returns, while the multivariate regression results show proof that higher economic independence contributes positively with significance for stock returns at a 5% level of confidence.

Kurihara, Morikawa, and Takaya (2012) also developed an essay on the effects of CBI on stock market prices. The authors argue that few papers have tested stock returns against macroeconomic variables, aiming to proceed with the test of some of those variables — including the independence of central banks — on stock prices and using the same indices used by Förch and Sunde (2012), using a similar equation with annual data with the four macroeconomic explanatory variables being: inflation, GDP growth, export growth and interest rate. Stock returns are measured as the yearly change of and similarly to Förch and Sunde (2012), the authors divide CBI into total, economic and political independence. All of the coefficients for CBI are statistically significant and present positive values, when the total set of countries is considered. If there is a focus on developed countries, it is possible to conclude that only the economic independence has a significant effect and no conclusion could be taken for developing countries. The conclusion of their work is also that political independence again appears not to be significant for stock market returns, while economic independence seems to have a positive impact. In the analysis, one must not forget however other aspects that affect central banks, such as the parties on the executive governments and the very conservatism of institutions.

3. METHODOLOGY AND DATA

3.1. DATA

To test the relationship between the evolution of CBI and stock market returns, we conduct an empirical study using a panel data analysis, following the development of Förche and Sunde (2012), who analysed the effect of central bank independence on stock market returns in emerging economies (we will detail this further on). Their work uses the same period sample from 1988 until 2007 but instead of emerging economies we use developed countries. The choice of the developed economies was not only done with this exclusion criterion, as we also take in consideration the definition of developed economies by the IMF in its 2015 report (International Monetary Fund, 2015). Similarly to the study conducted by those authors, the Morgan Stanley Capital International (MSCI) indices, quoted in USD dollars, of each country will be used in the calculus of the financial returns, as they allow a better level of comparability given the homogeneity in construction, development and monetary base.

Because of data constraints, it was not possible to include all the world's 35 developed economies. Czech Republic, Cyprus, Estonia, Latvia, Lithuania and the Slovak Republic were excluded because these countries do not have initial values of central bank independence, as they were part of other republics that have been dismantling since the end of the 1980s. San Marino is also unavailable as its economy does not have any financial market (International Monetary Fund, 2010), making it impossible to use in the dependent variable set. The United States of America (US) does not present values for the interest rate spread variable and its MSCI index values begin

only in 2005. Other countries do not present some values in the interest rate spread variable (Austria) or in the foreign direct investment variable (Belgium and Luxembourg). Slovenia lacks a substantial part of values for the majority of the variables prior to 1995 and there are no MSCI indexes for neither Iceland, Luxembourg nor Malta. The dataset is therefore reduced to the 21 developed countries that have a quoted MSCI index in US Dollars for the great majority of the period between 1988 and 2007 (N=21 and T=20). We use yearly observations for all variables from Australia, Canada, Denmark, Finland, France, Germany, Greece, Ireland, Israel, Italy, Japan, (South) Korea, Netherlands, New Zealand, Norway, Portugal, Singapore, Spain, Sweden, Switzerland, and United Kingdom (UK). The data were extracted from the World Bank's world development indicators, which compile values from the World Bank itself, the International Monetary Fund (IMF) and the OECD. The returns for the MSCI indices were calculated using the year closing prices of each index supplied by Bloomberg. Next section refers to the CBI measures used in this paper.

THE CBI INDEX

We use the measures of CBI presented by Arnone, Laurens, and Segalotto (2007), as the authors present both the initial values developed by Cukierman et al. (1992), Grilli et al. (1991) — considered by the majority of the literature as the first set of CBI representing the situation of developed, emerging and developing economies at the end of the 1980's, being widely used in a vast set of studies using central bank statutes — and the correspondent updates for each country as of 2003. Moreover, the values presented by Arnone et al. (2007) have a standardised form (between 0 and 1, with 1

being the maximum achievable level of independence), allowing for an easy comparison across the countries and through time, which is essential for our analysis. Please see table VII to observe in detail the policies considered in the construction of the index, both from the original GMT and the conversion for a standardised form by Arnone et. al (2007). Table I presents the values for political, economic, and overall or total independence.

TABLE I. CBI LEVELS AS OF LATE 1980'S AND AT THE END OF 2003

Country	CBI as of late 1980's			CBI as of 2003		
	Political	Economic	Overall	Political	Economic	Overall
Australia	0.38	0.75	0.56	0.25	1	0.63
Canada	0.5	0.88	0.69	0.38	0.88	0.63
Denmark	0.38	0.63	0.5	0.5	1	0.75
Finland	0.4	0	0.22	1	0.88	0.94
France	0.25	0.63	0.44	1	0.88	0.94
Germany	0.75	0.88	0.81	1	0.75	0.88
Greece	0.25	0.25	0.25	1	0.63	0.81
Ireland	0.38	0.5	0.44	1	0.63	0.81
Israel	0.33	0.2	0.27	0.13	0.63	0.38
Italy	0.5	0.13	0.31	1	0.63	0.81
Japan	0.13	0.63	0.38	0.13	0.75	0.44
Korea	0.2	0.2	0.2	0.25	0.88	0.56
Netherlands	0.75	0.5	0.63	1	0.75	0.88
New Zealand	0	0.38	0.19	0.25	0.63	0.44
Norway	0.33	0.2	0.27	0.5	1	0.75
Portugal	0.13	0.25	0.19	1	0.63	0.81
Singapore	0.25	0.25	0.25	0.38	0.38	0.38
Spain	0.25	0.38	0.31	1	0.75	0.88
Sweden	0.25	0.4	0.32	0.88	1	0.94
Switzerland	0.63	0.88	0.75	0.88	1	0.94
UK	0.13	0.63	0.38	0.38	1	0.69

Source: Arnone et al. (2007), p. 45

Most countries improved their levels of independence, only with a few exceptions. Australia, Canada and Israel are the exceptional countries to see their political independence levels lowered, while Germany was the only country which economic independence decreased. Overall independence increased in all countries, with Germany recording the highest initial values of independence and Finland, France, Sweden and Switzerland having 0.94 of overall independence. Moreover, the levels of political independence were set to the maximum level of 1 for the EMU countries.

We assume that all countries begin with the CBI values referred to as "Late 1980s" and there is only one change for the levels of CBI in each country; this means that when the value of CBI is updated (using the values for the end of 2003) for a given country it remains unchanged until the end of 2007. This is similar to the method used by Förche and Sunde (2012). In order to identify the year of change of CBI standards, three main sources were consulted: Arnone et al. (2006a), Acemoglu, Johnson, Querubin and Robinson (2008) and Daunfeldt and de Luna (2003). When there was no identifiable year of central bank reform in terms of independence, we assume that the date of the last amendment of the country's central bank until 2003 holds as the date from which there is a change of the value of CBI. The majority of reforms towards independence took place in the second half of the 1990s, partially due to the European Monetary Union (EMU) members reforms and had to meet the requirements of the final stage to be able to enter the Euro, which notes and coins began its circulation in January 2002. This explains a great increase in the levels of CBI for almost all countries and a convergence to certain levels of independence by the EMU countries. Table VIII (in the appendix), presents the dates when these reforms took place.

3.2. ECONOMETRIC METHODOLOGY

The use of panel data allows a multivariate analysis through time, which is essential to understand the effects of central bank independence on stock market returns of a set of countries. According to Baltagi (2005), panel data allows a better control of the individual (cross-section) heterogeneity, gives better information and is more efficient in dealing with multicollinearity and estimation bias. Plus it often can identify effects that pass undetected with cross-section or time-series analysis by tracing the relationships between dependent and independent variables through time, as also defended by Papadamou, Sidiropoulos, and Spyromitros (2014).

As mentioned before, this paper aims to test if central bank independence has an impact on the developed countries stock markets' returns. We used a similar model to the one developed by Förch and Sunde (2012), including the same independent variables. The focus of our regressions falls on the significance of the CBI variables; however, we will also compare the signal and significance results of the other independent variables and compare with the authors' conclusions. Their empirical strategy appears to lack econometrical tests for stationarity, heteroscedasticity and the suitability of fixed effects for the panel estimation[3] so we try to test the model in our dataset and improve its statistical power. We begin our regressions using a two-way fixed effects approach (i.e. country and year fixed effects), similarly to Förch and Sunde (2012), which will be followed by unit root tests in all variables and suitability tests on

[3] Fixed effects is usually the most used model to test for changes in policy measures and to study its impact. On the other hand, stationarity seems to be neglected in most empirical applications. In this work, we simply widen the econometrical analysis and introduce these concerns and by doing so we try to verify if the results are robust to such tests.

the regression in order to find the best estimation method: panel fixed effects, panel random effects or simple pooled OLS (Ordinary Least Squares). The sets of our regressions are comprised by four equations: (i) using the total measure of CBI as an independent variable; (ii) using the economic level of CBI as an independent variable; (iii) using the political level of CBI as an independent variable; (iv) using both the economic and political levels, separately, as independent variables.

The main equation to estimate is given by:

(1) $$\mathrm{MSCIreturns}_{it} = \alpha + \beta_1 \mathrm{CBI}_{it} + \beta_2 \mathrm{GDPpcg}_{i,t-1} + \beta_3 \mathrm{ToT}_{i,t-1} + \beta_4 \mathrm{Openness}_{i,t-1} +$$

$$+ \beta_5 \mathrm{FDI}_{i,t-1} + \beta_6 \mathrm{IRSpread}_{i,t-1} + \beta_7 \mathrm{Inflation}_{i,t-1} + \varepsilon_{it}$$

Where *i* refers to the developed country and *t* refers to the year between 1988 and 2007 (*t-1* indicates that the variable is lagged by one period, in this case one year).

MSCIreturns is the dependent variable and it refers to the annual stock market returns measured by using the financial index of each country — the returns are from the MSCI indices measured in US dollars; the returns are calculated in two different ways: the first set of estimations uses equation (2) to measure the returns, while the second and third sets follow use equation (3).

(2) $$\mathrm{MSCIr}_t = \frac{\mathrm{MSCIp}_t - \mathrm{MSCIp}_{t-1}}{\mathrm{MSCIp}_{t-1}},$$

(3) $$\log(\mathrm{MSCIp}_t) - \log(\mathrm{MSCIp}_{t-1}) = \Delta\log(\mathrm{MSCIp}_t),$$

where the indices returns *r* are calculated using the arithmetic variation in the indices (yearly closing) prices *p*.

A total of seven independent variables is used to explain the indices returns.

CBI is our major explanatory variable interest and it is used in three dimensions: overall independence (CBItot), political (CBIpol) and economic independence (CBIeco);

GDPpcg is the annual growth of the gross domestic product per capita;

ToT refers to the terms of trade of the country, measured as the capacity to import less total exports in constant local currency prices;

Openness is the trade openness of the country measured as the sum of total exports and imports measured as a share of gross domestic product, also known as trade-to-gdp ratio;

FDI is the foreign direct investment measured as the sum of equity capital, reinvestment of earnings and other capital and data are in current US dollars;

IRSpread is interest rate spread, which equals the average interest rate charged by banks to private sector customers (lending interest rate) minus the interest rate paid by commercial banks for demand, time or savings deposits (deposit interest rate);

Inflation is measured by the consumer price index, as it is rather used than the GDP deflator in empirical studies of CBI.

A second set of estimations will be underdone using equation (3) to compute the stock market returns; moreover, unit root tests are applied to the variables and first differencing is used when needed to deal with the non-stationary problem. As we have an unbalanced panel, the Levin-Lin-Chu cannot be used and the Im-Pesaran-Shin (IPS) and the Fisher p-values combination tests are in order to verify the existence of unit roots.

The IPS test can be applied to an unbalanced panel with fixed N (21 countries) and T (20 years) and its null hypothesis states that each series in the panel contains unit

roots against the alternative that some, but not all, of the individual series have unit roots (Baltagi, 2005). A time trend can be included with the test and it is possible to remove cross section averages in order to mitigate cross section dependence. Its performance is good even for small N and T (Im, Pesaran and Chin, 2003) but only if no serial correlation exists. To attest if this assumption is violated, the Wooldridge serial correlation test (Wooldridge, 2012) is run on the dataset variables. If serial correlation exists, one should run the IPS test using robust statistics. One must keep in mind however that because the statistics provided by the robust test are only valid for large N and T, as the valid statistic is developed asymptotically, we only use them as a general guidance in our estimations[4].

The Fisher tests combine the p-values from unit root tests for each cross-sections. For N fixed, the produced statistic follows a chi-squared distribution. Maddala and Wu (1999) claim that the Fisher and the IPS tests are directly comparable, the first being an exact test and the latter an asymptotic one. To execute the test it is required to indicate the number of lags to be considered, so it can mitigate serial correlation. Similarly to the IPS test, it is also possible to test for unit roots using a trend and intercept and an adjustment for the existence of cross-sectional dependence.

After assuring stationarity, the Hausman test (Hausman, 1978) will be used to compare the coefficients of the fixed and random effects; an equation using random effects is estimated and the null hypothesis states that such equation is not misspecified. If one rejects the null hypothesis, a fixed effects equation should be used

[4] In order to choose the correct number of lags to adjust for serial correlation, the Akaike information criterion (AIC) is used, as it is the best choice for a small sample such as ours. The adjustment was also made using the other two information criteria and the conclusions did not change.

to regress on the dependent variable. If the null is not rejected, we apply a test using the Breusch and Pagan Langragian multiplier, which helps to decide between the use of random effects or a simple ordinary least squares regression. The objective of this point is to verify if there are important changes in the significance levels of the explanatory variables, especially the CBI variables while using the model that, seemingly, better applies to our dataset.

Finally, we run a third set of estimations with robust errors to deal with the presence of heteroscedasticity and serial correlation using a clustering technique suggested by Wooldridge (2012).

4. EMPIRICAL RESULTS

The purpose of our estimates is to assess the impact of the independence of central banks on stock market returns, using three levels of CBI: economic, political and total. 21 developed countries are used in our dataset, in which we use the returns of the MSCI indices quoted in US Dollars as our dependent variable. Table III presents the results of the first set of estimations. The variable representing economic independence appears to present a positive and significant value at the level of 5%, in both regressions where it is used. Overall independence appears to present no level of significance, probably influenced by political independence, which appears in the two regressions where it is used with a negative sign but apparently lacking any significance. Using fixed effects for both country (cross-section) and year (period), the values of R-squared are around 0.5 in all estimated equations. GDP per capita growth presents itself as the strongest variable for this first set of estimations given that it appears to be significant

at the 1% level in all four regressions with a negative value. Its coefficients and standard errors are very stable, which strengthens the power of these results.

TABLE II. SET OF REGRESSIONS 1: TWO-WAY FIXED EFFECTS RESULTS

Dependent Variable:	MSCIr			
	(1)	(2)	(3)	(4)
CBItot	7.46 (9.17)			
CBIeco		16.18 ** (7.86)		22.41 ** (8.70)
CBIpol			−4.42 (7.52)	−13.66 (8.27)
MSCIr (-1)	−0.01 (0.05)	−0.02 (0.05)	−0.01 (0.05)	−0.02 (0.05)
GDPpcg (-1)	−2.43*** 0.57	−2.46 *** (0.56)	−2.35 *** (0.57)	−2.38 *** (0.56)
ToT (-1)	−2.08e-13 (3.24e-13)	−2.67e-13 (3.23e-13)	−1.94e-13 (3.23e-13)	−3.00e-13 (3.23e-13)
Openness (-1)	0.16 (0.13)	0.18 (0.13)	0.18 (0.13)	0.23 * (0.13)
FDI (-1)	−8.39e-11 (9.05e-11)	−6.99e-11 (9.02e-11)	−9.32e-11 (9.03e-11)	−6.97e-11 (8.99e-11)
IRSpread (-1)	0.10 (0.95)	0.08 (0.91)	−0.35 (0.99)	−0.53 (0.98)
Inflation (-1)	−0.18 (0.66)	−0.10 (0.66)	−0.30 (0.66)	−0.19 (0.66)
Constant	22.65 ** (11.50)	16.56 (11.61)	27.41 *** (10.99)	17.21 (11.58)
Country F.E.	Yes	Yes	Yes	Yes
Time F.E.	Yes	Yes	Yes	Yes
Number of countries (N)	21	21	21	21
Number of periods (T)	20	20	20	20
Observations	335	335	335	335
R-squared	0.5157	0.5216	0.5152	0.5261
Standard error of regression	0.2007	0.1995	0.2008	0.1989

Source: Author's calculations using Stata 13.1 statistical package.

The asterisks represent statistical significance at the 10% (*), 5% (**) and 1% (***) levels.

The standard error of each coefficient is presented in brackets.

Regarding the other explanatory variables, only trade openness show a casual level of significance in regression 4. Comparing these first results to those achieved by Förch and Sunde (2012), the returns of the indices for the previous period and the variable for inflation fail to present any level of significance until the 10% margin.

To try and improve the power of previous estimation, we apply unit root tests on every variables, as stationary variables are usually necessary to avoid the spurious regression problem and to be able to infer statistically without distorting the efficiency of the regressions. Table III reports the unit root tests results. For both tests the correct choice of lags allows to mitigate the serial correlation problem and the AIC is used.

TABLE III. UNIT ROOT TESTS: RESULTS

Variables	Im-Pesaran-Shin		Fisher p-values combination
	t-bar	*W-t-bar*	*P*
MSCIr [b]	−4.2212 ***	−13.6943 ***	327.6321 ***
log(MSCIp) [ab]	−2.1347	−1.2888 *	40.9926
CBItot [ab]	−2.1286	−0.1509	35.1392
CBIeco [ab]	−2.1566	−0.5104	34.0365
CBIpol [ab]	−1.9953	0.9060	36.5069
GDPpcg [b]	−2.8847 ***	−7.2819 ***	143.3850 ***
ToT	−0.6926	0.3084	1.5001
Openness [ab]	−1.6892	−0.1846	34.5952
FDI [b]	−2.0304 ***	−2.0254 **	81.6729 ***
IRSpread [ab]	NA	−5.5894 ***	194.8213 ***
Inflation [ab]	−2.7051 ***	−3.8344 ***	77.0586 ***

IPS Test H_0: All panels contain unit roots. H_a: Some panels are stationary.
Fisher p-values Test H_0: All panels contain unit roots. H_a: At least one panel is stationary.
The asterisks symbolise rejection of the null hypothesis at the 10% (*), 5% (**) and 1% (***) levels.
[a] A trend and intercept test was performed.
[b] There appears to exist cross-sectional dependence, so a transformation is underdone in the tests.
Source: Author's calculations using Stata 13.1 statistical package.

Regarding cross-section dependence, the Pesaran test (Pesaran, 2004) is run on the dependent and independent variables. The null hypothesis states the independence between cross-sections and it is only rejected in the Terms of Trade variable. The Wooldridge test, in which the null hypothesis of no serial correlation is tested, is also applied to our variables. The null is always rejected even at a 1% level and even though the test requires a large dataset to be efficient, we use it as a guidance in our panel and we are led to believe that there may exist serial correlation in our variables. In the IPS test the exact number of lags can be directly chosen while performing the test, while in the Fisher tests, all variables except the CBI levels the AIC suggests them to be tested using a range of lags, starting from 0. The reported results for *P* were achieved using 0 lags by default but the significance levels and respective conclusions are robust to every lag tested.

The use of first differences allowed for the rejection at the 1% level of all unit root tests and by so the elimination of time persistence from the non-stationary variables. In the appendix, Table XI shows the unit root tests results for the differentiated variables. All tests lead to clear and objective conclusions except for the variable of FDI. Even though there is a rejection of the null hypothesis in the three tests, this only means that not all panels in the variable have unit roots. Supporting our analysis with the plots and correlogram of this variable, we decided it was more correct to take first differences and assure stationarity. It is noticeable that we have tested for the logarithm of prices instead of the initial variable of returns. In econometric studies, the natural logarithm (log) is widely used with variables that are always positive and usually referred to monetary or population amounts, especially when there exists a lot of variation. Moreover, if the

dependent variable has the form log(y) the estimated model/equation will more often closely satisfy the classical linear model assumptions and it will also reduce the OLS variation and by so minimises the impact of outliers (Wooldridge, 2012). From our set of variables, only the dependent variable (the stock index returns) is suitable for a log transformation, as all others either possess a percentage form or can take negative or zero values or both. Using the log returns diminishes the standard deviation and improves skewness and kurtosis if compared with the arithmetic calculus of the MSCI returns. A usual way of computing stock returns in the logarithmic form is by taking the first difference of the log of prices and this method is used to calculate the dependent variable in our second and third sets of estimations.

We apply the Hausman test in the new estimations to decide between using fixed and/or random effects and, if random effects are in order, the Breusch-Pagan Lagrangian multiplier (LM) is used to decide between random effects and simple OLS estimation. Beginning with an estimation with country and year fixed effects and with country and year random effects, the Hausman test leads us to conclude that with the transformed variables the random effects estimation is more suitable given that the null hypothesis is not rejected. The LM test is thus applied to the random effects estimations and the null hypothesis is not rejected, so the random effects model is not justifiable versus the standard OLS estimation. The results are presented in Table IV.

Given that the estimation is done by a simple OLS regression, the Breusch-Pagan test (Breusch and Pagan, 1979) for heteroscedasticity can be directly used. For this test, a p-value below the considered significance level leads us to reject the null hypothesis of homoscedasticity. Even though for the second set of estimations the null is not

rejected, one must keep in mind that the Breusch-Pagan test can only hold if there is no serial correlation. In the unit root tests on the variables we had already found evidence of serial correlation, so we cannot fully accept these results.

TABLE IV. SET OF REGRESSIONS 2: SIMPLE OLS RESULTS

Dependent Variable:	Δlog(MSCIp)			
	(1)	(2)	(3)	(4)
ΔCBItot	0.33 ** (0.14)			
ΔCBIeco		0.28 ** (0.13)		0.15 (0.18)
ΔCBIpol			0.27 ** (0.12)	0.18 (0.16)
Δlog(MSCIp) (-1)	−0.04 (0.06)	−0.04 (0.06)	0.03 (0.06)	0.04 (0.06)
GDP p.c. (-1)	−0.02 *** (0.006)	−0.02 *** (0.006)	−0.02 *** (0.006)	−0.02 *** (0.006)
ΔToT (-1)	−5.56e-15 (6.13e-15)	−5.38e-13 (6.14e-13)	−5.78e-15 (6.13e-15)	−5.58e-15 (6.14e-15)
ΔOpenness (-1)	−0.0004 (0.003)	−0.0005 (0.003)	−0.0005 (0.003)	−0.0004 (0.003)
ΔFDI (-1)	−6.87e-13 (8.01e-13)	5.45e-11 (8.02e-11)	8.11e-13 (8.07e-13)	7.06e-13 (8.16e-13)
IRSpread (-1)	−0.0002 (0.007)	0.0009 (0.007)	−0.001 (0.007)	−0.0003 (0.007)
Inflation (-1)	−0.0002 (0.005)	−0.009 (0.005)	−0.008 (0.005)	−0.008 (0.005)
Constant	0.14 *** (0.04)	0.13 *** (0.04)	0.14 *** (0.04)	0.14 *** (0.04)
Number of countries (N)	21	21	21	21
Number of periods (T)	20	20	20	20
Observations	316	316	316	316
R-squared	0.0774	0.0741	0.0753	0.0776
Standard error of regression	0.2457	0.2461	0.2460	0.2461

Source: Author's calculations using Stata 13.1 statistical package.

The asterisks represent statistical significance at the 10% (*), 5% (**) and 1% (***) levels.

As a consequence, a third set of regressions is produced in which we account for the presence of serial correlation and heteroscedasticity, following the suggestion of clustering by Wooldridge (2012) in order to make robust estimations. This technique defines each cross section as a cluster of observations over time where serial correlation and changing variances are allowed. Table V summarises the results.

TABLE V. SET OF REGRESSIONS 3: SIMPLE OLS WITH ROBUST ERRORS RESULTS

Dependent Variable:	Δlog(MSCIp)			
	(1)	(2)	(3)	(4)
ΔCBItot	0.33 (0.23)			
ΔCBIeco		0.28 (0.31)		0.15 (0.48)
ΔCBIpol			0.27 (0.17)	0.18 (0.32)
Δlog(MSCIp) (-1)	−0.04 (0.04)	−0.04 (0.04)	0.03 (0.05)	0.04 (0.06)
GDP p.c. (-1)	−0.02 *** (0.006)	−0.02 *** (0.007)	−0.02 *** (0.007)	−0.02 *** (0.007)
ΔToT (-1)	−5.56e-15 ** (2.28e-15)	−5.38e-15 ** (2.48e-15)	−5.78e-15 ** (2.23e-15)	−5.58e-15 * (2.68e-15)
ΔOpenness (-1)	−0.0004 (0.003)	−0.0005 (0.003)	−0.0005 (0.003)	−0.0004 (0.003)
ΔFDI (-1)	−6.87e-13 (5.24e-13)	5.45e-11 (5.43e-13)	8.11e-13 (5.40e-13)	7.06e-13 (6.80e-13)
IRSpread (-1)	−0.0002 (0.006)	0.0009 (0.006)	−0.001 (0.006)	−0.0003 (0.007)
Inflation (-1)	−0.008 (0.005)	−0.009 (0.005)	−0.008 (0.005)	−0.008 (0.005)
Constant	0.14 *** (0.04)	0.13 *** (0.04)	0.14 *** (0.04)	0.14 *** (0.04)
Observations	316	316	316	316
R-squared	0.0774	0.0741	0.0753	0.0776
Standard error of regression	0.2457	0.2461	0.2460	0.2461

Source: Author's calculations using Stata 13.1 statistical package.
The asterisks represent statistical significance at the 10% (*), 5% (**) and 1% (***) levels.

There is clear evidence that the use of an equation with robust standard errors to mitigate serial correlation and heteroscedasticity drops the statistical significance of all levels of CBI. This cannot be mitigated with the use of an OLS pooled regression with a full first-differenced equation. This is due to the fact that the problem of violating the assumptions of serial correlation and heteroscedasticity in linear regression is not related with the unbiasedness of the estimators but with its efficiency. In other words, in the presence of these two factors the estimated regression will appear to be 'better' than it really is. Interestingly however, Terms of Trade presents statistical significance in all four estimations when using robust statistics. By making the regression robust to such behaviour, a predictable impact is the increase of the standard errors for some explanatory variables followed by a change in the t-statistics and respective p-values, which was already discussed. Table VI shows the increase in the standard errors of the CBI variables using the robust statistics in the third set of equations. On the other hand, the variables GDP per capita growth and Terms of Trade appear to be significant at the 1% and 5% levels, respectively.

TABLE VI. COMPARISON OF THE STANDARD ERRORS FOR THE CBI VARIABLES IN SETS 2 AND 3

Dependent Variable:	Δlog(MSCIp)	
	Set of Regressions 2	Set of Regressions 3
First difference of CBItot	0.14091	0.22906
First difference of CBIeco	0.13219	0.30816
First difference of CBIpol	0.12382	0.16610

Source: Author's calculations using Stata 13.1 statistical package.

If we compare with the work in which our model is based, we reinforce the conclusions taken by Förch and Sunde (2012) regarding the CBI levels, even though we use a yearly basis. Our first set of regressions is the most similar to the authors' as are the conclusions, with the economic level of CBI presenting a positive and significant contribute to stock market returns. On the other hand, the strongest result of the three sets performed here is the high level of significance of GDP per capita growth, at the 1% level and with a negative sign. This variable appears to lack significance in all estimations underdone by Förch and Sunde (2012), while Kurihara et al. (2012) regressions using developed countries also verifies a negative sign and some level of significance. Regardless of the sign that the variable for GDP represents in our sets of estimations, the significance found is supported by some literature. Gjerde and Sættem (1999) show that domestic real activity has a delayed impact on the stock market and in our estimations the lagged GDP growth variable seems to have a clear impact on stock returns.

Surprisingly, and contrary to the work of Förch and Sunde (2012), inflation does not show any level of significance in our regressions (this may be related with our annual variables). The same can be said regarding Foreign Direct Investment, for which we cannot find statistical significance nor consistency of signal, as happens with Trade Openness. Terms of Trade and Interest Rate Spread only show a slight significance in some regressions, with no strong conclusion in terms of signal.

The most puzzling conclusion of our set of results is indeed linked with the apparent absence of statistical significance, in the three sets of estimations, of the inflation variable. In fact, it is one of the variables which can be usually linked to the

development of stock returns as early suggested in Fama's seminal study (Fama, 1981) and recently proven, for instance, in the comprehensive study by Flannery and Protopapadakis (2002).

5. CONCLUSIONS AND FINAL REMARKS

The three sets of regressions developed throughout this paper have lead us to take satisfactory conclusions, despite the fact that guaranteeing stationarity and dropping both country and year fixed effects clearly reduced our R-squared values. While a high R-squared is desirable, this paper makes sure that the estimations are not a case of spurious regression. Although in practical applications using panel data testing for stationarity is not a priority, it is uncomfortable to see R-squared values close to 1, as it is the case of the work conducted by Kurihara et al. (2012). If one considers all of the variables that may impact a country financial market performance throughout the year, it is not reasonable to assume that CBI can have a great impact, thus these values are not too discouraging. However, it could be possible to increase R-squared and adjusted R-squared by dropping some of the non-significant explanatory variables (Fama, 1990). We have not proceeded in such a way because it was our desire to follow the original model in the three sets of estimations and doing such a thing could raise issues regarding unbiasedness of sample and variable selection, falsely increasing the explanatory power of the regressions.

In our first set of regressions following a two-way fixed effects panel estimation, where we have no concern with stationarity, suitability of the model, heteroscedasticity and serial correlation, the economic part of CBI appears to have a positive impact on

stock market returns. It is in this set of regressions that the highest R-squared values are achieved — even though the use of one-way fixed effects panel clearly reduces it. In the second set of regressions, in which the variables are stationary and a simple pooled OLS regression appears to be the most adequate candidate, all levels of CBI seem to have a significant and positive impact on stock market returns. However, a more careful analysis seems to indicate that the assumptions for the absence of heteroscedasticity and serial correlation are violated. Thus, a robust by clustering set of estimations is performed and, despite the fact that all CBI levels lose statistical significance, they do not change sign. More importantly, no significant negative impact is achieved by the robust set of regressions. This means that the 'free lunch' theory around central bank independence, i.e. central bank independence is a condition for good inflation behaviour and monetary stability in the long run without harming other aspects of the economy, is not rejected in this study.

Further research on this topic may pass by using a bigger dataset both in terms of countries and time. Dincer and Eichengreen (2014) update the CBI levels for a very large dataset as of 2010 which may allow for the inclusion of a second change in this variable dataset. Moreover, it may be possible to develop a new model that includes other variables known to influence directly stock prices. The major problem of developing such an alternative model is of course the fact that central bank independence is a macroeconomic variable, i.e., it affects the country and not the companies. Being so, common variables like market capitalisation, book-to-market ratio or liquidity are harder to develop in a macro setting than the variables that we use here. Although our GDP per capita variable produced the most consistent results, an Industrial Production variable

may be used instead, as it is often more related with financial indicators. Other works that follow could use an alternative to the variable interest rate spread, as this is a measure which most countries, namely in the EMU, stopped publishing in the beginning of the 2000s and in the case of the US it has never been published. Moreover, testing the relationship between CBI and stock market volatility could bring a new perspective to the free lunch argument, similarly to previous studies that focused on the stability of inflation. Another dependent variable to be considered could be related with the market's expectations, which is frequently as important as the effective stock returns when we are analysing the impact of government and public institutions on financial behaviour.

REFERENCES

Acemoglu, D., Johnson, S., Querubin, P., & Robinson, J. A. (2008). When Does Policy Reform Work? The Case of Central Bank Independence. *NBER Working Papers, Vol. 39, No. 1*, 351-429.

Alesina, A., & Summers, L. H. (1993). Central Bank Independence and Macroeconomic Performance: Some Comparative Evidence. *Journal of Money, Credit and Banking, Vol. 25, No. 2*, 151-162.

Arnone, M., & Romelli, D. (2013). Dynamic central bank independence indices and inflation rate: A new empirical exploration. *Journal of Financial Stability, Vol. 9, No. 3*, 385-398.

Arnone, M., Laurens, B. J., & Segalotto, J.-F. (2006a). Measures of Central Bank Autonomy: Empirical Evidence for OECD, Developing, and Emerging Market Economies. *IMF Working Paper*, 1-38.

Arnone, M., Laurens, B. J., & Segalotto, J.-F. (2006b). The Measurement of Central Bank Autonomy: Survey of Models, Indicators, and Empirical Evidence. *IMF Working Paper*, 1-85.

Arnone, M., Laurens, B. J., Segalotto, J.-F., & Sommer, M. (2007). Central Bank Autonomy: Lessons from Global Trends. *IMF Working Paper - Monetary and Capital Markets Department*.

Bade, R., & Parkin, M. (1988). *Central bank laws and monetary policy.* Ontario: Department of Economics, University of West Ontario.

Baltagi, B. H. (2005). *Econometric Analysis of Panel Data* (3rd ed.). Chichester, West Sussex, England: John Wiley & Sons Ltd.

Berger, H., de Haan, J., & Eijffinger, S. C. (2001). Central Bank Independence: an update of theory and evidence. *Journal of Economic Surveys, Vol. 15, No. 1*, 3-38.

Breusch, T. S., & Pagan, A. R. (1979). A Simple Test for Heteroscedasticity and Random Coefficient Variation. *Econometrica: Journal of the Econometric Society, Vol. 47, No. 5*, 1287-1294.

Campbell, J. Y. (1987). Stock returns and the term structure. *Journal of Financial Economics, Vol. 18, No. 2*, 373-399.

Crowe, C., & Meade, E. E. (2008). Central bank independence and transparency: Evolution and effectiveness. *European Journal of Political Economy, Vol. 24, No. 4*, 763-777.

Cukierman, A. (1992). *Central bank strategy, credibility, and independence: Theory and evidence.* MIT press.

Cukierman, A., Kalaitzidakis, P., Summers, L. H., & Webb, S. B. (1993). Central bank independence, growth, investment, and real rates. *Carnegie-Rochester Conference Series on Public Policy, Vol. 39*, 95-140.

Cukierman, A., Webb, S. B., & Neyapti, B. (1992). Measuring the Independence of Central Banks and Its Effect on Policy Outcomes. *The World Bank Economic Review, Vol. 6, No. 3*, 353-398.

Daunfeldt, S.-O., & Luna, X. d. (2008). Central bank independence and price stability: Evidence from 23 OECD countries. *Oxford Economic Papers, Vol. 60, No. 3*, 410-422.

de Haan, J., & Kooi, W. J. (2000). Does central bank independence really matter?: New evidence for developing countries using a new indicator. *Journal of Banking & Finance, Vol. 24, No. 4*, 643-664.

de Haan, J., Masciandaro, D., & Quintyn, M. (2008). Does central bank independence still matter? *European Journal of Political Economy, Vol. 24, No. 4*, 717-721.

Debelle, G., & Fischer, S. (1994). How independent should a central bank be? *Federal Reserve Bank of San Francisco, Vol. 94, No. 5*, 195-221.

Dincer, N. N., & Eichengreen, B. (2014). Central Bank Transparency and Independence: Updates and New Measures. *International Journal of Central Banking, Vol. 10, No. 1*, 189-253.

European Central Bank. (2015, March). *ECB: ECB, ESCB and the Eurosystem*. Retrieved from ECB - European Central Bank Web site: https://www.ecb.europa.eu/ecb/orga/escb/html/index.en.html

Fama, E. F. (1981). Stock Returns, Real Activity, Inflation, and Money. *The American Economic Review, Vol. 71, No. 4*, 545-565.

Fama, E. F. (1990). Stock Returns, Expected Returns, and Real Activity. *The Journal of Finance, Vol. 45, No. 4*, 1089-1108.

Flannery, M. J., & Protopapadakis, A. A. (2002). Macroeconomic Factors Do Influence Aggregate Stock Returns. *The Review of Financial Studies, Vol. 15, No. 3*, 751-782.

Förch, T., & Sunde, U. (2012). Central bank independence and stock market returns in emerging economies. *Economics Letters, Vol. 115, No. 1*, 77-80.

Gjerde, Ø., & Sættem, F. (1999). Causal relations among stock returns and macroeconomic variables in a small, open economy. *Journal of International Financial Markets, Institutions and Money, Vol. 9, No. 1*, 61-74.

Goodhart, C. A. (2011). The changing role of central banks. *Financial History Review, Vol. 18, No. 2*, 135-154.

Grilli, V., Masciandaro, D., Tabellini, G., Malinvaud, E., & Pagano, M. (1991). Political and Monetary Institutions and Public Financial Policies in the Industrial Countries. *Economic Policy, Vol. 6, No. 13*, 341-392.

Hausman, J. A. (1978). Specification Tests in Econometrics. *Econometrica, Vol. 46, No. 6*, 1251-1271.

Hayo, B., & Hefeker, C. (2001). Do We Really Need Central Bank Independence? A Critical Re-examination. *University of Basel WWZ Working Paper, No. 01/03*.

Im, K. S., Pesaran, M. H., & Shin, Y. (2003). Testing for unit roots in heterogeneous panels. *Journal of Econometrics, Vol. 115, No. 1*, 53-74.

International Monetary Fund. (2010). *San Marino: Financial Sector Assessment Program - Financial System Stability Assessment.* Washington.

International Monetary Fund. (2015). *World Economic Outlook: Uneven Growth - Short and Long Term Factors.* Washington.

Jácome, L., & Vázquez, F. (2005). Any Link Between Legal Central Bank Independence and Inflation? Evidence from Latin America and the Caribbean. *IMF Working Paper*, 1-42.

Kurihara, Y., Morikawa, K., & Takaya, S. (2012). Central Bank's Independence and Stock Prices. *Modern Economy, Vol. 3, No. 6*, 793-797.

Maddala, G. S., & Wu, S. (1999). A comparative study of unit root tests with panel data and a new simple test. *Oxford Bulletin of Economics and Statistics, Vol. 61, No. S1*, 631-652.

Masciandaro, D., Quintyn, M., & Taylor, M. W. (2008). Inside and outside the central bank: Independence and accountability in financial supervision: Trends and determinants. *European Journal of Political Economy, Vol. 24, No. 4*, 833-848.

Neumann, M. J. (1991). Precommitment by Central Bank Independence. *Open Economies Review, Vol. 2, No. 2*, 95-112.

Neyapti, B. (2001). Central bank independence and economic performance in eastern Europe. *Economic Systems, Vol. 25, No. 4*, 381-399.

Papadamou, S., Sidiropoulos, M., & Spyromitros, E. (2014). Does central bank transparency affect stock market volatility? *Journal of International Financial Markets, Institutions & Money, Vol. 31*, 362-377.

Pesaran, M. H. (2004). General Diagnostic Tests for Cross Section Dependence in Panels. *CESifo Working Paper Series No. 1229; IZA Discussion Paper No. 1240*, 1-41.

Rogoff, K. (1985). The Optimal Degree of Commitment to an Intermediate Monetary Target. *The Quarterly Journal of Economics, Vol. 100, No. 4*, 1169-1189.

Siklos, P. L. (2008). No single definition of central bank independence is right for all countries. *European Journal of Political Economy, Vol. 24, No. 4*, 802-816.

Wooldridge, J. M. (2012). *Introductory Econometrics* (5th ed.). Mason: Cengage Learning.

APPENDIX

TABLE VII. VARIABLES UNDER CONSIDERATION AND CONVERSION TO A STANDARDISED SCALE

GMT Variable (1991)	Definition	Conversion to GMT Scale
	POLITICAL INDICATORS	
1) Governor not appointed by government.	Appointed by board of the central bank.	1
	Appointed by a board composed of members of executive branch, parliament, and the board of the central bank.	1
	Appointed by the legislative branch.	1
	Appointed by the executive branch.	0
	Appointed by one or two members of the executive branch.	0
2) Governor appointed for more than 5 years.	Greater than or equal to 8.	1
	Between 8 and 6.	1
	Equal to 5.	0
	Equal to 4.	0
	Less than 4.	0
(3) No mandatory involvement of government in board.	Governor prohibited by law from holding government office.	1
	Prohibited unless authorized by the government.	0
	No prohibitions of law in this matter.	0
(4) Government approval not required in formulating monetary policy.	Central bank alone has this authority.	1
	Authority is shared by government and central bank.	0
	Central bank has advisory role in setting policy.	0
	Only government has this power.	0
(5) Central bank is required to pursue monetary stability as one of its primary objectives.	Price stability sole/main objective; takes precedence if conflict.	1
	Price stability the only objective.	1
	Price stability mentioned together with other objectives that do not conflict with it.	1

(5) cont.	Price stability mentioned together with other objectives that may potentially conflict with it.	1
	Central bank law does not include objectives of this type.	0
	Central bank law identifies objectives but not price stability.	0
(6) Legal protections exist to strengthen the central bank's position in event of conflict with the government.	Central bank has final authority on matters explicitly defined by law as its objectives.	1
	Government has ultimate authority only on policy matters not explicitly defined as objectives of the central bank, or in the event of internal conflict within the central bank.	1
	In case of conflict, the final decision lies with a body comprising members of the central bank, the legislative branch, and the executive branch.	1
	Legislative branch has final authority in policy matters.	1
	Executive branch has final authority in policy matters, but is subject to possible opposition by the central bank.	0
	Executive branch has unconditional final authority.	0
	ECONOMIC INDICATOR	
(1) Direct credit is not automatically extended to the government.	Advance lending to the government is prohibited.	1
	Advances are possible but limited in absolute terms, or subject to other types of similarly restrictive limitations	1
	Advances are possible and subject to more accommodating limitations.	1
	No legal limitations on advances; amount is periodically negotiated between the central bank and the government.	0
(2) Direct credit provided at market interest rates.	Loan is possible only at market rates.	1
	Minimum level applies to interest rate paid by the government.	0
	Ceiling applies to interest rates paid by the government.	0
	No explicit legal provisions on interest applied to loans by the central bank.	0

	Law does not provide for the government to pay interest on loans from the central bank.	0
(3) Direct credit is explicitly temporary.	Limited to six months.	1
	Limited to one year.	1
	Limit of more than one year.	1
	No legal limit on maturity of loan.	0
(4) Direct credit subject to limitations on amount.	Limit on loan amount is prescribed in absolute terms.	1
	Limit on loan amount is prescribed in terms of capital or other liabilities of the central bank.	1
	Limit on loan amount is prescribed in terms of percentage of government's revenues.	1
	Limit on loan amount is prescribed in terms of percentage of government expenses.	1
	No limit (NA).	0
(5) Central bank does not participate in the primary market for public debt securities.	Central bank prohibited from underwriting public debt securities on the primary market.	1
	Central bank may underwrite public debt securities on the primary market.	0

Source: Grilli et. al (1991); Arnone et. al (2007)

TABLE VIII. YEAR OF CBI REFORMS FOR EACH COUNTRY

Country	Year of change	Source	Observations
Australia	1996	Acemogul et al. (2008)	An evolution occurred in the 1990s rather than a CBI reform. Nevertheless, 1996 was the year when a new Statement for the monetary policy was signed and put into a formal agreement many informal measures taken by the Reserve Bank of Australia and the Treasurer.
Canada	2001	Arnone et al. (2006a)	Bank of Canada Act, promulgated in 2001.
Denmark	1998	Acemoglu et al. (2008); Arnone et al. (2006a)	With no clear CBI reform, we consider the last amendment of the National Bank of Denmark Act for the update of the CBI level of the country.
Finland	1997 (1998)	Acemoglu et al. (2008); Arnone et al. (2006a)	The beginning of 1998 brought several reforms in the legislation governing the Bank of Finland. All measures had entered in force by May 1998.
France	1993 (1994)	Acemoglu et al. (2008); Arnone et al. (2006a); Daunfeldt and de Luna (2003)	A major reform in the Banque of France statutes was promulgated by August 1993. It entered in force in January 1994.
Germany	2002	Arnone et al. (2006a)	None
Greece	1994	Acemoglu et al. (2008); Arnone et al. (2006a)	Even though in 1997 there was a new law promulgated for the statutes of the Bank of Greece mainly towards the requirements of the Treaty of the EMU, it was in 1994 that the major reform towards CBI was implemented.
Ireland	1998	Acemogul et al. (2008); Daunfeldt and de Luna (2003)	Change in the statutes of the Bank of Ireland to meet the requirements to participate in Stage Three of EMU.
Israel	2002 (2003)	Arnone et al. (2006a)	With no clear CBI reform, we consider the last amendment of the Bank of Israel Law from December 2002 for the update of the CBI level of the country.
Italy	1993	Acemogul et al. (2008)	The major CBI reform by the Legislative Decree 385 of 1993.
Japan	1997 (1998)	Acemoglu et al. (2008); Arnone et al. (2006a); Daunfeldt and de Luna (2003)	The change in the Bank of Japan Law that entered in force in 1998 was the reform towards independence at the levels of money and currency control.
Korea	1997	Acemogul et al. (2008)	None
Netherlands	1998	Acemoglu et al. (2008); Arnone et al. (2006a); Daunfeldt and de Luna (2003)	None

New Zealand	1989 (1990)	Acemoglu et al. (2008); Arnone et al. (2006a); Daunfeldt and de Luna (2003)	The change in the statutes of the Reserve Bank of New Zealand promulgated in 1989 entered in force in February 1990.
Norway	2003	Acemogul et al. (2008); Daunfeldt and de Luna (2003)	With no reform in terms of CBI nor a clear change in the central bank's legislation, we take the updated values as of 2003 onwards.
Portugal	1998	Acemoglu et al. (2008); Arnone et al. (2006a); Daunfeldt and de Luna (2003)	The Organic Central Bank Law from 1990 made the first improvements towards CBI but we consider the 1998 reforms towards the requirements of the Stage Three of the EMU as the great reform, in par of other EMU members.
Singapore	2003	Acemogul et al. (2008)	With no reform in terms of CBI nor a clear change in the central bank's legislation, we take the updated values as of 2003 onwards.
Spain	1994	Acemoglu et al. (2008); Arnone et al. (2006a); Daunfeldt and de Luna (2003)	None
Sweden	1999	Acemogul et al. (2008); Daunfeldt and de Luna (2003)	None
Switzerland	2000	Arnone et al. (2006a); Daunfeldt and de Luna (2003)	None
UK	1998	Acemoglu et al. (2008); Arnone et al. (2006a); Daunfeldt and de Luna (2003)	None

TABLE IX. UNIT ROOT TESTS: DIFFERENTIATED VARIABLES

Variables	Im-Pesaran-Shin		Fisher p-values combination
	t-bar	*W-t-bar*	*P*
ΔLog(MSCIprices) [b]	−3.9476 ***	−12.6289 ***	281.6298 ***
ΔCBItot [b]	−4.3709 ***	−14.2594 ***	346.6173 ***
ΔCBIeco [b]	−4.3189 ***	−13.9197 ***	338.8423 ***
ΔCBIpol [b]	−4.2968 ***	−13.1157 ***	327.1977 ***
ΔToT [b]	−2.6748 ***	−6.7949 ***	109.0386 ***
ΔOpenness [b]	−3.0497 ***	−8.1718 ***	156.8280 ***
ΔFDI [b]	−5.3748 ***	−15.3982 **	574.8295 ***

IPS Test H_0: All panels contain unit roots. H_a: Some panels are stationary.

Fisher p-values Test H_0: All panels contain unit roots. H_a: At least one panel is stationary.

The asterisks symbolise rejection of the null hypothesis at the 10% (*), 5% (**) and 1% (***) levels.

[a] A trend and intercept test was performed.

[b] There appears to exist cross-sectional dependence, so a transformation is underdone in the tests.

Source: Author's calculations using Stata 13.1 statistical package.