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Central Banks' Gold Holdings and Independence

Master's thesis

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Declaration of Authorship

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Prague, July 31, 2019

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Abstract

In this thesis, we aim to unveil potential relation between gold in the reserves of central banks and the independence of these institutions. As a reaction to several statements of central bank representatives, we assume that gold might be a determinant of central banks' independence. Following these statements, the key contribution of this thesis was defined: to verify these declarations and the general belief of gold's role within central banks' reserves in the relation to their independence, using empirical data. For that purpose, we examine panel data consisting of information from 145 countries between years 1970 and 2012. As for the control variables, economic variables such as GDP per capita, inflation, exchange rate regime, current account to GDP and broad money and political variables from the range of word governance indicators are employed. The regression results of basic model obtained by fixed effects estimation suggest that, indeed, there might be a significant effect of share of gold on the central bank independence index. However, as the results imply negative relation, we cannot confirm if the effect is real due to endogeneity problem. Moreover, the effect of gold reserves on the central bank independence was not confirmed when employing a different estimation technique - generalized method of moments for panel data, neither when including world governance indicators.

JEL Classification	E58, H11, E42, E50, G28
Keywords	central bank, gold reserves, central bank independence

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Abstrakt

Cílem této práce je odhalit potenciální vztah mezi zlatem v rezervách centrálních bank a nezávislostí těchto institucí. V návaznosti na několik prohlášení zástupců centrálních bank předpokládáme, že zlato by mohlo být důležitým faktorem s vlivem na nezávislost centrálních bank. Na základě těchto tvrzení byl definován klíčový přínos této diplomové práce: ověřit na empirických datech tato prohlášení a obecné přesvědčení o významu zlata v rezervách centrálních bank ve vztahu k jejich nezávislosti. Za tímto účelem zkoumáme panelová data, která obsahují informace ze 145 zemí v období mezi lety 1970 a 2012. Přihlížíme také ke kontrolním proměnným, a to k ekonomickým, jako je HDP na obyvatele, inflace, režim politiky měnových kurzů, běžný účet k HDP a peníze v oběhu a také k politickým proměnným ze série celosvětových indikátorů kvality státní správy (WGI). Regresní výsledky základního modelu získané odhadem fixních efektů naznačují, že ve skutečnosti může existovat významný vliv podílu zlata na index nezávislosti centrálních bank. Tento vztah se ale zdá být negativní a proto nemůžeme potvrdit, zda je účinek skutečný kvůli problému endogenity. Dopad zlatých rezerv na nezávislost centrálních bank navíc nebyl potvrzen při zahrnutí celosvětových indikátorů kvality státní správy ani při použití jiných technik modelování dat - zobecněné metody momentů (GMM) pro panelová data.

Klasifikace JEL	E58, H11, E42, E50, G28
Klíčova slova	centrální banka, zlaté rezervy, nezávislost centrální banky
Název práce	Centrální banka, jej zlaté rezervy a nezávislost
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Acronyms

2SLS Two stage least squares

avg average

BK Beck and Katz (refers to Beck & Katz (1995)

BM Broad Money

BP Bade and Parkin (refers to Bade & Parkin (1988)) or Breusch Pagan (refers to Breusch & Pagan (1979))

CB Central bank

CBD Central bank dependence

CBGA Central bank gold agreement

CBI Central bank independence

CBII Central bank independence index

CD Cross-sectional dependence

CEO Chief executive officer

CNW Cukierman, Webb & Neyapti (refers to paper Cukierman *et al.* (1992))

CoC Control of Corruption

CurA Current Account

ERR Exchange rate regime

FDI Foreign direct investment

FE Fixed effects

FED Federal Reserve or US central bank

FOREX Foreign exchange market

GDP Gross domestic product

GLS Generalized least square

GMM Generalized method of moments

GMT Grilli, Masciandaro and Tabellini index (refers to Grilli *et al.* (1991))

GNI Gross national income

gov_debt Government debt

Gov_Eff Government Effectiveness

gvnt government

IFS International financial statistics

IMF International monetary fund

LDV Lagged dependent variable

LSDV Least squares dummy variable model

LVA legal variable aggregated

OECD Organization for Economic Co-operation and Development

OLS Ordinary least square

PCSE Panel-Corrected Standard Error

Pol_Sta Political Stability

RCB Russian central bank

RegQua Regulatory Quality

RoL Rule of Law

SNB Swiss national bank

TCMB Türkiye Cumhuriyet Merkez Bankasi or Central Bank of Turkey

TOR Turnover rate of governors

TSCS Time series cross-sectional data

US United States

VaA Voice and Accountability

WGI World governance indicators

WWI World War I

WWII World War II

Master's Thesis Proposal

Author	Bc. Monika Kamenská
Supervisor	doc. PhDr. Tomáš Havránek, Ph.D.
Proposed topic	Central Banks' Gold Holdings and Independence

Motivation Central banks' main roles could be divided into microeconomic and macroeconomic functions. In the first division, we may include regulation and supervision of banking system, bank of banks and bank of state etc. The second, more important and complex part consists of monetary policy, adjustment of the interest rate, management of the exchange rate, the control of the money supply and money issue etc. Concerning the monetary policy, there is several different directions that the central bank can decide to focus on. The central bank can dedicate effort to a few basic regimes such as a regime with an implicit nominal anchor, money targeting, exchange rate targeting or interest rate targeting.

As a public servant body, modern central banks need to devote monetary policy to price stability and to aim for a low and stable inflation to ensure economic prosperity of the society. However, the implementation of such policies is usually challenging, as the monetary policy is done through transmission mechanisms. In fact, there are several issues complicating the effort of central bank as it's not always easy to predict the exact outcome, the timing or side impacts of its actions. However, it has been proven, that the central bank's tools channelling the monetary policy are more proficient with the higher independence and credibility of that bank. Hence, it is important to recognize the roots, which are affecting this effectivity. The independence of central bank is indispensable in the spirit of the social well-being in the long run, independently of the short term goals of political pressure following the elections cycle. As there is usually a lag between the implementation of the monetary policy and its effect on economy and as there are sometimes trade-offs between long-run consequences and short term welfare (low unemployment), the monetary policy had to be separated from the fiscal policy makers, who are elected in shorter cycles than governor of central banks.

Sometimes ago Banca d'Italia claimed that the gold reserves are key to central

bank's independence. It is obvious, that the role of gold in economy changed drastically when the currencies discontinued to be backed by the gold. However, the gold remains an important part of FOREX reserves in many countries, developed or developing. A lot of central banks stressed out for Bullion Star (Manly, 2018) the gold's function in the event of crisis due to its mobility and universal acceptability in case of emergency. Additionally, as the gold was not issued by a government or other natural or legal person, it is not dependent on any counter-party and thus it is not subject to default, political and credit risk and it is convenient for diversification of risk of reserves. Moreover, another benefits of gold reserves are their high liquidity and that it can be used as a hedge against inflation. Or else, there is also a profit-making potential of gold via gold lending or derivatives, which is enforced by positive price development of gold prices in past decade. On the other hand, nominal return on gold is relatively small and the central banks could raise higher return by investing in money market instruments and if these receipts would be passed to treasury, it could be used for financing public interests (Bernholz, 2002). The other disadvantage of gold is its physical form, which implies the storage and safeguard costs.

The main objective of this thesis will be to clarify the reasons for holding gold reserves by central bank with enhancement of monetary policy efficiency. For that reason, main attention will be placed on investigation if the gold reserves of central banks improve their confidence and independence. For that purpose, I will analyze firstly the relation of gold reserves of central banks in several countries and different indices of independence and secondly, the relation of gold reserves with the confidence. In addition, I will control for this relation in different regimes of monetary policy and in the special events such as crisis, when the global risk is increased.

Hypotheses

Hypothesis #1: The central bank that holds higher gold reserves (or portion of gold reserves in their reserves) is given with the higher responsibility and independence by the state government.

Hypothesis #2: The central bank that holds higher gold reserves (or portion of gold reserves in their reserves) is perceived as more trustworthy.

Hypothesis #3: If the increase of gold reserves helps central banks to preserve their credibility and independence during the time of crisis.

Methodology For the purpose of research, I will use the panel data of gold reserves, credibility and independence index for different central banks, potentially separating them into clusters such as developed or developing countries. While the

gold reserves of a bank is an unequivocal variable, the credibility and independence indexes need to be determined and therefore it is crucial to choose adequate data. For that reason, I will consider and compare different theories to measure of credibility (for example: Svensson (1993), Cukierman & Meltzer (1986), Bomfim & Rudebusch (2000) or Cecchetti & Krause (2002)) and independence (for example: Dincer & Eichengreen (2014), Walsh (1994) or Cukierman, A., Webb S. B. and Neyapti, B. (1992)). I expect to obtain data about the gold reserves from the public data sources such as WorldBank, IMF, European Union Open Data Portal or others. I will review papers dedicated to credibility and independence of central banks (for example: Dincer & Eichengreen (2014) or Ch. Crowe & Ellen E. Meade (2008)) and use their constructed data, if relevant.

Once the credibility and independence indices are beyond a reasonable doubt, I will focus on the main part of the thesis: the models analyzing the independence of central banks' credibility and independence on the government and its gold reserves. In order to determine the effects of the gold reserves on credibility and independence distinctly, I will regress them separately in two models. I will investigate the relation from different angles, and I will not only use the absolute value of the gold reserves as independent variable, but I will consider also the proportion of gold in total reserves held by a central bank. As it was already suggested, credibility and independence indexes will be employed as the dependent variables. Additionally, I am concerned that this relation might be distorted during the time of crisis, thus I will control for this interrupting events and investigate further the relation through that period.

Certainly, it is indisputable that there are several other factors affecting the credibility and independence of central banks. To include them in the model, firstly we have to check of which criteria the chosen indexes are consisting, only then I can add other independent variables into models.

As we are evaluating the panel data, I will choose between pooled OLS, fixed or random effect models. When choosing the best possible model, we have to think about unobserved heterogeneity (if there might be any factor that affects the dependent variable). If so, that factor is correlated with some observed regressor, in that case pooled OLS would be inconsistent, whereas fixed effects model is consistent. To determine the adequate model, I will proceed econometric test such as the Breusch-Pagan test, Hausman test, F test and others. Last but not least, I will check the robustness of the models discovered by exercising standard econometric tests.

Expected Contribution The proclamation of Banca d'Italia suggests that the gold reserves are remaining a significant factor supporting the independence and credibility of central bank thus influencing the monetary policy. Therefore, with this thesis, I seek to confirm or disprove that the gold reserves advocate such important

role in reserves of a modern central bank. I believe that the results of the research will lead me to conclusion for what other reason, than perception as a safe haven asset, central banks might chose to hold gold reserves and approve its role even though it is less profitable when comparing to money market instruments.

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Core bibliography

CHORAFAS, DN 2013, The Changing Role of Central Banks, Palgrave Macmillan, New York. Available from: ProQuest Ebook Central. [13 May 2018].

A. MASLOWSKA, Quest for the Best: How to Measure Central Bank Independence and Show Its Relationship with Inflation. AUCO Czech Economic Review [online]. 2011, 5(2), 132-161 [cit. 2018-07-09]. ISSN 18024696.

J. NUGEE. Foreign Exchange Reserves Management. Handbooks [online]. 2000 [cit. 2018-07-09]. ISSN edsrep.

J. MACKIEWICZ-LYZIAK. Central Bank Credibility: Determinants and Measurement. A Cross-Country Study. Acta Oeconomica [online]. 2016, 66, 125 [cit. 2018-07-09]. DOI: 10.1556/032.2016.66.1.6. ISSN edsrep.

A. CUKIERMAN, A. H. MELTZER. A Theory of Ambiguity, Credibility, and Inflation under Discretion and Asymmetric Information. Econometrica [online]. 1986, 54(5), 1099-1128 [cit. 2018-07-09]. DOI: 10.2307/1912324. ISSN 00129682.

A.CUKIERMAN, S.B. WEBB, B. NEYAPTI. Measuring the Independence of Central Banks and Its Effect on Policy Outcomes. The World Bank Economic Review [online]. 1992, 6(3), 353-398 [cit. 2018-07-09]. ISSN 02586770.

Ch. CROWE, E. E. MEADE. Central bank independence and transparency: evolution and effectiveness. Central bank independence and transparency: evolution and effectiveness / Christopher Crowe and Ellen E. Meade [online]. 2008 [cit. 2018-07-09].

N. DINCER, B. EICHENGREEN. Central Bank Transparency: Causes, Consequences and Updates [article]. Theoretical Inquiries in Law [online]. 2010, 11(1), 75-124 [cit. 2018-07-09]. ISSN 15651509.

N. DINCER, B. EICHENGREEN. Central Bank Transparency and Independence: Updates and New Measures. International Journal of Central Banking [online]. 2014, 10(1), 189-253 [cit. 2018-07-09]. ISSN 18154654.

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Supervisor

Chapter 1

Introduction

In 2013, at London Bullion Market Association's annual conference former Senior Deputy Governor of Banca d'Italia, Salvatore Rossi, denied incentives of Banca d'Italia to sell portion of its gold reserves. He outlined that *"Gold reserves are key to the central bank's independence"* and *"Gold underpins the independence of central banks in their ability to (act) as the ultimate bearer of domestic financial stability"* (Harvey & Denina 2013b). Yet, this presumable relation has not been investigated by scholars on real empirical data. Therefore, this thesis aims to enlighten the effect of gold on the central bank independence.

The central bank fulfils numerous important roles in the economy and social well-being. The functions and the tools of these institutions have evolved in time. In the past, central bankers have wanted to follow several goals. In particular, they sought to support economic growth and employment of the country and, at the same time, they wanted to limit inflation and fluctuations of exchange rate. However, history and academics have proven that such disperse goals are not achievable simultaneously and thus should not be combined. Therefore, there are now many central banks that have abandoned this strategy and have redefined their primary goal: price stability.

In order to obtain price stability, central bankers have to tame and moderate the economy, which might imply a negative impact on the employment and on economic growth. It might be in the interest of policy makers to expand the active population and economic progress at the cost of higher inflation, thus it is necessary to ensure that monetary and the fiscal policies are conceived separately. The independence of central bank is important in order to hold full control over the price stability related policies. Several studies were undertaken on this topic finding a significant link between price stability and the

central bank's independence. It has been proven, that the central bank's tools are more proficient in directing monetary policy when benefiting from higher independence and therefore, central bankers and policy makers should seek to achieve a high level of independence of their central banks. The agency issues should not be omitted and a largely independent central bank should show accountability and transparency in its undertakings.

In the words of former European Central Bank's president Mario Draghi, the independence of the central bank is a key prerequisite for a credible monetary policy (Than & Szakacs 2012). As independence is believed to be crucial in achieving the primary goal, this thesis intends to explore the roots and the impacts on this characteristic of central banks. The main relationship studied concerns the impact of a central bank's gold reserves on its legal independence. Gold is a commodity that is perceived by the general public as a very stable and trustworthy asset, partially also because it is not affected by the political risk of an emitter. Hence, the general public may attribute more efficiency, independence and trust to those central banks, whose assets include a higher share of gold (Leyland 2010).

Not only the statements of central bankers confirming the importance of gold holdings are suggesting the relation of gold and independence. In the past, gold reserves have been in danger on multiple occasions when politicians have attempted to solve a country's lack of resources by violating their central bank's reserves and selling off gold holdings. A recent revival of the central bank's independence crisis in Italy, but also past sales of gold to satisfy governments in Cyprus or France, have evoked an impression that, indeed, higher gold holdings might be associated to a self-ruling central bank.

Nevertheless, the relation between the gold holdings and the independence of a central bank is not clear and unchallengeable. On the contrary, in some situations higher gold holdings may imply higher involvement in political games, as we observed in Russia or Hungary. Especially, in the situation when a country's government is in conflict with a foreign sovereign state and requires that the central bank loses foreign currency holdings and replace it with gold.

What is the relationship between gold holdings in central bank reserves and the independence of these institutions? Is the degree of dependence or independence attributable to gold? We will debate and discuss mainly the answers to the above-mentioned questions in this thesis. However, several limitations to the discussion may throw the findings into confusing.

Firstly, indications used as a proxy for a central bank's independence refer

to legal independence, rather than actual independence, which supposedly impacts the effectiveness of a central bank. In countries, where the rule of law is not sufficiently executed, the difference between legal and actual independence may be substantial. Furthermore, some sovereign states claim that their central bank can claim no actual ownership of the gold it holds. In some constitutional documents of a few central banks, there is a stipulation that the central bank is only the holder and caretaker of gold and that the gold, de facto, belongs to the nation (as in case of France (France 2001)). The measure of CBI is not an unequivocal variable, the CBI indices were computed and proposed by researchers and thus they might suffer from measurement error. Nevertheless, the author believes that any of the highlighted complications can be overcome to certain extent by using large and diverse sample and different variables dependent or independent.

In the Master thesis proposal, we defined three hypothesis that should be tested in this research. However, due to lack of data[1], we were not able to investigate hypothesis 1: the relation of gold reserves and the credibility or trustfulness of central bank. In addition, the independence and credibility are partially interconnected, so we do not believe that additional focus would bring significantly different results. Hypothesis 3 was not covered neither, as during analysis, we discovered other aspects, that we considered important and thus we focused on them.

The remainder of this paper is structured in 6 chapters. In Chapter 2, we describe the rationale behind the thesis, which is mostly the statements and the actions of central bankers. In following Chapter 3 we develop theoretical basis for understanding the independence of central bank, its importance and impact and also we focus additionally on gold. We briefly discuss theoretically methodology of the research and we detail data in next Chapter 4. In Chapter 5 we report and explain the undertaken statistical tests that lead our choice of model and standard errors for the empirical research. We disclose the empirical evidence and we interpret the results of models in subsequent Chapter 6. Finally, we summarize the contribution and the main outcomes in the closing Chapter 7.

[1] We did not obtain sufficiently large data set of central banks credibility indices.

Chapter 2

Motivation

Undeniably, gold ensures several coveted functions within the reserves of central banks. One of the qualities embraced by central bankers is a diversification of reserves and thus a diversification of risk. Some believe it can work as a hedge against inflation thanks to its safe haven asset properties. Others count on gold as it is not channelling any political risk and more advantages of gold holdings are listed in the section 3.4.2.

Some professionals recognize another specific function of gold. According to them, gold might contribute to the credibility of an institution and have an impact on its independence (Harvey & Denina 2013b). Supposedly, gold holdings can promote the independence of central banks.

2.1 Gold as a key to central bank independence

As stated by Salvatore Rossi, director general of the Italian central bank, at the London Bullion Market Association's annual conference, bullion still remains an important part in the reserves of the central bank thanks to its characteristics, but again also due to historical and psychological reasons. According to Rossi *"Gold underpins the independence of central banks in their ability to act as the ultimate bearer of domestic financial stability"* (Harvey & Denina 2013b).

In fact, the view that the gold supports a central bank's independence is a generally accepted opinion. Thanks to gold's long history, physical presence, its reputation and value storage, citizens generally like to see gold holdings in the reserves of a central bank and trust institutions that hold them. Leyland (2010) pointed out that a central bank's holdings have a positive effect on the perception of its credibility. National Bank of Romania indicated that the

higher portion of gold in reserves also raises public's confidence in the country's currency (Manly 2018). The greater soundness of national currency implies more adherence to central bank and hence it supports its independence and autonomy from the government.

Furthermore, we observed in past 5 years that the Deutsche Bundesbank transferred significant part of its gold holdings from New York and Paris to own storage in Frankfurt am Main. These actions were greatly publicized in details and made transparent to ensure that the German citizens are aware of them. Carl-Ludwig Thiele, member of the executive board of the Bundesbank, explained that the purpose of these actions was to increase confidence in this institution among the German public. The Deutsche Bundesbank, an autonomous institution, needs public confidence in order to act efficiently and independently from government. The Deutsche Bundesbank realized the interest of public in their gold reserves, and consequently decided to relocate those reserves in order to maintain and develop a relationship of trust with the general public. He further adds that *"the availability of reserve assets like gold strengthens public confidence in the stability of a central bank's balance sheet"* (Thiele 2017).

2.2 Gold as a political instrument

The recent purchases of gold by Russia and Hungary might be seeking to underline national independence from other nations. Gold in the reserves of central banks is usually considered as a substitute of the foreign exchange reserves, especially the US dollar. In case of political tension with the US, central banks might choose to deliberate their US dollars reserves (Ghosh 2016).

The gold reserves held by certain central banks have started to evolve and are attracting attention, as this part of reserves is considered very stable. Russia is in market spotlight as one of the largest investors in gold in recent times. One could assume that it is a result of geopolitics of the Russian central bank. Following sanctions introduced in 2014, the RCB is replacing its US dollars foreign reserves with gold as well as with recently acquired Euros, Yuan and Yen (Reuters (2018) and Doff & Andrianova (2019)). We could interpret these reserve alterations as a pursuance for independence from the US dollar and thus from political tension resulting from the complicated relationship with the USA. The Central Bank of Russia is not the only one to carry out such releasing actions.

Lately, we also saw the Hungarian central bank buying gold, which came to many as a surprise. However, official statements tried to elucidate the situation by explaining that the purchase was of economic and national strategic importance, supporting its decision with a more historical meaning of gold in Hungary. The aim to protect the nation's wealth and reduce economic risks was not accepted by the market as the sole credible purpose. As expressed by the economist Ash, this decision might be influenced by similar reasons, for example as in case of the Bank of Russia (Hopkins 2018). Due to the Hungarian Prime Minister, V. Orban, and his politics, the diversity of opinions and political pressure from the EU is increasing, which is resulting in a growing fear of sanctions from EU. The purchase might signify an assertion of independence from Brussels.

But the question which arises is, who is seeking separation from foreign or supranational governments? Actually, decisions concerning gold reserve management could be interpreted as political actions of governments. Evidently, such engagement in geopolitics and reserve management related to political tension could represent an influence of sovereign states within their central banks. As pointed out in the article by Hopkins (2018), the recent purchase of bullion by Hungary was triggered by a request from Orban to reassess the gold strategy of the central bank. Presumably, Putin is also involved in the management of the Bank of Russia's reserves, especially when it comes to abandoning US dollar holdings. In November 2018, he defended the decision to let go of US dollar reserves of the central bank of Russia, by claiming that *"We aren't ditching the dollar, the dollar is ditching us. The instability of dollar payments is creating a desire for many global economies to find alternative reserves currencies and create settlement systems independent of the dollar. We're not the only ones doing it, believe me"* (Doff & Andrianova 2019). He is not only supporting investment in other currencies, but also the acquisition of gold.

Moving on to another country, there has been the "Save our Swiss Gold" movement started by politicians of the Swiss People Party that has called for at least 20% of the central bank's assets are held in bullion, further restrictions in the sale of gold and that gold stocks should be stored within Switzerland. Nevertheless, this initiative was not successful, and the attack on the independence of reserves management of the SNB was shielded. According to the SNB, the minimal requirement of gold reserves would harm their ability to maintain an optimal monetary policy (Shotter 2014).

These particular cases demonstrate that higher bullion purchases represent

a higher dependence of central banks on governments and hence greater involvement of governments in the decisions of central banks.

2.3 Gold as a solution to public deficit or other financing needs

Rossi's words gained in value in 2019, when the Italian coalition government, in this case represented by Claudio Borghi, expressed its will to declare ownership of the gold reserves. The already stressed relationship between the Bank of Italy and politicians sharpened even further and many expressed their worries about such a threat to the independence of Banca d'Italia (Totaro 2019). Auxiliary to the interest in gold reserves, the deputy prime minister Matteo Salvini suggested a change in the senior management of the central bank, while the second deputy prime minister Luigi di Maio went even further by demanding the discontinuity of the institution (Economist 2019). Even though Borghi stated that the purpose of his actions was not to initiate the sale of bullion, Matteo Salvini confirmed that the government was considering as such. Supposedly, it could help to fill the missing resources in the country's deficit and prevent the populist government from raising VAT in 2020 (Scherer *et al.* 2019). It would not be the first time the country would use its gold reserves to support its financing. However, in 1974, the gold reserves were not affected as they served as collateral for government bonds.

We have seen a similar act in France in the past when Sarkozy requested the Banque de France to sell one fifth of its gold reserves in 2014. The sale, largely criticized by the public due to the loss made on transactions, took place between 2014 and 2019. Similar to the Italian central bank case, one of the missions of the French central bank is to manage gold reserves and Sarkozy's intervention could be perceived as taking control of the central bank's actions (Vignaud 2012).

In 2013, the attention of the bullion market was drawn to the Central bank of Cyprus. The Central Bank of Cyprus planned to sell approximately 72% of its gold reserves in order to raise €400M for financing the bail-out of the country's banking sector, after the financial crisis. This announcement raised fears that other countries, also drowning in post-crisis debt, would try to implement similar solutions and push their central banks to sell their gold reserves (Harvey & Denina 2013a). However, later that year, a representative

of the central bank denied intentions to sell part of its gold reserves. Such withdrawals of action were justified by officials, who stated that gold reserves were important to safeguard the institution's independence (Reuters 2013).

Italian, French and Cypriot gold are not the only ones alluring the government and other professionals by its market value and potential. The Swiss national bank's balance sheet is too high according to the country's lawmakers as its total assets exceed considerably that of Switzerland's output. They would prefer that the country transforms this reserves into sovereign wealth (Nag *et al.* 2018).

As described above, there is a concrete evidence of the relationship between gold and central banks' independence from sovereignty. As Leyland (2010) stressed, reserve management of gold holdings is a politically sensitive topic and thus implies more involvement from the government. However, it is not clear from any of the circumstances mentioned whether higher gold reserves reflect the independence or the dependence of central banking establishments from government. Therefore, the empirical research undertaken to investigate this relation through available data is carried out in this thesis.

Chapter 3

Theoretical background

In this chapter, the attention is put mainly on the independence, which should explain why is in our interest to understand and to determine what is impacting this attribute, but we will also focus on gold.

Firstly, we analyze why central bank's independence is important and we also present some limits of this trait. Consequently, we advance towards examination of papers studying the determinants of central bank independence. Subsequently, we precise the measurement techniques used to identify the level of independence of central bank. Lastly, the importance of gold within central bank's reserves will be illustrated.

3.1 Independence

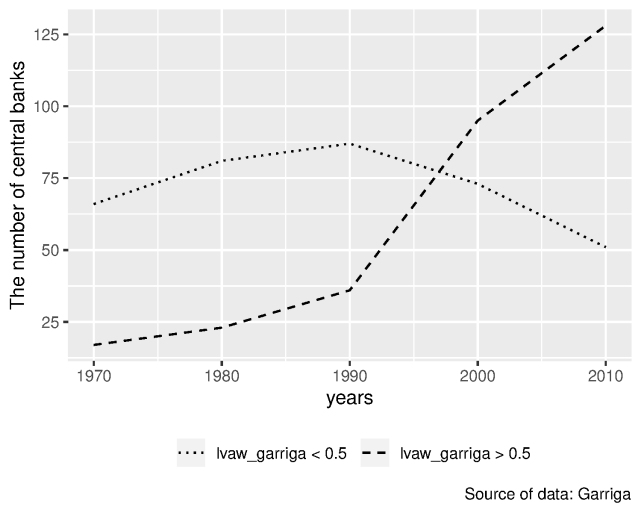
3.1.1 Main driver of independence for central banks

It all started in 1958, when Phillips (1958) published his article *The Relation between Unemployment and the Rate of Change of Money Wage Rates in the United Kingdom, 1861-1957*. This paper paved a path to many influential macroeconomics papers. Samuelson & Solow (1960) and have built further premises, based on Philips' paper, about at this time pertinent relation between economic activity and inflation. Phillip's curve suggested that the increase in inflation implies the increase of GDP and the decrease in unemployment and vice versa. However, the stagflation of 1970s raised questions and the liaison has been examined further by Phelps (1967) and Friedman (1968), who even correctly forecast that both inflation and unemployment would increase in late 1970s. They both argued that workers as the rational economic agents would

only care about their real wages and thus this relation is not stable, and it might work only in short-run.

In long run, the natural rate of unemployment, equilibrium level of unemployment, exists and is independent from the rate of inflation. Thus, the monetary policy could boost the economy, but once the expectations of rational agents are adapted, the alleged stimulus would only translate into inflation, with no impact on the output or employment. The policy of maintaining low inflation by electoral body is thus dynamically inconsistent as the policymakers would always have incentives to undertake expansive monetary policy, once the expectations are formed (Kydland & Prescott 1977; Barro & Gordon 1983). This problem could be addressed in two ways, firstly by mandatory and conclusive rules set for monetary policy, or secondly by delegating it to a separate, optimally conservative and independent institution, as suggested to be the best solution, by Rogoff (1985).

Figure 3.1: The evolution of central bank independence in time



Witnessing the increase in number of more independent central banks, we could conclude that lots of the countries had chosen the latter option. See the evolution of independence of central banks[1] in the graph 3.1. In particular, we observe the boom of CBI between 1990 and 2000, where we could assume that many sovereigns were inspired by the successful implementation of independent central bank in Germany. The Bundesbank achieved, at that time low level of inflation, in average just 3.0%.[2] This consensus, about the liaison between central bank's independence and low inflation, was examined and empirically proven multiple times (among many research see for example

[1]The threshold, defined by author, to be classified as more independent central bank was legal weighted CBI index above 0.5.

[2]In observed period dating 1955 - 1988, the Germany achieved the lowest average inflation from the studied sample, while having the highest average index of central bank independence (Alesina & Summers 1993).

Cukierman *et al.* (1992); Crowe & Meade (2008); Carlstrom & Fuerst (2006) or meta-analysis conducted by Klomp & De Haan (2010)). Alesina & Summers (1993) went even further by arguing that this achievement might not impose any cost to macroeconomic performance. Their findings suggest that central bank independence does not imply reduction in the economic output nor increase in the unemployment and thus the benefits (lower inflation) outweigh costs.

3.1.2 Other arguments in favor of independence of central bank

As the central banks are often not only responsible for monetary policy, but their tasks encompass more functions like for example ensuring financial stability, issuing currency, providing services as bank of banks, etc. These other duties incite also importance of independence of central bank.

Firstly, the independence of central banks might reduce the moral hazard present in the financial sector. Commercial banks on the market would probably count more on the liquidity aid in the time of crisis of dependent bank than independent one. In such case, the moral hazard result in the more excessive risk taking and thus increase in systemic risk and then further into resolutions backed by taxpayer's money, which is undesirable in modern central banking (Haldane & Qvigstad 2016).

Secondly, Garriga (2010) argues that central bank independence can have different implications for developed and developing countries. In her thesis, she defended the reasoning that in countries, where politics and economy are not reliable for foreign investors, central bank independence can be used as a signal of government's commitment to ensure the stability of economic development.

Galhau (2019), governor of the Banque de France, advocated that the success of the currency euro was based on three pillars, and one of them was independence of ECB. He emphasized that *"independence is not for the protection of central bankers; it is for the protection of the citizens, and their collective confidence in the currency."* We recently observed how the lack of independence can affect the management of an exchange rate of domestic currency. Turkish lira weakened by 30% in last year, reflecting capital outflows in response to accelerating inflation, delayed restrictive monetary policy, and increasing debt in private area. The central bank used its foreign reserves to support the lira before election. This action was criticized by the market (for

example rating agency Moody's) and raised question if an independent central bank would undertake such measures (Afanasieva 2019).

Giordano & Tommasino (2011) also pointed out an important factor of independent central banks. According to their research, the countries that decided to delegate the monetary policy to independent central bank have more sustainable debts and the probability of the default on this debt is lower. The underlying reasoning for this result could be that separating money-printing power to independent central bank prevents government's incentives to finance its budget deficit by seigniorage.

Furthermore, the central banks are crucial to preserve the institutional memory, particularly when it comes to cyclicality of financial crisis. Policymakers could underestimate the financial crisis, as its cycle is usually longer than the business cycle. However, according to Haldane & Qvigstad (2016) central bankers, being immune to election cycles, tend to be more rational thanks to their embedded institutional memory of the financial crisis and thus possess better preconditions to deal with the financial cycles.

Moreover, the financial cycle is, indeed, less frequent, but often financial crisis is more detrimental comparing to business crisis. In such case, the policymakers could have more incentives to be more merciful towards failing or bankrupt financial institutions. They could deprive the consistency of financial policies by undertaking safeguarding actions and hence harming the economy in long run. In order to prevent the lobbying power to manipulate the policy makers, the need for independent institution is further enforced (Haldane & Qvigstad 2016).

In addition to economic reasoning, there are also political arguments for central bank independence. De Haan & Eijffinger (2016) conclude that in political systems that are strongly polarized and in coalition governments or federal structures, the government could prefer the independent central bank to make sure that monetary policy is stable and pursued continuously without political and power influence.

3.1.3 Shortcomings of central bank independence

The independence of central bank itself is not determining the path of monetary policy. It is mostly the competency and preferences of central bankers, that are significant. In fact, if central bank had the same preferences as government, it would have act just like elected policy makers. The risk of unsustainable

expansionary policies would not be reduced, and the public would form the expectations of high inflation accordingly. Therefore, the characteristics of a central bank should incorporate conservatism, in other words, inflation aversion[3] (De Haan & Eijffinger 2016).[4] Generally, the central bank conservatism is considered as exogenous aspect and central bankers are considered as technocrats, due to technical abilities and professional aspect required to control monetary policy. However, Adolph (2013) suggests, that conservatism can be considered endogenous as it depends on the preferences and the background of central bankers or preferences of future employees.

Usually, in practice, the independence of central bank is not so straightforward. Firstly, the high legal independence does not imply automatically the high actual independence. The real independence often depends also on the country's rule of law and political system in overall. Furthermore, Franzese (1999) advocates that the impact of the central banks independence on the inflation depends on numerous other factors and on the broader political-economic environment.

As a matter of fact, there are several studies implying that the impact of the central bank independence on the inflation is not simple. Moser (1999) argues that some conditions have to be fulfilled in order to credibly delegate the monetary policy to independent monetary institution. He found out that the delegation is only trustworthy if there are at least two veto players in the legislative procedure. In such an instance, the central banks could proceed with their policies determined without fear to be overturned by politicians.

Notably, Walsh (2007) demonstrated that once we control for a country's average inflation in the previous period, the reform in central bank independence have no impact on the inflation. In his sample, often inflation was tamed prior to the central bank reforms. Therefore, he suggests that the relation between independence of a central bank and the inflation could go in opposite way and the countries with lower inflation tend to grant more independence to their central banks.

The optimal monetary policy should take into account macroeconomic situation in the country, which includes also the government's economic policies. Naturally, we assume that those policies are exogenous to central bank, but as pointed out by Fernández-Albertos (2015) we should probably consider also

[3]The inflation aversion for CB is expected to be higher than for the government.

[4]In fact, Eijffinger & Hoeberichts (1998) showed in other paper *The trade-off between central bank independence and conservatism* that the central bank's independence and conservatism might work as substitutes to some extent.

that central bankers would try to alter fiscal policies according to their own policy preferences. The assumption of the perfect separation of monetary policy from the fiscal policy might come as naïve and de facto we should consider an interaction between fiscal and monetary policy. As revealed in the survey carried out by Moser-Boehm (2006), central bankers and government representatives have regular meetings discussing different topics[5]. Surprisingly, approximately 50% of 24 surveyed banks admitted that the content of the discussion is also the coordination of fiscal and monetary policy.

Furthermore, controversy of independence of these institutions arise from the great power of central bankers. Important decisions impacting severely the world economy are taken by non-elected body. The central bank governors can manage the institution as a business, they are not obeying directly to anyone and they have more money than the state budget at disposal. In 90s, bankers of Wall Street were considered masters of the universe with their enormous power and influence on the economy. Nevertheless, the situation has changed since then. Nowadays, the central bankers are regarded as the rulers of that world (Sentance 2017). A. Sentance, a former member of the Bank of England Monetary Policy Committee, suggests that goals of today's central bankers might have shifted from the commitment to price stability to the sustainability of growth, which should be cared of by politicians. They have great power as we saw when they have significantly decreased interest rates, poured massive volumes of money into economy, rescued banks and experimented with new tools as quantitative easing.

Controversially, some of the reasons specified in previous section 3.1.2 are questionable. As we saw in recent financial crisis of 2008 - 2009, the central bankers acted as safeguards for lots of the systematically important banks in order to preserve financial stability on the market. In fact, the last financial crisis brought shadiness and criticism on central banking and its policies and some even challenged the fundamentals of central banking. The actions in which central banks were engaged, or more precisely those which were never undertaken, caused that the central banking is accused of being responsible for the magnitude of the last financial crisis.

As Fels (2016) argued the involvement by central banks on financial markets, in order to save several financial institutions or weak sovereign, as well as recently frequently seen quantitative easing is having significant distribu-

[5]Such as major developments, information on planned actions and initiatives, crisis management, monetary and fiscal policy

tive consequences. This should be usually the role of fiscal policy and hence executed by politicians. He reminded also that, at the end, central banks are often criticized for these actions, by politicians, who did not act correspondingly to the situation. His rather radical idea suggested that, in situation where developed economies fight more likely with deflation than inflation, the independence of central bank might be redundant. In fact, he is not alone in calling for the end of central bank's independent mandates. Munchau (2016) believes it is only matter of time to see the end of era of independent central banks as their goals, mainly price stability, are no longer relevant. However, we have to keep in mind that it would be difficult to tackle down the inflation again, once it would increase. Debelle (2017), Deputy Governor of the Reserve Bank of Australia, reacted to these implication by claiming that central bank independence is as important today as it was 20 years ago. He further underlined that central bank should have goal dependence and instrument independence. He admitted that one may question the transmission channels of monetary policy but that does not imply redundancy of central bank independence.

3.2 Determinants of central bank independence

This thesis aims to investigate if the gold has any significant influence on the central bank independence. Rather unusual determinant, which relies on the stipulation made by Bank of Italy (Harvey & Denina 2013b), have not been analyzed yet. On the other hand, other determinants of central bank independence attracted attention of several researches.

When it comes to endogeneity of central bank independence, Eijffinger & de Haan (1996) defined 7 main categories of determinants investigated in empirical researches, such as:[6]

1. *the natural or equilibrium rate of unemployment* The higher average employment - motivated inflationary bias implies that inflation shock is more valuable for politicians. It makes people to believe less in monetary policy of government and thus higher CBIs brings higher benefits in form of credibility.

2. *the burden of government debt* The higher the debt of government debt is, the higher are government's incentive to decrease real value of debt by

[6]More detailed description of determinants of central bank independence can be found in the paper of Eijffinger & de Haan (1996) or Cukierman (1992).

unexpected inflation. Therefore, again the public would internalize such expectations and would demand higher interest payments. In order to prevent this higher cost and to secure credible monetary policy, politicians are willing to delegate the monetary policy to independent central bank.

3. *political stability and party system* The less probable is that the politicians would be reelected - the higher the political instability, the more they are likely to dedicate the monetary policy to an independent institution.

4. *supervision over financial sector and its arrangement* The responsibility for the financial sector might shift the interests of a central bank. In order to preserve its reputation and credibility, a central bank might choose to lower the interest rates or increase the money growth to help financial institutions and in some cases those actions can be inappropriate for price stability. Avoiding conflict of interest, between monetary policy and financial section regulation support the independence of central bank in practice. On the other hand, central bank can effectively reduce financial risk by supervising and regulating the payments systems.

5. *financial opposition to inflation* The independent central bank will be effective in maintaining low inflation, only if there is a coalition of interests capable of protecting counter-inflationary actions. In this argument, we consider that financial sector is sufficiently capable to mobilize and to express their anti-inflationary attitude.

6. *public opposition to inflation* We expect that the societies that experienced in the past periods with high inflation or even hyperinflation tend to have stronger opposition to inflation. Therefore, the higher inflation in the past might stimulate the public desire for independent central bank, which would imply a two-way causal relation.

7. *other determinants* as for example veto players in political system, variance the productivity shocks, slope of Philips curve etcetera were examined in the academic papers.

Eijffinger & Schaling (1995) analyze the relation between optimal level of CBI and natural rate of employment (1), the benefits of unanticipated inflation (2), the society's aversion to inflation (3) and variance of productivity shocks (4). They showed theoretically that CBI is higher with higher (1), (2) and with lower (3) and (4).

One of the first studies on the determinant of the central bank's independence was conducted by Cukierman (1992), when he examined if the CBI is dependent on the political environment within the country. He found out that high political party instability leads to higher CBI as politicians are more willing to deprive of the control of monetary policy, when there is more probability that opposition will take it over in next electoral term. At the same time, the higher overall political regime instability induces higher dependence of monetary policy on government. Haan & Hag (1995), Farvaque (2002) and D'Amato *et al.* (2009) measured the same relation but only in the first two papers, authors declared a statistical significance. However, D'Amato *et al.* (2009) showed that the decision of government to delegate monetary policy to an independent institution depend on observability of governmental action among public and also on the openness of the economy.[7] In his paper, Farvaque (2002) argues that the CBI is positively influenced by the average duration of the government's tenure and by the presence of strong checks and balances, negatively by the proportion of senators to senate and house representatives. The dependence of CBI on strong checks and balance, in his paper at least 2 veto players, was firstly investigated by Moser (1999), who find significant positive relation. Posen (1995), on the other hand, defended the idea that in order to maintain independent central bank, country must have sufficiently efficient financial sector with strong anti-inflationary sentiment. Furthermore, several authors investigated the relation between inflation and central bank independence. As explained in the subsection 3.1.1, the central bank independence is supposed to ensure lower inflation. But some researchers pointed out that the relation might be two-way causal. Haan & Hag (1995) suggest that public experience of high inflation of hyperinflation raise anti-inflationary society that put pressure on the government to ensure independent monetary institution. D'Amato *et al.* (2009) confirmed their result later. Recently, Garriga (2010) carried out a different approach and she suggested that in developing countries, CBI can be used as a signal of government's commitment to ensure the stability of economic development. In her research, she confirmed that developing countries with growth problems or/and decreasing FDI will increase CBI in order to attract foreign investors. Other investigated relations, also the ones that have not proven to be significant and hypothesis tested can be found in the table 3.1.

[7]The observability of governmental actions was proxied daily newspaper circulation per capita and the openness were calculated as share of imports on GDP

Table 3.1: Empirical researches about the determinants of CBI

Study	CBI measure	Determinants	Effect	Comments
Cukierman (1992)	LVAW & LVAU	regime political instability index (pir) index party political instability (pip) inflation	-, S in $\wedge$ with pip +, S in $\wedge$ with pir -, S in developed countries	"*In countries with a sufficient degree of internal cohesion, more political instability should be associated with a higher degree of CBI, whereas the reverse should be true in countries with relatively low levels of national concensus.*" hypothesis defined by Cukierman (1992). High inflation entails conditions that make it simpler for government to control monetary policy.
Moser (1999)	LVAU, LVAW, GMTE, GMTP, GMTT, AI	Dummy for no checks and balances Dummy for weak checks and balances Dummy for strong checks and balances	+ and most of the variables S at 1% or 5% level	In OECD countries with extensive checks and balances in their legislative processes, the legal CBI is significantly higher. This paper argues that countries with political systems with checks and balances are better in credibly delegating the chosen policy.
Haan & Hag (1995)	LVAU, SUMLV, GMTT	equilibrium unemployment rate during 1980s gvnt gross debt to GDP	-, NS -, NS	The higher impact of unanticipated inflation on unemployment or gvnt debt, the less credible would be monetary policy performed by politicians, hence more CBI is desired.

		frequency of gvnt changes during 1980s	-, S	The less probable is re-election of a politicians, the more independent CB will be in order to limit the other party's future abilities. Two contrary hypotheses are tested with inflation: (1) as argued by Cukierman (1992) (2) People of countries that experienced high rates of inflation are strongly anti-inflationary oriented and thus prefer independent CB. Countries whose CB has no or little regulatory powers over the financial sector, are strongly against inflation.
		frequency of significant gvnt changes	-, NS	
		avg level of inflation	+, S	
		UB - dummy for universal banking system	+, NS	
		CBO - dummy for level of oversight	-, NS	
Farvaque (2002)	Cukierman's legal CBI	tenure of avg gvnt duration	+ S at 5%	He tested a relationship between Hayo's hypothesis of country's political stability culture and CBI. He confirmed that countries preferring stability use CBI as a binding commitment and thus CBI is thoughtful choice implemented ex-ante by inflation averse societies.
		n° of senate member to total n° of senate and house representatives	- S at 1%	
		strong checks and balances	+S at 1%	
		age of political parties	+ S at 10%	
		proximity	+ S at 10%	
		federalism	+ S at 1%	
Posen (1995)	LVAU	effective financial position composed of 4 dummies: universal banking, banking supervision by CB, federal political structure, diversification of pol party system	+, S at 1% level	Financial sectors with universal banking and without strong CB oversight should express stronger anti-inflationary sentiment. Financial opposition to inflation should be more effective in federal systems of gvnt and in countries with

				less fractionalized party system.
Garriga (2010)	change in LVAW	growth problems FDI decrease growth problems*FDI decrease debt growth problems*debt CBI(t-1) democracy	-, S -, S +, S +, NS -, limited S -,S -, NS	Developing countries with growth problems or/and decreasing FDI will increase CBI to attract foreign investment. Developing countries that are highly indebted and/or with growth problems will increase CBI to obtain loans. Reform of central banks are less probable in developing countries with higher CBI. It is more probable that democratic countries will use CBI as a signal than are autocracies.
D'Amato *et al.* (2009)	LVAW	Share of imports over the GDP Yearly correlation between US/ World real GDP growth and country-specific real GDP growth daily newspaper circulation per capita Change in the GDP deflator	+, S -, NS -, S +, S	With the greater openness of economy, the lower is the inflationary bias for central banker and thus less incentives for gvnt to dedicate monetary policy to independent CB. Gvnt in each country has a strategic incentive to commit monetary policy to try to free-ride on the stabilisation provided abroad. The larger the degree of correlation among shocks, the larger the incentives to commitment (higher CBI). The more CBI is observable, the more incentives the gvnt has to support it. Two inflation related hypothesis as tested by Haan & Hag (1995) were

		real GDP per capita	-, NS	verified. The larger per capita GDP should reduce the inflationary bias and thus the incentives to commit decrease (lower CBI). Higher CBI is expected to be associated with lower gvnt's debt and deficit and with smaller economies.
		GDP	+, NS	
		Total gvnt expenditure as percentage of GDP, Central gcnt deficit as percentage of GDP and M2 over GDP	-, NS	
		Measure of political instability	+, NS	
Romelli (2015)	GMT	lagged CBI	+, highly S	The results confirmed several previous researches, as unemployment and political stability have proven to have positive and significant effect on CBI. Furthermore, the research found high correlation between the actual level of CBI and its lagged value. Euro area members and countries with Anglo-Saxon law seem to enjoy higher CBI. No tests or methods employed were described in the paper, so we cannot judge the consistency and unbiasness of results.
	CWN	unemployment	+, highly S	
	ECBI - own constructed	political stability	+, highly S	
		real gdp cap	-, S	
		currency union	+, highly S	
		common law	-, highly S	
		inflation targeting regime	+, NS	

Note: +: positive effect, -: negative effect; S: significant; NS: non-significant

3.3 Measure of central bank's independence

The independence of central bank is a characteristic, an ambiguous trait that has no exact denomination. However, as described in previous sections, the independence is considered as an important attribute of a central bank with significant impact on monetary policy efficiency and thus several measures were proposed by academics in order to ensure an empirical research.

One of the first attempt to measure the independence of central bank by Bade & Parkin (1988) (BP index) focused on laws that defined the power of the government and/or central bank over the monetary policy and the power of the government over the central bank representatives. This proposal was complemented by 4 countries thanks to Alesina (1988)[8]. Subsequently, Grilli *et al.* (1991) came up with more complex and sophisticated index (GMT index), which divided CBI in two subcategories - political and economic independence. The political independence index studied the process of CB board appointment, the formulation of monetary policy and its actors, and CB's responsibilities towards monetary policy. Economic independence index assesses the availability of credit from CB to government and CB's power over the nature and use of monetary instruments. The final GMT index was the combination (a simple addition) of the economic and political indices. Later Alesina & Summers (1993) combined BP index and GMT index to create an average index used in their research. For further description of the different central bank independence indices refer to Parkin (2013) or Arnone *et al.* (2006)

3.3.1 Cukierman's indices

Although, the indices proposed above are considered as a base for all research conducted in the area of the central bank independence, the most widely employed indices by scholars, and also the one used in this thesis, were proposed by Cukierman (1992), and later developed in Cukierman *et al.* (1992). He was the first one to stress out the difference between the legal (described by the de jure indices) and "actual" (described by the de facto indices) independence. Therefore, a part of his endeavor was devoted to proposing de facto indices. Cukierman (1992) presents three various forms of measures of CBI. Firstly, he builds a new de jure index, and then he proposes different forms of proxies

[8]Alesina (1988) not only added 4 countries but he also used other information, hence some of the values differ from what was proposed by Bade & Parkin (1988)

for de facto indices, specifically the turnover rates of governors and the survey based indicators.

Legal central bank's independence

The part of the variables used in the construction of the legal index is overlapping with the previous studies. The Cukierman's legal index (LVA index) is, for example, also considering the appointment, dismissal and the tenure of the decisive body of central bank, the extent to which the central bank is influencing the monetary policy, the impact of government on central bank, the legal restrictions on borrowings from central bank, the final objectives of CB etc. However, what is praised the most in the LVA index by scholars is clarity and evident organization. All the appraisals are grouped in four classifications: (1) Chief executive officer (2) Policy formulation (3) Final objectives (4) Limitations on lending. Under the group (1), the variables such as tenure of CEO, who is allowed to appoint CEO, what are provisions for dismissal of CEO and restrictions on holding another office by CEO are grouped. In the group (2), the values of variables are based on answers to questions like *Who is responsible for formulation of monetary policy?*, *What are government directives and by who the conflict or unclear policies should be resolved?* and *Can CB actively participate in the formulation of government's budget?*. The group (3) solely focus on one variable - final objectives of central bank. In the last group (4) 8 variables are proposed, that are assessing diverse aspects of borrowings and its limitations, such as form, volume, maturity, rates, control of definition of terms of lending, who can be potentially borrower from CB. In total, Cukierman (1992) defined 16 variables and clear numerical codings for each of them by attaching a value, between 0 and 1, for each possible situation that could occur. Furthermore, he aggregated these 16 measures into 8 by averaging group (1) and four variables of group (4), keeping four variables of group (4) and by calculating a weighted mean of (2). Out of these 8 variables, he proposes a technique of further averages to calculate two different indices: weighted (LVAW) and unweighted (LVAU) legal independence index.[9]

[9]The weights for LVAW or more exhaustive description of methods such concrete lending restrictions variables, numerical codings, the procedure for aggregating the 16 variables into 8 etc. can be found in Cukierman (1992)

Turnover rate of governor of central bank

The legal independence of central bank is a considered as a good measure of CBI, but skeptics might argue that it is only a part of it, representing a base camp. Practice might differ from what is stipulated in the statutory instruments, especially in the countries with weak rule of law. The governor's tenure in Argentina's central bank was legally set to four years, but the actual term of office was much shorter in the 80s. Mainly as a result of the tradition, that the governor offered his resignation when a new government or finance minister was appointed. Apparently, actual relationship of central bank with the government is different from one specified in law and the bank is more dependent on the governing body. Accordingly, Cukierman (1992) proposed the measure based of the turnover rates of governors calculated as an average number of changes per year in a period 1950-89. Initially, the indices were calculated for 58 countries.

Further, the author developed the idea, that the low turnover rate not necessary implies the high independence. But, on the other hand, above some threshold, as per author's proposal between 0.2 and 0.25,[10] the high turnover rate is suspicious and should be considered as an association with higher real dependence on the government. Moreover, the author found out that the average turnover rate (TOR) in the developed countries is below 0.2, thus cannot be treated as good measure of CBI. In less developed countries, the average turnover rate is above the threshold 0.2, thus authors suggest that is a meaningful proxy of independence of central bank. Cukierman *et al.* (1992) and Masĺowska-Jokinen (2008) showed that in emerging countries, the actual independence, measured by TOR, is a good proxy that accurately explains changes in the inflation.

Questionnaire based index

The last proposed measure of central bank's independence was based on the 9 questions answered by qualified individuals. Cukierman (1992) admits that the use of questionnaire is implying subjective opinion of participants, which can lead to further complications in empirical research. Yet, the well informed insiders can be the significant source of information and they can help to enlighten the divergence of legal conventions from actual practice in central banks. The

[10]The threshold between 0.2 and 0.25 represents an average term of office of 4 to 5 years, which is quite common in well developed countries.

questions aimed at the very similar topic as in previous indexes. They could be aggregated in the following groups, firstly the legal form of CBI, then the difference in legal aspects and actual practice and monetary policy, with the focus on the instruments and designator, targets and indicators and final objectives and their relative importance. Similarly, like in the case of LVA index, further weighting aggregation and the two definitive indices, weighted and unweighted version of it, are proposed.[11] Finally, there were presented indices for 24 countries, covering the period 1980 - 1989.

Application of Cukierman's indices

The measurements, designed by Cukierman, were further developed and updated by other authors. Some researchers generated their own indices, usually for the most recent year preceding their research, but they all generally used methods proposed by Cukierman (1992). For example, Crowe & Meade (2008) updated the CNW's data by additional 27 countries and by CBI measures for year 2003. Other researchers also added some extra characteristics as for example Dincer & Eichengreen (2014)[12] or Moser (1999) used in his analysis also an average measure of two CBIIs, proposed by Cukierman *et al.* (1992) and Grilli *et al.* (1991).

In recent period, much wider and longer data set were constructed. Garriga (2016) constructed data set based as well on Cukierman (1992) for 182 countries from 1970 to 2012. The second biggest data set[13] was composed by Bodea & Hicks (2018) including 144 countries covering the years 1972 to 2015. Other smaller and limited data set are available, see Garriga (2016)'s paper where she compared her data set with the most relevant data available.

[11] For specific details such as exact questions, or aggregating methods and weights refer to Cukierman (1992).

[12] Such as measures of limits on the reappointment of the CEO, measures of provisions affecting (re)appointment of other board members similar to those affecting the CEO, restrictions on government representation on the board, and intervention of the government in exchange rate policy formulation

[13] to author's knowledge

3.4 Gold

3.4.1 History of gold standard

The gold enchants humankind for millennia and fascinated even the ancient civilizations. Since the very beginning is perceived as noble and precious metal, a symbol of richness and glory. Its history was always adherent to the money and means of payment. The gold had been used as a mean of payment in form of coins for the first time in the ancient civilization Lydia. However, due to its rarity and high value, it was not used so frequently as money and only served occasionally as a high-denomination currency. Even thought, it was never as suitable for world's trading system as for example silver, gold found its special role in the history of money.

At first, English bankers were issuing notes claiming that the gold was stored in a bank and an owner of gold could use this document as a mean of payment. This system laid the foundation of gold standard that is a monetary system, in which the value of currency is fixed to the gold. At the beginning of 18th century, the United Kingdom adopted a first form of the gold standard (Bie & Pedersen 1999). Other countries used bimetallic regime at that time and France, Germany and the US switched to the gold standard only in 1870s, followed by many other nations. The gold standard was firstly abandoned in 1914 for the World War I. The gold exchange standard was again re-established after WWI by the United Kingdom in 1925. On the other hand, as time revealed, it was not sustainable mainly due to insufficient gold supplies to support the world output growth and due to the confidence issues between countries. The disruption of the economy during the WWI, the issuance of bank notes not backed by gold and the depreciation of the currencies prevented the restoration of functional classical gold monometalism. After the Great Depression, the world monetary system was led to a complete disappearance of the classical gold standard (Paulík 2012).

Bretton Woods System

In order to stabilize the world monetary system after the WWII, the Bretton Woods system was proposed and adopted in 1944. The system was designed mainly by two countries, the United Kingdom and the United States. The British resources were depleted after war and its economy was weakened from the war. On the other hand, the US was considered after war as one of the

strongest players on the world market. Furthermore, the US dollar emerged as a main currency spent in private international trade and replace sterling as a dominant currency in world reserves and thus US dollar played a key function in this system (Bordo 1992). The Bretton Wood system as planned was fully operational only from 1958.[14] The US dollar, that was pegged at the price 35$ per ounce of gold, served as an anchor for other currencies. The central banks of members had to trade US dollars in order to maintain the currency's parity within predetermined 1% margin (Bordo 2018). The US guaranteed that at the determined price, US dollars can be converted into monetary gold by foreign monetary authorities.

On the other hand, the various events and speculators on the market pushed price of gold above 35$ per ounce in 1960 and it led to the fear that monetary authorities would opt for conversion of US dollar to gold. During the following years, the US monetary authorities tried to prevent the countries from such conversion, among other efforts, by controlling gold price with other members through London Gold Pool (Bordo 1992). However, the expansionary fiscal policy, mainly represented by government's exhaustive spending on military and on social programs, accompanied by the negative balance of payments contributed in the confidence crisis in US dollars. Members of the Bretton Wood system, notably France, Netherlands, Belgium or Great Britain, demanded the conversion of US dollars to gold. These actions brought the US gold reserves to significant reduction and in 1971, R. Nixon, the US president, issued an Executive Order by which he stopped outflow of the gold from US Treasury (Bordo 2018). Although it took another 5 years to formally terminate the role of gold, at that point, the gold retired as a mean of payment or as a backing to any currency and the world monetary system became running on fiat currencies (Astrow 2012).

3.4.2 Reasons to hold gold

Even though the gold standard did not withstand to our days, it preserved its popularity among governments and central banks. In the 1980s, gold's share in the world's official reserves still stood at more than 60%, but later declined to approximately 15% (Bie & Pedersen 1999). Nevertheless, in 2017, 17% of available gold in the world was held by the official sector, mainly central banks,

[14] Before the 1958, the world monetary system worked in so called pre-convertibility, but in December 1958 Western European industrial nations established current account convertibility (Bordo 2018).

other monetary institutions and governments in the world (World Gold Council 2017). Several reasons could explain the lasting importance of gold in the reserves of central banks. In 2018, Manly (2018) arranged a survey among central banks and some of the international monetary institutions asking for reasons to hold gold as a reserve asset. The 21[15] respondents have similar views and coinciding arguments. They emphasized gold's liquidity and serviceability in the time of crisis as emergency and safe haven asset and also remarked the diversification of portfolios and mitigation of risks. They did not forget to mention gold's main features such as lack of counter-party risk implying no credit and political risk, limited availability, storage of value and physical attributes as imperishability and durability. Few of them noticed return, as generally gold is not considered as for-profit investment nowadays, but potentially return can be generated from gold lending, swaps or when used as collateral. National Bank of Romania suggested that the gold reserve strengthen the confidence in the stability of financial system in country and its currency.

Apart from the efficiency and usefulness reasons related to gold's attributes, there are also legal requirements, as for example the Swiss Constitution orders the SNB to hold share of the monetary reserves in gold or parliament banned sales of gold reserves for Banque de Liban. Furthermore, central banks of gold producing nations have also different reasons. For example, the South African central bank is expressing the confidence in the metal by holding the share of their reserves in gold and thus supporting the producers and Central Bank of Philippines appreciate that they do not have to rely on external purchases and spend along their foreign exchange reserves when acquiring gold.

Empirical research on factors influencing level of gold in reserves

Green (1999) suggests that the current level of gold in foreign exchange reserves of central banks is heritage from the world economies from 50 years ago. He argues that the limitation that was imposed on monetary gold trading after the fall of Bretton Wood system prevented central banks to undertake transactions that would truly reflect the global economy. Aizenman & Inoue (2012) took a different approach and they analyzed the gold holdings in a relation to global power of countries. Even though, their argument narrows to the same logic as they argue that the global power is situated in the nations that represented an empire in the past or supplied the today's key currency, they do not reject the

[15] out of 42 institutions contacted

idea of active management of gold reserves. Weber (2001) defends the idea that the central banks are operating on the gold market in order to make profits.

Furthermore, Gopalakrishnan & Mohapatra (2018) studied the relation between global risk and central banks gold holdings. They found out that central banks are indeed adjusting their gold holding in response to global risk. Ghosh (2016) also confirmed, in an empirical analysis that central banks reacted to the global financial crisis by increasing their gold holdings. Furthermore, he suggested that they use gold as US dollar and inflation hedge and they also respond to higher exchange rate risk and monetary policy instabilities by expanding their gold reserves.

Central bank gold agreements

The National Bank of Romania is not the only one to believe that the gold reserves imply the confidence in currency. According to Baur (2016), gold is held by central banks within official reserves in order to build a confidence in fiat currency. As he further suggests, the unexpected jump in gold price might trigger the public concerns about the fiat currencies and to signal the troubles of other main foreign reserves components such as US dollar, euro or yen. Furthermore, as the gold is still representing a significant part of foreign exchange reserves, the remarkable decrease of the gold price would harm central bank's balance and wealth. In fact, Weber (2001) argues that gold holdings imply moral hazard for central bankers as they could create profits by inflating the currency. In his paper, he describes how central banks' gold loans, made for profit, supported the expansion of gold mining. Moreover, he suggests that such involvement in financial markets widen the moral hazard, as central banks could build up an interest to save private institutions in order to look after their exposures.

The interest on gold price and gold derivative operations, coupled with the fact the central banks own almost one fifth of gold ever mined and hence possess notable power over the gold price, led to the Central Bank Gold Agreement. The first CBGA, also called Washington Agreement on Gold, was signed in 1999. It was an answer to market's confusion and destabilization from uncoordinated central bank's releases of gold reserves, resulting in gold price decrease. By their signature, participants committed to limit the sales of gold to 400 tonnes per year and to keep stable or lower level of leasings and use of gold derivatives over the five-year period. They claimed that gold would persist an

important element of global monetary reserves (World Gold Council 2019). As announced in the first agreement, it was reviewed and resigned several times through years. Some central banks decided not to sign it anymore and some points were eliminated. Therefore, the current version, signed in 2014 by approximately 20 banks, is not stating the exact ceiling for gold sales. The signing institutions obliged them, in order to avoid market disruptions, to continue to coordinate their gold transactions, to preserve gold as an important component of monetary reserves and emphasized that they have no intentions to liberate outstanding amounts of gold to market (European Central Bank 2014). Some of the other central banks that are not participating in this agreement expressed their will to limit their gold sales, for the same reasoning, to make market and gold price more stable.

Such agreement implies the limitation in movement of gold holdings in central banks and complicates the sales and purchases corresponding to market or political events. Therefore, it is necessary to include, in the analysis comprising gold holdings, sufficiently long period data, incorporating the period before 1999 and sufficient number of countries.

Chapter 4

Data

4.1 Empirical research background

4.1.1 Panel data formulation

In our empiric research, we examine panel data. These data are typical in comparative political economy. In case of our data, the units are non-sampled and they are rather fixed (as number of countries in the world is limited) and thus consistently asymptotics are in T. Panel data, as per definition, are repeated observations on a cross-section of individuals over time and the basic multiple regression for panel data can be considered as follows:

$$y_{i,t} = \alpha + \beta X_{i,t}^{'} + z_i^{'} + u_{i,t} \tag{4.1}$$

where

$y_{i,t}$ is dependent variable, in this research indexes of central bank's independence

α is an intercept, the presence of an intercept depends on the estimation applied, in our case fixed effects estimation is employed and intercept is specific for each country

β is the vector of parameters (with the same length as the vector $X_{i,t}^{'}$)

$X_{i,t}^{'}$ is the vector of independent variables, fundamental studied explanatory variable is gold holdings of central banks, but other control variables will be employed

$z_i^{'}$ represent time-invariant individual effects

$u_{i,t}$ is the disturbance term or idiosyncratic error term

When examining panel data, we are interested in the heterogeneity across individuals i or time t also called individual effects and time effects, respectively. One of the most crucial questions, when it goes to modelling panel data, is if the individual effect $z_i^{'}$ is observed or unobserved. Observed specific effects are rarely the case, but in such situation simple OLS model could be used. In this thesis, we deal with unobserved individual effects, which imply further assumptions.

4.1.2 Panel data assumptions

To get the estimates of parameters efficient, consistent and unbiased certain assumptions must be fulfilled. As it will be further introduced in following chapters, several models can produce intended estimates. Each model requires specific assumptions, however some of them are needed commonly.

1. *Linearity in parameters*
   The model (4.1) should be linear in all parameters and also in the individual effect and disturbance term.

2. *Full rank & Time variance*
   Observations should represent a random sample from cross section, so the explanatory variables are independent across cross section, however we can allow for dependency across the time. Also, we need explanatory variables that vary over time.[1]

3. *Strict exogeneity*
   In the cross section data, the exogeneity, which is the state when the correlation between explanatory variables $X_{i,t}^{'}$ and disturbance term $u_{i,t}$ is not existing, is required. In panel data environment, the assumption must be enriched in the way that the disturbance term $u_{i,t}$ is also non-correlated with the individual specific term $z_i^{'}$.

$$E[u_{i,t}|X_{i,t}^{'}, z_i^{'}] = 0 \tag{4.2}$$

[1]The last one does not hold for Random Effects Model

As the heterogeneity across individuals can violate this assumption, a check for endogeneity is necessary.

Under these three assumptions above the estimates of coefficients coming from the pooled OLS, Fixed and Random effects model should be unbiased and consistent (Wooldridge 2012).

4.1.3 Panel data models

Usually, for modeling of panel data we can use models such as Pooled OLS, Fixed or Random effects model and also dynamic panel models, in case of endogeneity, such as 2SLS or generalized method of moments. To choose between the models, usually several tests must be applied, which will be presented later in this thesis. We will use for modeling fixed effects model, alternatively GMM.

Modelling unobserved effects

The unobserved effects can be addressed by the Pooled OLS, only if they are constant. If they are not constant but still unobserved, the Fixed and Random effects could be of use. The key factor differentiating two models is the correlation of the unobserved effects with the other variables. In case there is no correlation (i.e. $E[z_i^{'}\alpha|X_{i,t}^{'}] = 0$), Random effects model would be convenient. In the situation when unobserved effects are correlated with the other variables included (i.e. $E[z_i^{'}\alpha|X_{i,t}^{'}] \neq 0$) the random effects model would not be efficient, hence the fixed effects model would be more appropriate.

Fixed effects model

In this thesis, the relation between central bank's independence and their gold reserves will be mostly estimated by fixed effects model. In this estimation method the model (4.1) is considered, but firstly, for each i, the average over time is calculated, to obtain the following equation:

$$y_i = \alpha z_i^{'} + \beta X_i^{'} + u_i \tag{4.3}$$

As individual effects $z_i^{'}$ are fixed over time, they do not change, when we average the data over time.
Subsequently, we will subtract the (4.3) from (4.1) in order to obtain time-demeaned data and thus the unobserved effect $\alpha z_i^{'}$ will disappear from the

resulting equation:

$$y_{i,t} - y_i = \beta(X_{i,t}^{'} - X_i^{'}) + u_{i,t} - u_i \tag{4.4}$$

This transformation is usually called fixed effects or within transformation, because it calculates the deviations within the individuals. Finally, the last step consists of running OLS on the transformed data. The other way to estimate the fixed effects could be least squares dummy variable model (LSDV), but due to many individuals, we would have to estimate a large number of extra parameters. LSDV model, in such case, suffers from a loss of degrees of freedom and the coefficients of individual effects would not be consistent, this is also called incidental parameter problem (Baltagi 2008). One might realize that in such transformation, we lose information on time-invariant variables. In this study, we do not consider any time-invariant variables, so this loss does not affect the intended model.

4.2 Panel data description

Descriptive statistics and the sources of data used for modeling are disclosed in the table (4.1) or discussed in the following sections. The information was obtained from several sources, so the names of countries and other obstructions were checked and adjusted manually. The data gathered were chosen by author's intuition and supervisor's suggestions and confirmations, usual conventions, availability and conformable literature as described in the chapter 3.2. The preliminary analysis of variables used was undertaken by checking correlation between couples of variables (see Table B.1).

4.2.1 Dependent variable

In the thesis, our attention will be mainly put on the central bank's independence. As the variable is not exact and numerically measurable, we exploited relevant literature for proposed indices (see 3.3). Based on literature review and availability of data, we are using two indexes proposed by Cukierman (1992), constructed and updated by Garriga (2016) for de jure central banks' independence index (here-in-after *CBII*) and the rate of turnover of governors (here-in-after *TOR*), which was calculated by author, based on Dreher *et al.* (2010) data set.

Table 4.1: Data description

Statistic	N	Mean	St. Dev.	Min	Max	Source
Central bank's independence measures						
creation	6,764	0.01	0.10	0	1	Garriga (2016)
reform	6,764	0.06	0.23	0	1	Garriga (2016)
direction	6,753	0.03	0.22	−1.00	1.00	Garriga (2016)
increase	6,753	0.04	0.20	0.00	1.00	Garriga (2016)
decrease	6,753	0.01	0.09	0.00	1.00	Garriga (2016)
regional	6,764	0.14	0.34	0	1	Garriga (2016)
lvau_garriga	5,866	0.50	0.20	0.02	0.97	Garriga (2016)
lvaw_garriga	5,866	0.49	0.20	0.02	0.98	Garriga (2016)
cuk_ceo	5,866	0.55	0.20	0.00	1.00	Garriga (2016)
cuk_obj	5,835	0.51	0.26	0.00	1.00	Garriga (2016)
cuk_pol	5,866	0.45	0.33	0.00	1.00	Garriga (2016)
cuk_limlen	5,846	0.47	0.26	0.00	1.00	Garriga (2016)
time in office	7,350	−92.74	295.50	−999.00	29.00	Dreher *et al.* (2010)
TOR	6,637	0.52	0.37	0.03	0.17	own calculation
Central banks' reserves						
Reserves - gold	5,003	17,840.40	109,615.70	0.00	3,331,120.00	IMF (2018)
Gold	5,358	3,229.33	16,053.49	0.00	433,434.50	IMF (2018)
Total reserves	5,003	21,293.01	113,654.90	0.00	3,387,293.00	IMF (2018)
Share of gold	5,002	0.17	0.22	0.00	0.96	Own calculation
Economy indicators						
logGDP	4,993	23.75	2.22	17.42	30.41	World Bank Data (2018)
logGDP_growth	4,119	1.41	0.88	−6.20	5.01	World Bank Data (2018)
logGDPcap	4,990	7.78	1.62	4.05	11.66	World Bank Data (2018)
CurA_to_GDP	3,919	−2.37	9.6	−240.52	56.71	World Bank Data (2018)
ERR	5,358	7.43	4.41	0	15	Ilzetzki *et al.* (2017)
inflation	4,438	27.5	255.18	−17.64	11,749.64	World Bank Data (2018)
BM_to_GDP	4,127	44.86	33.03	2.82	242.13	World Bank Data (2018)
imports	10,606	38.008	25.802	0.000	427.58	World Bank Data (2018)
gov_debt	7,290	48.801	46.766	0.024	677.180	Mbaye *et al.* (2018)
kaopen	7,100	−0.001	1.53	−1.91	2.36	Chinn & Ito (2006)
ka_open	7,100	0.44	0.36	0.00	1.00	Chinn & Ito (2006)
Quality of institutions						
VaA	3,936	−0.000	0.998	−2.313	1.801	Kraay (2010)
RoL	3,961	0.000	0.998	−2.606	2.100	Kraay (2010)
CoC	3,903	−0.000	0.998	−1.869	2.470	Kraay (2010)
Pol_Sta	3,901	−0.000	0.998	−3.315	1.965	Kraay (2010)
Gov_Eff	3,888	0.0001	0.998	−2.478	2.437	Kraay (2010)
RegQua	3,889	0.000	0.998	−2.645	2.261	Kraay (2010)

De jure central banks' independence index

Garriga (2016) is updating regularly the CBII, so the latest data available are covering 182 countries for the period from 1970 through 2012, which is making it the largest data set on central bank independence available. The data set includes also other information such as when the bank was created or when reforms affecting central bank were established and how they affected their independence, indicated by dummy 0 or 1 in concerned year. Furthermore, the CBII is composed of four categories *Chief executive officer, Policy formulation, Objectives* and *Limitations on lending to the government*, and all of them are stated explicitly, as well as their final aggregated index created by weighted (here-in-after LVAW) or equal average (here-in-after LVAU).

The turnover rate of governors

As proved by Cukierman *et al.* (1992) and Masĺowska-Jokinen (2008), the turnover rate of governors is a significant regressor, when estimating central bank's independence influence on the inflation of a country in the sample of emerging countries. Therefore, we will further divide our data sample into low and high income countries and we will use TOR as the dependent variable for estimating the model. Dreher *et al.* (2010) provided us with time in office of governors for 161 central banks for years between 1970 and 2017. The turnover rate of governors was further calculated as follows:[2]

$$TOR = \frac{1}{\text{time in office}} \tag{4.5}$$

where time in office is a number of years of a current CEO of central bank in function.

Moreover, as in the original data set several dummy variables were introduced (e.g.: -999 for year when central bank did not exist), we had to exclude such observations from our data sample. From such transformation, it is evident that the TOR will also reach limited values between 0 and 1. Values close to 0 represent higher independence, especially the threshold of 0.25 is indicating the actual independence as usually, the term of office of central bank's CEO is four or five years. For years when the new governor was appointed (time in office is 0), the TOR was set to 1, as the new governor has not proven yet her independence.

[2]The method is simplified compared with the Cukierman (1992).

4.2.2 Reserves and gold holdings of central banks

It was already unveiled that, the gold in central bank's possession will be the key studied explanatory variable. To obtain necessary information, we firstly retrieved gold reserves[3] from International Financial Statistics (IFS) of International Monetary Fund (2018). We obtained unbalanced annual data for 264 countries from 1957 to 2016. As inspired by the official reports published by World Gold Council (2018), the gold data in fine troy were priced by Gold Fixing Price 3:00 P.M. (London time) retrieved from ICE Benchmark Administration Limited (2018) and then added to reserves without gold[4] retrieved from the same source as gold holdings in order to obtain total reserves of central banks' in U.S. dollars. However, as price of gold is only available from 1968, the length of data set squeezed. Finally, the share of gold holdings per year and country was calculated as priced gold divided by total reserves. With adjustment to proportional quantity, we partially eliminated the effect of changes in prices and thus we can focus on real change in gold holdings.

4.2.3 Economic performance and wealth

Furthermore, we include some control variables into the model in order to to better understand the relation between gold holdings of central banks and their independence.

As the described in the section 3.2, the relation of the inflation and CBI can have a two-way effect and therefore we include it in the model.

We have a reason to believe that the countries with higher wealth and better economic performance would have more independent central bank (also tested by D'Amato *et al.* (2009) and Romelli (2015), suggested by Cukierman *et al.* (1992)). We can measure country's richness by its GDP level and its performance by its growth, economic development by GDP per capita. All of these were published by World Bank Data (2018) and they are all unbalanced panel data containing 264 countries from 1960 to 2017. Romelli (2015), who employed real GDP per capita in his research, found out that the countries with smaller GDP per capita usually enjoy higher independence of central banks. We decided to include only GDP per capita as control variable in our model, as the correlation matrix B.1 revealed, log GDP and log GDP per capita are

[3]International Reserves, Official Reserves Assets, Gold (Including gold deposits etc), Volume in Millions of Fine Troy Ounces

[4]International Liquidity, Total Reserves excluding Gold, US Dollars

strongly correlated, on top of that both are correlated also with other control variables, and they are not related intensively to CBI. But we still include GDP per capita, as it was used in previous researches too.

4.2.4 Other economic indicators

One of the suggested determinants of central bank's independence is economy's openness. We could consider several measures to proxy country's economic openness, in D'Amato *et al.* (2009)'s paper the import per GDP was used and we decided, due to availability of data, to use Current Account to GDP, which includes imports and other items of international trade and transactions. The current account is also considered as a proxy for country's competitiveness and country's economic health. It consists of the trade balance (the difference between the total value of exports of goods and services and the total value of imports of goods and services), the net factor income (difference between the return on investments generated by citizens abroad and payments made to foreign investors domestically) and net cash transfers, where all these elements are measured in the domestic currency.

In the study Garriga (2016) the Chinn-Ito index was employed as control a variable in relation to CBI. A Chinn-Ito index by Chinn & Ito (2006) is considered as a de jure measure of capital openness of a country. The capital account per year is indicating the net change of property of assets within a country. However, introducing Chinn-Ito index in our models as control variable affected heavily the standard errors of several other variables. Therefore, we suspected strong endogeneity and we decided to report the models only in Appendix B.3.1.

We employ in the model control variable ERR[5] that was constructed by Ilzetzki *et al.* (2017) as a proxy for exchange rate regime in the country. The index was designed for 194 countries and territories over 1946-2016. ERR can reach values from 1 to 15, where the smaller values refer to peg, mid-values to crawling peg and the higher values to free floating. The exact coding for each level can be found in the Appendix B.1. The dummy for exchange rate regimes was also used in other studies, as for example in Garriga (2016).

The measure of broad money, or so-called money supply, has multiple definition as its interpretation varies from country to country. However, the World Bank Data (2018), which is our source, defined it as "*the sum of currency out-*

[5]Garriga (2010) controlled for pegged exchange rate in her paper.

side banks; demand deposits other than those of the central government; the time, savings, and foreign currency deposits of resident sectors other than the central government; bank and traveler's checks; and other securities such as certificates of deposit and commercial paper". It can be considered as assets that are available to households and companies for all the payments and to hold as liquid investments such. Central banks follow the evolution of broad money as it can help them approximate the future inflation.

4.2.5 Quality of institutions

We have a reason to believe that the central bank's independence level is not only influenced by the functional characteristics related to the central bank itself, but also the overall quality of institutions and administration in countries.

Therefore, we will add several variables into model to account for such issues, all built by Kraay (2010), who prepared the World governance indicators including six composite components. We will not include all of them into model, but those at disposition: Voice and Accountability, Political Stability and Absence of Violence/Terrorism, Government Effectiveness, Regulatory Quality, Rule of Law, and Control of Corruption. These indexes are formulated opinions of experts, enterprises and citizens from several surveys of institutes, think tanks, non-governmental and international organizations or private sector companies. The indicators were constructed for years 1996, 1998 and then from 2000 to 2017 and for more than 200 countries. Possible values of the measures are from -2.5 (rarely even lower) which is the lowest quality possible up to 2.5 representing the highest quality of governance. Also, the percentile rank among other countries, standard error (variability of estimate) or lower and upper bound of 90% confidence intervals are enclosed.

4.2.6 Low and High income countries

The data set will be further divided into two subsamples - low and high income countries due to Cukierman (1992)'s suggestion that the relevancy of measure of CBI might differ in two types of countries. To do so, we constructed the dummy variable specifying the group the country belongs to for each year. The classification was obtained from World Bank Data (2018), where four categories are defined for current year (each year threshold is different) by the amount of their GNI per capita using the World Bank Atlas method in 2017:

- *low-income economies* have GNI per capita below $995
- *lower middle-income economies* are those with a GNI per capita between $996 and $3,895
- *upper middle-income economies* are those with a GNI per capita between $3,896 and $12,055
- *high-income economies'* GNI per capita is above $12,056

We joint the two lower and two higher categories to preserve only two classes, hence the low income countries are those with the GNI per capita below $3895, and the high income countries are those above specified threshold[6]. Even though the TOR variable was tested on emerging markets, the author believes that the differentiation between low and high income countries is appropriate option to model the similar relation as it is a good proxy.

[6]Please note that the threshold specified is different for each year, but always the one differentiating the lower and upper middle economies.

Chapter 5

Methodology

5.1 Tests

As the data prepared for the empirical research are unbalanced wide and long panel data, several issues might occur. In order to present the reliable results, we need to choose the correct methodology and ensure that estimators of coefficients are unbiased and consistent, as well as the estimators of the variances. For that purpose, several tests are employed to help us to decide which methods are suitable, and what needs to be controlled for.

5.1.1 Pooled OLS vs Fixed effects

Firstly, we need to check if there are individual effects present within the countries in the panel data. If there are no specific effects attributable to countries, there is no need to treat panel data specially and we could only use model pooled OLS, which would be consistent and efficient if all countries are sufficiently homogeneous. In that case the $z_i^{'}$ from the (4.1) would be a constant term.

To test if the pooled OLS offers consistent and unbiased estimators, the usual procedure is to compare the pooled OLS with two other most popular estimation models for panel data - fixed effects and random effects.

In panel data environment, we can used F tests of effects that compare the within and the pooling model, which is programmed in package plm, developed by Croissant & Millo (2008).

As per the tests (see 5.1), we reject the null hypothesis of no fixed effects. We consider that pooled OLS would not be adequate to provide us with the

Table 5.1: F test for twoways effects based on the comparison of the within and the pooling model

	df1	df2	statistic	p.value	alternative
Model 1	156	2595	45.338	0	significant effects
Model 2	156	2595	53.250	0	significant effects
Model 3	124	1219	37.300	0	significant effects
Model 4	124	1219	41.806	0	significant effects

consistent and efficient estimates and the fixed effects estimation would be preferable method in this case.

5.1.2 Time & individual fixed effects

In this subsection, we want to test the specific effects and to determine their nature. We will further investigate the form of effects, which can be individual effects, studied further in research and/or the time effects.

There are several forms of tests proposed by computational packages. The most commonly used might seem to be the Breusch Pagan (BP) test proposed by Breusch & Pagan (1979). The test assumes $H_0 : \sigma_\mu^2 = \sigma_\lambda^2 = 0$ (where σ_μ^2 is variation of individual effects and σ_λ^2 is variation of time effects). We can also test only the presence of the individual effects or only the presence of time effects. However Baltagi (2008) criticizes it for its performance when σ_μ^2 and σ_λ^2 are close to zero. Therefore *uniformly most powerful test* by Honda (1985) are performed concurrently[1]. Baltagi (2008) suggests that both BP and Honda tests perform appropriately when σ_μ^2 is large, even though the power of tests is weakened by augmented σ_λ^2. We have reason to believe that σ_μ^2 is sufficiently large, when it goes to data from for the sample of countries from all around the world.

Table 5.2 shows that, the null hypothesis considering zero variance in fixed effects is rejected in all the cases in favour of the alternative hypothesis: significant effects. Therefore, we need to take into account both the individual effects and the time-fixed effects, hence two-ways effects. The evidence of heterogeneity across time and among individuals is considered significant.

This test also serves to compare pooled OLS and random effects model. According to this test we should reject the null hypothesis and thus conclude

[1]Please note that t statistics of time & individual effects of Honda tests are only root of BP's statistics. In our case, the test does not bring any additional information.

Table 5.2: Lagrange Multiplier Test: Breusch-Pagan for time, individual & two-ways fixed effects for unbalanced panels

	statistic	p.value	parameter	method
	1741.44	0	1	time effects
Model 1	13553.028	0	1	individual effects
	15294.468	0	2	two-ways effects
	1724.523	0	1	time effects
Model 2	15677.623	0	1	individual effects
	17402.146	0	2	two-ways effects
	28.843	0.0000001	1	time effects
Model 3	4139.132	0	1	individual effects
	4167.975	0	2	two-ways effects
	24.455	0.000001	1	time effects
Model 4	4382.497	0	1	individual effects
	4406.952	0	2	two-ways effects

again that pooled OLS is not appropriate, and out of these two options random effects estimator would be better.

Two-way model

As per findings in (5.1.2), we will further develop the error component $u_{i,t}$ from our model. If we would discover that our model contains only the unobservable individual effect, we would further consider in our analysis a one-way error component model for the disturbances, such as:

$$u_{i,t} = \mu_i + \nu_{i,t} \tag{5.1}$$

However, as in our model both effects are present, we have to acknowledge the two-way error component, which is further necessary when computing tests (i.g. Hausman's specification test) in form but also for estimators:

$$u_{i,t} = \mu_i + \lambda_t + \nu_{i,t} \tag{5.2}$$

5.1.3 Random or fixed effects model

In order to choose between the two mostly used variable coefficients models Random effects model and Fixed effects model, we have to define if the z_i is

observed and correlated with $X'_{i,t}$, as described in (4.1.3). If the individual effects z_i are not correlated with $X'_{i,t}$, the individual constant terms may be treated as randomly distributed across the individuals. In opposite case, the random effects model would provide inconsistent and biased estimator $\hat{\beta}_{GLS}$. Hence we should consider fixed effects model as during the within transformation are individual effects left out and the within estimator $\hat{\beta}_{Within}$ is unbiased and consistent.

Hausman's specification test

For the purpose of choice of the correct model, the Hausman's specification test should be run (Hausman 1978). Hausman proposed a test that is evaluating the difference between $\hat{\beta}_{GLS}$ and $\hat{\beta}_{Within}$. Under H_0, the difference is equal to zero, both estimators are consistent but only $\hat{\beta}_{GLS}$ is asymptotically efficient and thus better estimator. Under alternative hypothesis $\hat{\beta}_{Within}$ remains consistent, but not $\hat{\beta}_{GLS}$. Furthermore, as per findings (5.1.2), we will have to examine Hausman's test for the two-ways model. We employed auxiliary-regression-based version as it could be robustified by specifying a robust covariance estimator, as used (see the Chapter 6) and explained later in this thesis (see the section 5.2)

Table 5.3: Auxiliary-regression-based Hausman test

	statistic	p.value	parameter	alternative
Model 1	14.688	0.0228	6	one model is inconsistent
Model 2	15.587	0.0162	6	one model is inconsistent
Model 3	32.351	0.001	12	one model is inconsistent
Model 4	33.005	0.001	12	one model is inconsistent

The Hausman's test revealed that the random effects estimator would be biased and not consistent. Even though the significance level varies lightly, the fixed effects estimators is preferred in all 4 models.

5.1.4 Testing for heteroskedasticity

Homoskedasticity is the state in which the variance of the error $u_{i,t}$ is always constant unconditionally on the explanatory variables, i.e. $Var(u_{i,t}|X'_{i,t}) = \sigma^2\mathbb{I}$. In panel data particularly, this assumption might be too restrictive as cross-sectional units may be more likely to demonstrate different variance. If the

disturbances are not homoskedastic, but heteroskedastic, the model will still offer consistent and unbiased estimates of coefficients. Nonetheless, we should be aware of heteroskedasticity because estimators of $Var(\hat{\beta})$ would be biased, the confidence intervals and validity of t-statistic, F-statistic and other statistics would be affected and also the estimates of coefficients could no longer be efficient. This problem was addressed by White (1980)[2] as he developed a heteroskedasticity-robust standard error for $\hat{\beta}$.

To test for the presence of heteroskedasticity in the panel data, the Breusch-Pagan test is applicable.

Table 5.4: Breusch-Pagan test against heteroskedasticity

	statistic	p.value	parameter
Model 1	125.356	$1.22 * 10^{-24}$	6
Model 2	66.867	$1.79 * 10^{-12}$	6
Model 3	80.471	$3.36 * 10^{-12}$	6
Model 4	100.525	$4.39 * 10^{-16}$	6

We see that the p-value is lower than any traditional threshold, thus the null hypothesis of homoskedasticity is rejected and we need to take heteroskedasticity into account. In such case, we have to adjust standard errors for heteroskedasticity in order to correct the statistical inference. How to modify the standard error to make them robust will be discussed later in this chapter (in section (5.2)), to jointly cover also autocorrelation and cross-sectional dependence.

5.1.5 Testing for endogeneity

The assumption of strict endogeneity is crucial in order to obtain unbiased estimators (see 4.1.2). In such cases, when independent variables are associated with errors, we do not have only direct effect of endogenous variables on dependent variable in the model, but also second one, undesirable, through ϵ. Estimate of parameter, which represents the first effect, would not be consistent and biased. Even with modern econometric, it is still complicated to check for the endogeneity as such bias is not observable and thus we cannot directly test if an endogenous variable is correlated with the error term. Endogeneity

[2]Sometimes, this solution is also attributed to Eicker and/or Huber

cover the issues such as omitted variables or selection bias, simultaneity, measurements errors and is often a problem of social researches. As for example, the dependent variable CBII is based on the coding decided by people who gather information so can easily suffer from measurement errors, as well as other variables or as availability of the variables was limited and additionally the panel data are unbalanced and missing periods might actually result from self-selection and thus the selection bias could be present in the data. We also could suspect omitted variable bias. We could suffer from endogeneity in our main studied relation: between gold and central bank independence. Less independent central banks could decide to increase their gold holding in order to become more autonomous, or they can be forced by their government.

As explained above it is reasonable to assume that endogeneity is present in the models and we need to take care of it in order to obtain correct inferences and conclusions about the relation between gold in reserves of central bank and the independence of this institution. For endogeneity issues we could use instrumental variables models or generalized method of moments. Ullah *et al.* (2018) suggest that for panel data, the GMM method is more convenient.

Generalized method of moments

GMM is popular estimation method in the scope of finance and economics as it relaxes several assumptions, that we have to made in order to use other methods of estimations. This general framework, that encompass roughly all common estimators[3] was developed by Hansen (1982).

In our case, GMM is especially useful because we have to deal with dynamic panel data, as the dependent variable (CBI) is very slowly evolving measure and we have to consider also dynamic endogeneity. It is comprehensible as the government is not changing law defying the role and the competence of central bank on yearly basis. Therefore, we can expect that the level of central bank independence strongly depends on its own lagged values from past years. Garriga (2010) suggests that the central banks that enjoy already high levels of independence are less likely to be reformed by their governments and thus the expected coefficient of LDV is negative. Including lagged dependent variable helps to cope with this endogenous relationship and GMM is able to provide us with the consistent results in presence of dynamic endogeneity.

[3]OLS - Ordinary least square, MLE - Maximum Likelihood Estimation or 2SLS is just a special case of the weighting matrix in GMM

GMM estimators can be obtained in two ways, one-step GMM that refers to first-difference transformation or two-step GMM known as second-order transformation (Ullah *et al.* 2018). In this paper, we will use two-step GMM as the one-step GMM can leave out many observations and Arellano & Bover (1995) recommend to use two-step GMM.

5.1.6 Testing for cross sectional dependence

Large macroeconomic panel data, similar to the one we are studying in this thesis, tend to contain different kinds of cross-sectional and temporal dependencies, i.e. correlation of regression disturbances over time and between individuals, which can cause that statistical inference and tests are biased. If we want to obtain valid standard errors, we need to adjust them for these dependencies. To test for cross-sectional dependencies, we can use Pasaran CD tests of dependence where under H_0 residuals across individuals are not correlated. The test results are verified by Breusch-Pagan LM test in Appendix C.

Table 5.5: Pesaran CD test for cross-sectional dependence in panels

	statistic	p.value	alternative
Model 1	28.116	$6.21 * 10^{-174}$	cross-sectional dependence
Model 2	32.329	$2.71 * 10^{-229}$	cross-sectional dependence
Model 3	23.577	$6.65 * 10^{-123}$	cross-sectional dependence
Model 4	24.276	$3.55 * 10^{-120}$	cross-sectional dependence

As we reject the null hypothesis of no cross-sectional dependence in all models, we have to take it into account in estimations. In order to obtain reliable statistical inference, we have to adjust the standard errors to make them robust against cross-sectional dependence. The modification of standard errors will be discussed later in this chapter (in section (5.2)), to jointly cover also serial correlation and heteroskedasticity.

5.1.7 Testing for serial correlation

One of the assumptions imposed in order to get efficient estimates of the regression coefficients and unbiased standard errors is that error terms across time series are not correlated. In the examined panel data, there is low probability

that this assumption would hold, as the independence of central banks is evolving slowly in time and thus is related to the state of previous years. Therefore, we have to test for the serial correlation. As represented in the table below 5.6, we employed the Breusch-Godfrey/Wooldridge test for serial correlation in panel models to find out that the serial correlation is present in the model and we can resolve the issue with two possible approaches. Firstly, to introduce efficiency, we could alter the standard errors to make them robust or we engage dynamic regression model by introducing lagged dependent variable (Kelly & Keele 2004).

Table 5.6: Breusch-Godfrey/Wooldridge test for serial correlation in panel models

	statistic	p.value	parameter	alternative
1	1794.533	0	2	serial correlation in idiosyncratic errors
2	1834.690	0	2	serial correlation in idiosyncratic errors
3	400.391	$4.53 * 10^{-89}$	1	serial correlation in idiosyncratic errors
4	447.954	$2.01 * 10^{-99}$	1	serial correlation in idiosyncratic errors

From results in the table 5.6, we can conclude that the serial correlation is present in our panel models. We will deal with it using the robust standard errors, but also we will employ the dynamic panel data model method - generalized method of moment as robustness check.

5.1.8 Testing for unit roots

We have to test if unit roots are present in our panel data as regression based on non-stationarity data can lead to biased results. It such case, we would have a spurious regression, i.e. a supposed relationship between variables that are, in reality, not related. In order to test unit roots in our data, we have to check each variable separately. As our panel data are unbalanced and comprise information from 145 countries and 43 years, possibilities to test the unit roots in panel data are limited and we used different software - Stata 13 to test for unit roots in our data. Furthermore, as we detected serial correlation and heteroskedasticity, we employed Fisher-type unit-root test based on Phillips-Perron tests. Under H_0 all panels in the data contains unit roots and under alternative hypothesis at least one panel is stationary. The details of the test results can be found in Appendix C.2.

We reject the null hypothesis of non-stationary for all the explanatory variables, except for log GDP per capita. Furthermore, we also fail to reject the null hypothesis of our dependent variables - we tested both form of CBII and all of 4 components.

Kao (1999) suggests that the estimations of coefficients of non-stationary variables remain consistent in panel data. He argues that we should be concerned about the standard errors as they might be biased in case of non-stationary data. Furthermore, as argued by Beck & Katz (2011), the testing for unit roots in political economy TSCS datasets is not always consistent, as they described how even if the autoregressive coefficient is close to 1, the series are not I(1) on two examples: budget spent on social security and Christian Democratic cabinet participation. They further criticise that there are not many tools to estimate models with I(1) in case of political TSCS datasets. However, they suggest the series to be modelled by the EC specification, that "*combines short-run first-differences with the long-run tendency for series to be in equilibrium*" (Beck & Katz 2011). In our case we develop our analysis by modelling the series with generalized method of moments and twoways effect, when the model is estimated in first differences.

5.2 Robust standard errors

As already mentioned in previous subsections (such as 5.1.6 and 5.1.4), the test prevailed the heteroskedasticity, cross-sectional dependence and serial correlation. These violations of assumptions that cause that the estimates are not efficient, can be addressed by robust standard errors. As serial correlation (temporal dependence) can be solved by lagged variable, we need to control mainly for the heteroskedasticity and cross sectional dependence. The asymptotic variance of an estimate of classical linear regression model is defined as:

$$Var[\hat{\beta}|X] = (X'X)^{-1}X'(\sigma^2\Omega)X(X'X)^{-1} \tag{5.3}$$

We usually impose the assumptions on the models mentioned above that implies that $\Omega = I$, and in such case the $Var[\hat{\beta}|X] = \sigma^2(X'X)^{-1}$. However, in cases where $\Omega = I$ does not hold, different definition of standard errors is necessary. Robust standard errors are ubiquitous topic and therefore several solutions were offered by the academics. Due to autocorrelation present in our data sample, the very popular White heteroscedasticity consistent estimator would

not be useful. As in our data sample N > T, we consider using panel corrected standard errors developed by Beck & Katz (1995) (here-in-after $PCSE_{BK}$). The other reason considered, when deciding the robust standard errors was also the fact that $PCSE_{BK}$ were developed for time series cross sections data. Typically used is social science, they are defined as repeated observations over time on some set of units, such as for example countries, which is exactly the dataset we are working with in this thesis. We can expect that $PCSE_{BK}$ count in the correlation at same time point across units (word factors affecting all markets) and also correlation at different time points across units (contagion effects over time). In case, of heteroskedastic and contemporaneously correlated errors, the Ω is a $NT \times NT$ block diagonal matrix such that:

$$\hat{\Omega} = \hat{\Sigma} \otimes I_T \tag{5.4}$$

To obtain the estimate of Ω, we need to estimate Σ. The $\hat{\Sigma}_{i,j}$ would be comprised of

$$\hat{\Sigma}_{i,j} = \frac{\Sigma_{t=1}^{T_{i,j}} e_{i,t} e_{j,t}}{T_{i,j}}$$

where $e_{i,t}$ is the OLS residual for unit i at the time t. In this case, the estimate of coefficients remains unchanged, while the variation of coefficient become $Var[\hat{\beta}|X] = (X'X)^{-1}X'(\sigma^2\hat{\Omega})X(X'X)^{-1}$, with the $\hat{\Omega}$ as defined in 5.4

Chapter 6

The econometric analysis

In this chapter, we proceed to the main part of the thesis, the econometric analysis. As already stated before, we will deploy several models for estimating coefficients in panel data and we will start by fixed effects model, within transformation. Firstly we start with the baseline model (Table 6.1), then we further analyze the relation by diving the data into two data sets for different periods (Table 6.2) or into data sets for high and low income countries (Table 6.3). Additionally, we estimate the model on distinct components of central bank's independence indices (Table 6.5). We also verify the results using different estimation technique - generalized method of moments for panel data (Section 6.6).

6.1 Empirical model

The baseline equation takes the following form:

$$LVAW_{i,t} = \lambda_t + \beta Shareofgold_{i,t} + \delta X_{i,t} + \varepsilon_{i,t} \tag{6.1}$$

where $LVAW_{i,t}$ is the central bank's independence weighted index (also measured by $LVAU_{i,t}$ - its unweighted form) in country i and year t. λ_t is a country-specific intercept (fixed effect). *Share of gold* is the portion of gold in total reserves of a central bank in country i at the year t. $X_{i,t}$ represents a vector of economic and financial variables for country i at the year t, including logarithm of GDP per capita, Current account scaled by GDP, Exchange rate regime indicator, Inflation and Broad money. $\varepsilon_{i,t}$ is error term. We also estimate other models specified in the Appendix D.

6.2 Estimation results

The fundamental model can be found in the table 6.1 in the first column. The main studied variable *Share of gold in total reserves* is statistically significant at 5% level. However, it has negative coefficient and the sign does not change through analysis. Even if statistical significance decrease in different models, it remains negative.[1] If the ratio of gold in total reserves increases across time and between countries by 1 percentage point, the independence of central bank is expected to decrease by -0.104, which is relatively considerable impact as the measure goes from 0 to 1.

It is an interesting finding opposing the main idea tested in this thesis that the gold is the key to central bank's independence as suggested by Salvatore Rossi, the director general of the Italian central bank. The research indicates that the relation might go in opposite direction and the larger share of gold in total reserves is linked to less independent central bank. The possible explanation might be that the management of gold within reserves is partially representing also political decision, as we saw in case of Russia or Hungary. However, we must also consider potential endogeneity issue. Less independent banks might have incentives to hold higher portion of gold reserves, in order to increase their independence from government. As described in 2, gold strengthens the trust of public in central bank's actions and thus it might lead to more autonomy from government for central bank. Hence central banks, who realize this relation might desire to carry more gold when they strive for independence. As a result, the relation of CBI and gold reserves might be negative.

We note that the explanatory power of the model is very low but other included control variables, such as log GDP per capita, Inflation and Broad money are statistically significant at common thresholds (at least 5%). GDP per capita has opposite sign as declared in previous studies of Romelli (2015) and D'Amato *et al.* (2009) where coefficients were negative. However, this result might imply that more developed countries enjoy more independent central bank. The negative and statistically significant coefficient of inflation is very small, if the inflation increases by 1 percentage point across time and countries, the independence of central bank is expected to decrease by -0.00002. The result suggests that countries with higher inflation experience lower central bank independence.

In order to introduce form of a robustness check, we can test two types

[1] With a few exceptions

of dependent variables - LVAU and LVAW, unweighted and weighted index.[2] Cukierman (1992) proposed two estimates and he reported mainly models using LVAW. Some authors used also LVAU in their research, so it can be considered as an applicable measure. We observe that gold has larger effect on unweighted version of CBII (also higher statistical significance in several models). According to the results from the Table 6.1, the variable share of gold has statistically higher significant effect as the probability of the phenomenon being random is less than 1%. Along with higher significance, if the ratio of gold in total reserves increases by 1 percentage point, the independence of central bank measured by LVAU is expected to decrease more in comparison with LVAW, i.e. by -0.145. Therefore, we can suspect that the share of gold in total reserves is associated with the elements on which higher weight is put in the LVAU. As the distinct components are available in data set provided by Garriga (2010), the relation between each component of LVAU/LVAW and gold can be investigated on independent basis (Table 6.5).

On the other hand, it is visible from the table 6.1 that including WGI is having impact on the size of the effect and statistical significance of main studied explanatory variable and all control variables. This issue might be more complex as we do not know if it is the effect of introducing new variables and thus the consequence from omitted variable bias in the baseline model, or the fact that including WGI is limiting the data from 1996 to 2012.[3] The issue is verified further in this research by dividing the data set into two periods (Table 6.2). Even if the p-value is not small enough to reject the hypothesis of no significant effects of share of gold on CBI and the coefficient is in comparison to model in column (1) smaller, it remains negative. The effect of log of GDP per capita on LVAW and LVAU is no longer statistically significant and the significance of effect of inflation is minor. The estimate of coefficient of broad money is stable through all the models and remains statistically significant at 5%. It indicates that countries with higher amount of money in a national economy, profit from more CBI. As for WGI, only control variable Pol_Sta is statistically significant at 5%. The coefficient is negative in conformity with expectations. As described by Eijffinger & de Haan (1996) the countries with higher political instability have more incentives to devote the monetary policy to non-elected independent institution.

[2]There is only slight difference between them: LVAU is a simple average of 4 main categories, while LVAW is aggregating 4 categories using pre-determined weights.

[3]Number of observations decreased from 2 758 to 1 356.

Table 6.1: Estimation results of baseline models using fixed effects method

	Dependent variable:			
	LVAW	LVAU	LVAW	LVAU
	(1)	(2)	(3)	(4)
% of gold	-0.104^{**}	-0.145^{***}	-0.036	-0.059
	(0.052)	(0.050)	(0.071)	(0.063)
log GDP cap	0.053^{***}	0.040^{**}	0.028	0.020
	(0.020)	(0.018)	(0.022)	(0.021)
CurA to GDP	0.0001	0.0001	0.001	0.001
	(0.0004)	(0.0004)	(0.001)	(0.001)
ERR	-0.003	-0.001	-0.001	-0.001
	(0.002)	(0.002)	(0.002)	(0.002)
inflation	-0.00002^{**}	-0.00001^{**}	-0.001^{*}	-0.0005
	(0.00001)	(0.00001)	(0.0004)	(0.0004)
broad money	0.001^{**}	0.001	0.001^{**}	0.001^{**}
	(0.0004)	(0.0004)	(0.0005)	(0.0004)
VaA			0.030	0.022
			(0.024)	(0.022)
RoL			0.016	-0.013
			(0.033)	(0.031)
CoC			0.023	0.032
			(0.027)	(0.025)
Pol_Sta			-0.031^{**}	-0.032^{**}
			(0.014)	(0.013)
Gov_Eff			-0.00002	-0.00002
			(0.00001)	(0.00001)
RegQua			0.040	0.033
			(0.025)	(0.023)
Observations	2,758	2,758	1,356	1,356
R^2	0.064	0.061	0.062	0.054
Adjusted R^2	0.006	0.002	-0.043	-0.052
F Statistic	29.747^{***}	28.031^{***}	6.718^{***}	5.786^{***}
	(df = 6; 2595)	(df = 6; 2595)	(df = 12; 1219)	(df = 12; 1219)

Notes:
[1] The table reports linear models for panel data carried out using the "plm" package in R Studio (Croissant & Millo 2008). The model within (fixed effects estimation) and two ways effects were used for estimation. The panel corrected robust standard errors ($PCSE_{BK}$) of Beck & Katz (1995) disclosed in brackets are clustered for groups (145 countries), weighted by HC0 scheme, that is suitable for large samples and calculated with the method arellano, that allows for heteroskedasticity and serial correlation.
[2] *, **, *** indicates significance at 10 percent ($p < 0.10$), 5 percent ($p < 0.05$) and 1 percent ($p < 0.01$), respectively.

6.3 Evolution of CBI in time

As noted in the previous section 6.2, when we include WGI into model, the data set is shrunk as WGI only date back to 1996 (up to 2012). As consequence, the main studied variable share of gold in the total reserves loses statistical significance. As the longer data set suggest higher statistical importance of the relation of gold reserves to CBII, we could assume that the relation was more prevailing in olden years than in more recent period.

In order to test this hypothesis and to investigate if the relation of gold and CBI evolved in time, the data set has been sub-sampled into two periods with similar length. In the table 6.2, first two columns (1) and (2) are referring to the recent period from 1992 - 2012 and the column (3) and (4) referring to the earlier period from 1970-1991.

Surprisingly, when dividing the data set into two period, the relation seems to be more relevant in the more recent period (1992 - 2012) as the effect of gold on LVAU is statistically significant at 10%. The estimate of coefficient for both dependent variables remains similar in size in the late years model as in the baseline model, i.e. close to -0.1, but is much lower in the precedent period. This result can be considered rather unanticipated, as per literature review recent period is marked by decreasing gold reserves (the reason for signing the first CBGA) and increasing CBII (see the figure 3.1). After all, we only can allege that gold clearance only concerned few countries and also per data visualization in Appendix A we do not observe that the share of gold would notably decrease in many countries. Furthermore, we can note again that the share of gold in total reserves preserved it is negative influence on the CBII in both periods.

Interestingly, log GDP per capita has a positive and statistically significant coefficient in recent period, and in the precedent period the coefficient is non-significant and negative. This finding is again non consistent with previous studies but suggests countries with higher population's well-being and development have more independent central bank, mainly in recent period. The similar conclusion can be drawn about the broad money whose estimator of effect is much higher and statistically significant in the contemporary period. The estimates of coefficients of independent variables are comparable in size to baseline models in column (1) and (2) in 6.1.

Additionally, it is regrettable that the CBII data goes only up to 2012, as few events influencing independence of central banks had happened since. In 2013,

we have seen central bank of Japan to coordinate their policy decision with the government (Condon 2018), recently we have observed political pressure on several central banks such as FED, TCMB or Bankitalia. On the other hand, we see that some countries (Russia or Hungary) started to increase their gold reserves in last years, which previously were considered very stable.

Table 6.2: Estimation results for two separate time periods using the FE method

	Dependent variable:			
	LVAW	LVAU	LVAW	LVAU
	1992-2012	1992-2012	1970 - 1991	1970 - 1991
	(1)	(2)	(3)	(4)
% of gold	−0.101	−0.123*	−0.007	−0.007
	(0.075)	(0.066)	(0.016)	(0.013)
log GDP cap	0.063***	0.044**	−0.006	−0.004
	(0.024)	(0.022)	(0.007)	(0.006)
CurA to GDP	0.0002	0.0003	0.0002	0.0002
	(0.001)	(0.001)	(0.0002)	(0.0001)
ERR	−0.003	−0.002	−0.001*	−0.0003
	(0.003)	(0.002)	(0.001)	(0.001)
inflation	−0.00002	−0.00002	0.00000	0.00000
	(0.00003)	(0.00003)	(0.00000)	(0.00000)
broad money	0.001**	0.001**	0.0002	0.0002
	(0.001)	(0.0005)	(0.0002)	(0.0001)
Observations	1,891	1,891	867	867
R^2	0.052	0.049	0.022	0.012
Adjusted R^2	−0.023	−0.027	−0.096	−0.107
F Statistic	16.126***	14.939***	2.857***	1.529
	(df = 6; 1751)	(df = 6; 1751)	(df = 6; 773)	(df = 6; 773)

Notes:
[1] The table reports linear models for panel data carried out using the "plm" package in R Studio (Croissant & Millo 2008). The model within (fixed effects estimation) and two ways effects were used for estimation. The panel corrected robust standard errors ($PCSE_{BK}$) of Beck & Katz (1995) disclosed in brackets are clustered for groups (145 countries), weighted by HC0 scheme, that is suitable for large samples and calculated with the method arellano, that allows for heteroskedasticity and serial correlation.
[2] *, **, *** indicates significance at 10 percent ($p < 0.10$), 5 percent ($p < 0.05$) and 1 percent ($p < 0.01$), respectively.

6.4 Low vs high income countries

Further, we divided the data into two data sets separating high and low income countries. We can observe from Table 6.3 that the effect of share of gold on the CBII is still negative in both type of nations. The variable share of gold has a statistically significant effect only in one model for group of high income countries.

When it goes to control variables, only the effect of log GDP per capita on the CBII is statistically significant at 5% and again it is positive. However, this statistical significance holds particularly in the data restricted for high income countries. The effect on the CBII is different for two types of nations in case of control variables Current Account to GDP and Inflation. While the coefficient of inflation is positive for high income countries, it remains negative for low income countries. Notably, the effect of inflation on CBII is statistically significant in low income countries. Contrarily for the coefficient of Current account to GDP, which is negative in high income countries and positive in low income countries.

As per argumentation of Cukierman *et al.* (1992), in the less developed or low income nations, the "legal" independence might not be actual practice. Therefore, the indices LVAU and LVAW should more indicative in high income countries.

When controlling for the Worldwide Governance Indicators "WGI" (see the figure E.1 in the Appendix E), the effect of most of the independent variables is statistically insignificant. However, we see that there is a clear difference between high income and low countries, while the effect of share of gold in the total reserves in low income is still negative, in high income countries this relation seems to be positive. The same impact of separated data is observed with the variable log GDP per capita, ERR - Exchange rate regime and Rule of law, Political Stability, Government Effectiveness and Regulatory Quality from WGI.

6.4.1 De facto CBII - Turnover rate of governors

Due to the results presented in the table 6.3 when the effect of gold is not statistically significant in low income countries, we decided to follow the suggestion of Cukierman *et al.* (1992) and we investigate de facto CBI measure Turnover of central bank's governors. TOR is measuring the independence in opposite way

Table 6.3: Estimation results for low and high income countries using the FE method

	Dependent variable:			
	LVAW	LVAU	LVAW	LVAU
	High Income country	High Income country	Low Income country	Low Income country
% of gold	−0.110	−0.212**	−0.084	−0.078
	(0.115)	(0.096)	(0.070)	(0.064)
log GDP cap	0.107***	0.071**	0.050	0.044
	(0.037)	(0.031)	(0.031)	(0.029)
CurA to GDP	−0.001	−0.0004	0.001	0.001
	(0.001)	(0.0004)	(0.001)	(0.001)
ERR	0.002	0.001	−0.005	−0.002
	(0.004)	(0.003)	(0.003)	(0.003)
inflation	0.00003	0.00003	−0.00004**	−0.00004**
	(0.00005)	(0.00004)	(0.00002)	(0.00002)
broad money	0.001	0.001*	0.002**	0.002**
	(0.001)	(0.001)	(0.001)	(0.001)
Observations	872	872	1,316	1,316
R^2	0.074	0.094	0.081	0.067
Adjusted R^2	−0.038	−0.015	−0.005	−0.021
F Statistic	10.375***	13.492***	17.731***	14.429***
	(df = 6; 777)	(df = 6; 777)	(df = 6; 1202)	(df = 6; 1202)

Notes:
[1] The table reports linear models for panel data carried out using the "plm" package in R Studio (Croissant & Millo 2008). The model within (fixed effects estimation) and two ways effects were used for estimation. The panel corrected robust standard errors ($PCSE_{BK}$) of Beck & Katz (1995) disclosed in brackets are clustered for groups (145 countries), weighted by HC0 scheme, that is suitable for large samples and calculated with the method arellano, that allows for heteroskedasticity and serial correlation.
[2] *, **, *** indicates significance at 10 percent ($p < 0.10$), 5 percent ($p < 0.05$) and 1 percent ($p < 0.01$), respectively.

when comparing to LVAU, LVAW - the higher independence is represented by lower number. In previous papers, the relation between TOR and inflation of the country has been investigated already and Cukierman (1992) or Masĺowska-Jokinen (2008) found out that it might be a suitable CBI measure for low income countries. In this paper, we test both group of countries - low and high income countries.

Interestingly, in the models without WGI (first two columns in the table 6.4), the effect of share of gold in total reserves on TOR is positive but statistically non-significant. The implication is similar as in the previous models that the higher share of gold in reserves entails higher dependence of central bank.

Our attention was caught by the models when we include WGI (last two columns in the table 6.4). Firstly, we notice that the signs are opposite, and thus the higher share of gold in the reserves is linked to higher de facto independence of a central bank. Moreover, the statistical significance of relation between the portion of gold in total reserves and TOR in case of low income countries when we control for WGIs might suggest that TOR can have explanatory power for low income countries. Furthermore, the estimate of coefficient of share of gold is substantial as it reaches -0.614, i.e. the measure TOR decreases, on average, by about 0.614 with each percentage point increase in the level of share of gold in total reserves. This is as well supported by explanatory power of the model, as we can see F statistic, testing the null hypothesis of coefficients being irrelevant, is only significant for models testing low income countries (column (2) and (3)).

Table 6.4: Estimation results of low and high income countries with TOR as dependent variable using the FE method

	Dependent variable:			
	TOR			
	High Income country	Low Income country	High Income country	Low Income country
% of gold	0.046	0.112	−0.299	−0.614**
	(0.205)	(0.159)	(0.458)	(0.296)
log GDP cap	−0.019	−0.093*	0.098	0.044
	(0.096)	(0.056)	(0.132)	(0.088)
CurA to GDP	0.001	0.005**	0.003	0.005
	(0.001)	(0.002)	(0.004)	(0.003)
ERR	−0.003	0.005	−0.007	−0.003
	(0.009)	(0.005)	(0.012)	(0.009)
inflation	0.0002**	0.00002	0.003	0.003**
	(0.0001)	(0.00004)	(0.003)	(0.002)
broad money	0.0002	0.001	0.0004	−0.0003
	(0.001)	(0.001)	(0.002)	(0.002)
VaA			0.130	0.110
			(0.153)	(0.085)
RoL			0.128	0.221*
			(0.205)	(0.128)
CoC			−0.123	−0.064
			(0.149)	(0.101)
Pol_Sta			−0.107	−0.130**
			(0.085)	(0.054)
Gov_Eff			0.00003	−0.0002**
			(0.0001)	(0.0001)
RegQua			−0.103	−0.209**
			(0.139)	(0.093)
Observations	857	1,210	574	676
R^2	0.007	0.014	0.019	0.074
Adjusted R^2	−0.113	−0.078	−0.154	−0.071
F Statistic	0.857	2.681**	0.788	3.863***
	(df = 6; 764)	(df = 6; 1105)	(df = 12; 487)	(df = 12; 584)

Notes:
[1] The table reports linear models for panel data carried out using the "plm" package in R Studio (Croissant & Millo 2008). The model within (fixed effects estimation) and two ways effects were used for estimation. The panel corrected robust standard errors ($PCSE_{BK}$) of Beck & Katz (1995) disclosed in brackets are clustered for groups (145 countries), weighted by HC0 scheme, that is suitable for large samples and calculated with the method arellano, that allows for heteroskedasticity and serial correlation.
[2] *, **, *** indicates significance at 10 percent ($p < 0.10$), 5 percent ($p < 0.05$) and 1 percent ($p < 0.01$), respectively.

6.5 Different components of Cukierman's indexes

It has been already mentioned in Chapter 3, the indexes LVAU and LVAW proposed by Cukierman are composed of 4 categories. As each category is available in our dataset, we can verify, if the share of gold reserves has specific or diverse effect on a particular component and compare differences in the relations to each component.

Firstly, we employ the regular model without WGI (see table 6.5). Coefficient of share of gold in total reserves seems to have negative effect on all of the components and it is statistically significant at least at 5% in 3 models. According to this analysis, the gold holdings have the highest impact on the objectives component - cuk_obj, which is a dummy indicating if the price stability is the major goal of CB and if it is prioritized over other policies. The higher is the index, i.e. closer to 1, the more it is prevalent over other goals (as full employment) and CB's mission is superior to government's role when it comes to price stability policy. If a central bank increases share of gold reserves by 1 percentage point, the measure of independence of CB's objectives is expected to decrease by 0.257. As the relation is negative, we could conclude that countries with higher share of gold in total reserves are less likely to allow their central bank to aim for price stability independently as sole and major objective.

However, as usually when including the WGI (table E.2 in Appendix E) the statistical significance of coefficient of variable share of gold decrease. In the model testing, estimate of coefficient of cuk_ceo became positive and statistically insignificant. Interestingly, for the cuk_pol the effect of variable share of gold remains statically significant and negative at confidence level 95%. So, it might suggest that the higher is the share of gold in the total reserves, the more is the government involved in policy formulations. It could support the idea, that the decision about gold reserves are indeed politically motivated and that the gold my attract the interest of politicians and ignite their involvement.

In the final index LVAW, the weights of the components are as follows: cuk_ceo or central bank CEO: 20%, cuk_obj or central bank objectives: 15%, cuk_pol or policy formulations: 15% and central bank lending lim_len: 50%. The highest importance is attributed to the component limits on central bank lending. As per results from Tables 6.5 and E.2, we cannot reject the null hypothesis of no significant effect of gold on lim_len. Furthermore, the effect gold has remained statistically significant after inclusion of WGI only in relation

to component cuk_pol. This component, on the other hand, has the lowest weight when incorporated in the final measure LVAW. These implications might explain why the effect of share of gold on LVAU proven to be more statistically significant on several occasions.

Table 6.5: Estimation results using the FE method with different components of CBII as dependent variable

	Dependent variable:			
	cuk_ceo	cuk_obj	cuk_pol	cuk_limlen
	(1)	(2)	(3)	(4)
% of gold	−0.110**	−0.257***	−0.181**	−0.034
	(0.046)	(0.086)	(0.091)	(0.072)
log GDP cap	−0.002	0.013	0.068**	0.083***
	(0.017)	(0.031)	(0.034)	(0.027)
CurA to GDP	0.0005	−0.0002	−0.0002	0.0002
	(0.0004)	(0.001)	(0.001)	(0.001)
ERR	−0.002	0.002	0.001	−0.007**
	(0.002)	(0.003)	(0.003)	(0.003)
inflation	−0.00001	−0.00001	−0.00002	−0.00002**
	(0.00001)	(0.00001)	(0.00001)	(0.00001)
broad money	0.0004	0.001	−0.0001	0.001**
	(0.0004)	(0.001)	(0.001)	(0.001)
Observations	2,758	2,753	2,758	2,742
R^2	0.029	0.046	0.030	0.067
Adjusted R^2	−0.031	−0.014	−0.031	0.009
F Statistic	13.019***	20.660***	13.372***	31.026***
	(df = 6; 2595)	(df = 6; 2591)	(df = 6; 2595)	(df = 6; 2581)

Notes:
[1] The table reports linear models for panel data carried out using the "plm" package in R Studio (Croissant & Millo 2008). The model within (fixed effects estimation) and two ways effects were used for estimation. The panel corrected robust standard errors ($PCSE_{BK}$) of Beck & Katz (1995) disclosed in brackets are clustered for groups (145 countries), weighted by HC0 scheme, that is suitable for large samples and calculated with the method arellano, that allows for heteroskedasticity and serial correlation.
[2] *, **, *** indicates significance at 10 percent ($p < 0.10$), 5 percent ($p < 0.05$) and 1 percent ($p < 0.01$), respectively.

6.6 Dynamic panel data model

In this section, we consider a different estimation technique - generalized method of moments. As argued by Beck & Katz (2011), the TSCS data often require a lagged dependent variable (LDV). It usually copes with the issue of serially correlated errors. As the error term contains common omitted variables, adding dependent variable from previous time period, that contains the omitted variables from previous period, should lower the serial correlation.

However, including LDV in the model leads to biased estimates since the LDV co-varies with the time-invariant part of the error term and thus fixed effects estimation is no longer consistent. This effect is also known as dynamic panel bias or Nickell's bias, described by Nickell (1981). Even though, the Nickell's bias tends to be negligible with the sufficient T observations, which is the case of our data set, we should be aware of it and deal with it. Judson & Owen (1999) found out that even with 30 time periods observed, the bias may reach 20% of the true value of the estimated coefficient.

There are several possible solution to Nickell's bias, we decided to use Arellano & Bond (1991)'s GMM estimator or also called "difference GMM." and to allow for lagged variables in order to obtain consistent estimators.

$$LVAW_{i,t} = \alpha_t + \lambda LVAW_{i,t-1} + \beta Shareofgold_{i,t} + \delta X_{i,t} + \varepsilon_{i,t} \tag{6.2}$$

where $LVAW_{i,t}$ is the central bank's independence weighted index in country i and year t. α_t is a country-specific intercept (fixed effect). $LVAW_{i,t-1}$ is the lagged value of central bank's independence weighted index by one year. *Share of gold*$_{i,t}$ is the portion of gold in total reserves of a central bank in country i at the year t. $X_{i,t}$ represents a vector of economic and financial variables for country i at the year t, including logarithm of GDP per capita, Current account scaled by GDP, Exchange rate regime indicator, Inflation and Broad money. Alternatively, different lags of independent variables will be explored as well.

As we can see from the table 6.6, none of the employed independent variable seem to be statistically significant. In conformity with Garriga (2010)'s results, the coefficient of LDV is negative in the majority of models, but it is not statistically significant. Furthermore, the main studied variable - share of gold in total reserves of a central bank - appears to have positive effect on CBI, but only in certain cases. We have tried more lags of dependent variable (see table

E.4), and also lags of different variables (see table 6.6 and E.3). However, none of the model provide us with significant results. By using twostep method we get the finite-sample corrected two-step covariance matrix, but these standard errors are downward biased (Mileva 2007). We supposed that non-significance of results might be caused by downward bias of twostep estimation, but we exploited also one-step estimator and the results were similar.

Table 6.6: Estimation Results Using the GMM

	Dependent variable:			
	LVAW			
	(1)	(2)	(3)	(4)
lag(LVAW, 1:2)1	−0.021	−0.261	−0.248	−0.055
	(0.376)	(0.308)	(0.361)	(0.596)
lag(LVAW, 1:2)2	−0.057	−0.092	0.005	−0.099
	(0.391)	(0.331)	(0.362)	(0.417)
% of gold	0.016		0.001	−0.017
	(0.082)		(0.068)	(0.043)
log GDP cap	0.036	0.023		0.007
	(0.033)	(0.029)		(0.034)
CurA to GDP	0.0001	0.0002	0.0002	0.0002
	(0.0002)	(0.0002)	(0.0002)	(0.0002)
ERR	0.001	−0.0001	0.001	0.0003
	(0.001)	(0.002)	(0.001)	(0.001)
inflation	−0.00000	−0.00000	−0.00000	−0.00000
	(0.00000)	(0.00000)	(0.00000)	(0.00000)
broad money	0.0004	0.0004	0.0004*	
	(0.0003)	(0.0002)	(0.0002)	
lag(% of gold, 0:1)0		0.0004		
		(0.048)		
lag(% of gold, 0:1)1		0.006		
		(0.067)		
lag(log GDP cap, 0:1)0			0.024	
			(0.026)	
lag(log GDP cap, 0:1)1			0.013	
			(0.025)	
lag(broad money, 0:1)0				0.0002
				(0.0004)
lag(broad money, 0:1)1				0.0001
				(0.0003)
Observations	2577	2573	2567	2565

Notes:
[1] The table reports generalized method of moments estimation for panel data carried out using the "plm" package in R Studio (Croissant & Millo 2008). The twoways effect, when the model is estimated in first differences and time dummies are included, was employed. We used two-step estimation, as in that case the standard covariance matrix should be robust to panel-specific autocorrelation and heteroskedasticity. Standard errors are reported in brackets.
[2] *, **, *** indicates significance at 10 percent ($p < 0.10$), 5 percent ($p < 0.05$) and 1 percent ($p < 0.01$), respectively.

Tests

Table 6.7: Test statistics related to Table 6.6

	Models:			
	column (1)	column (2)	column (3)	column (4)
Sargan test	21.108	19.016	18.447	26.134
p-value	*1*	*1*	*1*	*1*
Autocorrelation test (1)	0.081	0.726	0.615	0.058
p-value	*0.935*	*0.468*	*0.539*	*0.953*
Autocorrelation test (2)	0.086	0.123	-0.150	0.145
p-value	*0.931*	*0.902*	*0.880*	*0.885*
Wald test for coefficients	8.797	6.573	8.212	5.305
p-value	*0.360*	*0.682*	*0.513*	*0.807*
Wald test for time dummies	55.529	42.869	51.99	34.027
p-value	*0.052*	*0.349*	*0.097*	*0.735*

All the tests are performed on robust standard errors. Sargan test shows under the null hypothesis that the over-identifying restrictions are valid. In all our cases we fail to reject the null hypothesis, so we consider that the over-identifying restrictions are valid.

The Wald tests for coefficients tests under H_0 they are simultaneously equal to zero, i.e. the coefficient is relatively small to its standard error. We fail to reject the null hypothesis, and thus the Wald test is suggesting that the variables emplyed might be irrelevant.

The Arellano - Bond test for autocorrelation has a null hypothesis of no autocorrelation and is applied to the differenced residuals. The test for AR (1) process in first differences usually rejects the null hypothesis. The test for AR (2) in first differences is more important, because it will detect autocorrelation in levels (Mileva 2007). We cannot reject the null hypothesis, so we can consider no autocorrelation neither for first nor second order in our models.

Chapter 7

Conclusion

If monetary policy was kept under control of the government, the public would expect growing price levels, as the government is incentivised to increase inflation since the government can profit from it. In order to obtain price stability and to tame the inflation, the monetary policy should be dedicated to independent institution. Therefore, it is important to understand and to distinguish determinants of central bank's independence as it is a critical element in order to attain price stability in the economy.

From a historical point of view, gold has represented a significant part of reserves of central bank thanks to periods when the value of national currencies was tied to gold. Its role has changed crucially since then, but this precious metal preserved a position in reserves of many central banks. On several occasions, central bank representatives accredited to gold reserves a special role. At bullion industry conference in 2013, the importance of gold was confirmed when *"Banca d'Italia said gold reserves are key to cenbank*[1] *independence"* (Harvey & Denina 2013b). However, to our knowledge, this supposed relationship has not be assessed yet. As a consequence, we decided to fill this niche in the literature concerning central bank's independence determinants and to investigate this alleged influence of gold on central bank's independence using real empirical data. Correspondingly, we accompanied the empirical analysis with a comprehensive literature review and a summary of relevant recent events and statements related to the topic.

We have analyzed the data for 145 countries between years 1970 - 2012. The dependent variables in our models are several measures of central bank independence. As this trait has no exact or numerical value, we had to explore

[1] central bank

relevant literature. Based on the research undertaken, we have decided to use very common indices proposed by Cukierman (1992) - LVAW and LVAU. In order to explore the relation between CBI and gold, we employed the share of gold in total reserves (%) as the main studied explanatory variable. Furthermore, we included several control variables, such as log GDP per capita, current account to GDP, dummy for exchange rate regime, inflation and broad money. We also enriched the model by political environment measures from the spectre of world governance indicators.

We estimate the relationship between CBII and explanatory variables using the method of fixed effects. Due to detected heteroskedasticity, cross sectional dependence and serial correlation, we employ panel corrected standard error to obtain robust statistical inference.

We found that the effect of gold holdings on the central bank independence might be statistically significant. However, contrary to expectations, the coefficient is negative. These estimation results might suggest that, central banks that hold larger portions of gold are in fact more dependent on their governments. Possible explication for this implication is that management of gold within its reserves is a political decision. This precious metal is often considered as a substitute for the foreign currencies in reserves. Therefore, in case of geopolitics tension it is probable that there will be pressure on reserves management and government will require divestment of the currency in concern and thus influence central bank's decisions and limit its independence. In such situation, gold might be a natural choice of substitute and hence we would observe a higher share of gold in total reserves. Similarly, the same effect could be observed in case of endogeneity, when dependent central bank would increase their gold reserves in order to strengthen their position in the eyes of public and to stimulate its independence.

To further analyze the relationship, we decided to subsample the data set into different categories: into two different periods (1970 - 1991 & 1992 - 2012) and then into low-income and high-income countries. The breakdown of time did not bring any crucial information, only that the statistical significance of the effect of gold dropped. In all subsamples, we observe a negative parameter of gold, but for high income countries when including WGI. We could conclude that countries with higher income per capita enjoy positive relationship of gold and CBII, i.e. greater share of gold in reserves imply more independence of central bank.

Through the study, we noted that the effect of gold is more often statis-

tically significant in case of LVAU. As a result of supplementary analysis of components of this index, we discovered that the reason is high portion of variable central bank lending in final LVAW as gold is not significantly related to this component. Moreover, the policy formulations, a variable that has a negative statistically significant impact on CBI, even when including WGI, is represented in final index only with 15%.

Additionally, to check the robustness of the methods employed and results obtained, we used a different estimation method - generalized method of moments. We examined several lags of dependent variable, as well as some lags of independent variables as instruments for this technique. However, output from generalized method of moments did not allow us to confirm the results obtained from fixed effects estimation. The estimates of coefficient of share of gold are smaller in all the models, they are rarely negative and almost none of the explanatory variable has a statistically significant effect.

Finally, as estimation results provide us with rather surprising implications, we suggest additional studies employing different methods and control variables to be used. We recommend to re-estimate the relationship, once the more recent data (especially for CBI) are available, as described in Section 6.3, in order to investigate contemporary events illustrated in Chapter 2.

Bibliography

Adolph, C. (2013): *Bankers, Bureaucrats, and Central Bank Politics*. Cambridge University Press.

Afanasieva, D. (2019): "Breakingviews - Turkey elections pave way for bad economic choices." *Reuters* .

Aizenman, J. & K. Inoue (2012): "Central banks and gold puzzles." *Working Paper 17894*, National Bureau of Economic Research.

Alesina, A. (1988): "Macroeconomics and Politics." In "NBER Macroeconomics Annual 1988, Volume 3," NBER Chapters, pp. 13–62. National Bureau of Economic Research, Inc.

Alesina, A. & L. H. Summers (1993): "Central bank independence and macroeconomic performance: Some comparative evidence." *Journal of Money, Credit and Banking* **25(2)**: pp. 151–162.

Arellano, M. & S. Bond (1991): "Some tests of specification for panel data: Monte carlo evidence and an application to employment equations." *The Review of Economic Studies* **58(2)**: pp. 277–297.

Arellano, M. & O. Bover (1995): "Another look at the instrumental variable estimation of error-components models." *Journal of Econometrics* **68(1)**: pp. 29–51.

Arnone, M., B. J. Laurens, & J.-F. Segalotto (2006): "The Measurement of Central Bank Autonomy; Survey of Models, Indicators, and Empirical Evidence." *IMF Working Papers 06/227*, International Monetary Fund.

Astrow, A. (2012): *Gold and the International Monetary System: A Report by the Chatham House Gold Taskforce*. Chatham House.

Bade, R. & M. Parkin (1988): "Central bank laws and monetary policy." .

Baltagi, B. (2008): *Econometric analysis of panel data.* 3rd edition. ISBN 0-470-01456-3.

Barro, R. J. & D. B. Gordon (1983): "Rules, discretion and reputation in a model of monetary policy." *Working Paper 1079*, National Bureau of Economic Research.

Baur, D. G. (2016): "Central banks and gold." *FIRN Research Paper* .

Beck, N. & J. N. Katz (1995): "What to do (and not to do) with time-series cross-section data." *The American Political Science Review* **89(3)**: pp. 634–647.

Beck, N. & J. N. Katz (2011): "Modeling dynamics in time-series-cross-section political economy data." *Annual Review of Political Science* **14(1)**: pp. 331–352.

Bie, U. & A. H. Pedersen (1999): "The role of gold in the monetary system, danmarks nationalbank." *Monetary Review* .

Bodea, C. & R. Hicks (2018): "CBI: Updated data." *History Lab at Columbia University* .

Bordo, M. D. (1992): "The Bretton Woods International Monetary System: An Historical Overview." *Working Paper 4033*, National Bureau of Economic Research.

Bordo, M. D. (2018): "The Imbalances of the Bretton Woods System 1965 to 1973: U.S. Inflation, The Elephant in the Room." *Working Paper 25409*, National Bureau of Economic Research.

Breusch, T. S. & A. R. Pagan (1979): "A Simple Test for Heteroscedasticity and Random Coefficient Variation." *Econometrica* **47(5)**: p. 1287.

Carlstrom, C. & T. Fuerst (2006): "Central bank independence: the key to price stability?" *Economic Commentary* p. 4.

Chinn, M. D. & H. Ito (2006): "What matters for financial development? capital controls, institutions, and interactions." *Journal of Development Economics* **81(1)**: pp. 163–192.

Choi, I. (2001): "Unit root tests for panel data." *Journal of International Money and Finance* **20(2)**: pp. 249 – 272.

Condon, C. (2018): "Why is central bank independence under attack?" *Bloomberg* .

Croissant, Y. & G. Millo (2008): "Panel data econometrics in R: The plm package." *Journal of Statistical Software* **27(2)**: pp. 1–43.

Crowe, C. & E. Meade (2008): "Central bank independence and transparency; evolution and effectiveness." *IMF Working Papers 08/119*, International Monetary Fund.

Cukierman, A. (1992): "Central Bank Strategy, Credibility, And Independance: Theory And Evidence." *Journal des Economistes et des Etudes Humaines* **3(4)**: pp. 1–10.

Cukierman, A., S. B. Webb, & B. Neyapti (1992): "Measuring the independence of central banks and its effect on policy outcomes." *The World Bank Economic Review* **6(3)**: pp. 353–398.

D'Amato, M., B. Pistoresi, & F. Salsano (2009): "On the determinants of central bank independence in open economies." *International Journal of Finance and Economics* **14**: pp. 107–119.

De Haan, J. & S. Eijffinger (2016): "The politics of central bank independence." *DNB Working Papers*, Netherlands Central Bank, Research Department.

Debelle, G. (2017): "Central bank independence in retrospect." Speech at the Celebration of 20 years of central bank independence for the Bank of England.

Dincer, N. N. & B. Eichengreen (2014): "Central bank transparency and independence: Updates and new measures." *International Journal of Central Banking* **10(1)**: pp. 189–259.

Doff, N. & A. Andrianova (2019): "Russia Buys Quarter of World Yuan Reserves in Shift From Dollar." *Bloomberg* .

Dreher, A., J.-E. Sturm, & J. d. Haan (2010): "When is a central bank governor replaced? evidence based on a new data set." *Journal of Macroeconomics* **32(3)**: pp. 766–781.

Economist (2019): "A threat to the independence of Italy's central bank." *The Economist* .

Eijffinger, S. & J. de Haan (1996): "The political economy of central-bank independence." *Princeton studies in international economics*, International Economics Section, Departement of Economics Princeton University.

Eijffinger, S. & E. Schaling (1995): "The ultimate determinants of central bank independence." *Discussion Paper 1995-5*, Tilburg University, Center for Economic Research.

Eijffinger, S. C. W. & M. Hoeberichts (1998): "The trade off between central bank independence and conservativeness." *Oxford Economic Papers* **50(3)**: pp. 397–411.

European Central Bank (2014): "ECB and other central banks announce the fourth central bank gold agreement." *Directorate General Communications* .

Farvaque, E. (2002): "Political determinants of central bank independence." *Economics Letters* **77(1)**: pp. 131–135.

Fels, J. (2016): "The Downside of Central Bank Independence." *Pacific Investment Management Company LLC* .

Fernández-Albertos, J. (2015): "The politics of central bank independence." *Annual Review of Political Science* **18(1)**: pp. 217–237.

France (2001): "Code monétaire et financier, Article L141-2."

Franzese, R. J. (1999): "Partially Independent Central Banks, Politically Responsive Governments, and Inflation." *American Journal of Political Science* **43(3)**: pp. 681–706.

Friedman, M. (1968): "The role of monetary policy." *The American Economic Review* **58(1)**: pp. 1–17.

Galhau, F. V. D. (2019): "Monetary Challenges for 2019 - Speech at the Bank of Portugal." Speech at the Bank of Portugal.

Garriga, A. C. (2010): *Determinants of Central Bank Independence in Developing Countries: A Two-Level Theory.* Ph.D. thesis, The University of Pittsburgh.

Garriga, A. C. (2016): "Central bank independence in the world: A new data set." *International Interactions* **42(5)**: pp. 849–868.

Ghosh, A. (2016): "What drives gold demand in central bank's foreign exchange reserve portfolio?" *Finance Research Letters* **17**: pp. 146–150.

Giordano, R. & P. Tommasino (2011): "What determines debt intolerance? the role of political and monetary institutions." *European Journal of Political Economy* **27(3)**: pp. 471–484.

Gopalakrishnan, B. & S. Mohapatra (2018): "Global risk and demand for gold by central banks." *Applied Economics Letters* **25(12)**: pp. 835–839.

Gould, W. (2013): *Stata 13*.

Green, T. (1999): "Central bank gold reserves: An historical perspective since 1845." *World Gold Council* .

Grilli, V., D. Masciandaro, G. Tabellini, E. Malinvaud, & M. Pagano (1991): "Political and monetary institutions and public financial policies in the industrial countries." *Economic Policy* **6(13)**: pp. 342–392.

Haan, J. D. & G. J. V. Hag (1995): "Variation in central bank independence across countries: Some provisional empirical evidence." *Public Choice (1986-1998)* **85(3-4)**: pp. 335–351. Copyright - Copyright Kluwer Academic Publishers Dec 1995.

Haldane, A. G. & J. F. Qvigstad (2016): *The Evolution of Central Banks*, pp. 627–672. Studies in Macroeconomic History. Cambridge University Press.

Hansen, L. P. (1982): "Large sample properties of generalized method of moments estimators." *Econometrica* **50(4)**: pp. 1029–1054.

Harvey, J. & C. Denina (2013a): "Analysis: If Cyprus can sell gold to help bailout, why not others?" *Reuters* .

Harvey, J. & C. Denina (2013b): "Banca d'Italia says gold reserves key to cenbank independence." *Reuters* .

Hausman, J. A. (1978): "Specification tests in econometrics." *Econometrica* **46(6)**: p. 1251.

Hlavac, M. (2018): *stargazer: Well-Formatted Regression and Summary Statistics Tables.* Central European Labour Studies Institute (CELSI), Bratislava, Slovakia. R package version 5.2.2.

Honda, Y. (1985): "Testing the error components model with non-normal disturbances." *Review of Economic Studies* **52(4)**: pp. 681–690.

Hopkins, V. (2018): "Hungary increases gold reserves tenfold." *Financial Times* .

ICE Benchmark Administration Limited (2018): "Gold Fixing Price 3:00 P.M. (London time) in London Bullion Market, based in U.S. Dollars." [GOLDP-MGBD228NLBM].

Ilzetzki, E., C. M. Reinhart, & K. S. Rogoff (2017): "Exchange arrangements entering the 21st century: Which anchor will hold?" *Working Paper 23134*, National Bureau of Economic Research.

International Monetary Fund (2018): "International financial statistics (IFS)." Washington, D.C.

Judson, R. A. & A. Owen (1999): "Estimating dynamic panel data models: a guide for macroeconomists." *Economics Letters* **65(1)**: pp. 9–15.

Kao, C. (1999): "Spurious regression and residual-based tests for cointegration in panel data." *Journal of Econometrics* **90(1)**: pp. 1 – 44.

Kelly, N. & L. Keele (2004): "Dynamic models for dynamic theories: The ins and outs of lagged dependent variables." *Nathan J Kelly* **14**: p. 32.

Klomp, J. & J. De Haan (2010): "Inflation and central bank independence: a meta-regression analysis." *Journal of Economic Surveys* **24(4)**: pp. 593–621.

Kraay, Aart Kaufmann, D. M. M. (2010): "The worldwide governance indicators : methodology and analytical issues." *The World Bank* .

Kydland, F. E. & E. C. Prescott (1977): "Rules Rather Than Discretion: The Inconsistency of Optimal Plans." *Journal of Political Economy* **85(3)**: pp. 473–491.

Leyland, J. (2010): "The evolution in central bank attitudes toward gold." *World Gold Council* .

Manly, R. (2018): "Why the world's central banks hold gold - in their own words." *BullionStar* .

Masłowska-Jokinen, A. (2008): "Quest for the best: How to measure central bank independence and show its relation with inflation?" *Discussion Papers 37*, Aboa Centre for Economics.

Mbaye, S., M. M. M. Badia, & K. Chae (2018): "Global debt database: Methodology and sources."

Mileva, E. (2007): "Using arellano - bond dynamic panel gmm estimators in stata." *Fordham University* .

Moser, P. (1999): "Checks and balances, and the supply of central bank independence." *European Economic Review* **43(8)**: pp. 1569–1593.

Moser-Boehm, P. (2006): "The relationship between the central bank and the government." *Central Banks and the Challenge of Development* pp. 45–63.

Munchau, W. (2016): "The end of the era of central bank independence." *Financial Times* .

Nag, A., R. Vollgraaff, & W. Brandimarte (2018): "All Around the World, Central Bank Independence Is Under Threat." *Bloomberg* .

Nickell, S. (1981): "Biases in dynamic models with fixed effects." *Econometrica* **49(6)**: pp. 1417–1426.

Parkin, M. (2013): "Central Bank Laws and Monetary Policy Outcomes: A Three Decade Perspective." *University of Western Ontario, Economic Policy Research Institute* **(20131)**.

Paulík, D. (2012): *Základy financií a meny.* IAM press.

Phelps, E. S. (1967): "Phillips curves, expectations of inflation and optimal unemployment over time." *Economica* **34(135)**: pp. 254–281.

Phillips, A. W. (1958): "The relation between unemployment and the rate of change of money wage rates in the united kingdom, 1861-1957." *Economica* **25(100)**: pp. 283–299.

Phillips, P. C. B. & P. Perron (1988): "Testing for a unit root in time series regression." *Biometrika* **75(2)**: pp. 335–346.

Posen, A. S. (1995): "Declarations are not enough: Financial sector sources of central bank independence." *NBER Macroeconomics Annual* **10**: pp. 253–274.

R Development Core Team (2006): *R: A Language and Environment for Statistical Computing*. R Foundation for Statistical Computing, Vienna, Austria. ISBN 3-900051-07-0.

Reuters (2013): "UPDATE 1-Cyprus central bank has no plan to sell gold reserves-sources." *Reuters* .

Reuters (2018): "Russia cuts dollar, euro share in reserves, lifts weight of gold." *BONDS NEWS* .

Rogoff, K. (1985): "The optimal degree of commitment to an intermediate monetary target." *Quarterly Journal of Economics* **100**: pp. 1169–1189.

Romelli, D. (2015): "Regulatory reforms and central bank independence." *University of Cergy-Ponoise* .

Samuelson, P. A. & R. M. Solow (1960): "Analytical aspects of anti-inflation policy." *The American Economic Review* **50(2)**: pp. 177–194.

Scherer, S., M. D. Giorgio, & G. Vagnoni (2019): "Using Italy's gold reserves to plug budget hole an "interesting idea" - Deputy PM." *Reuters* .

Sentance, A. (2017): "We expect too much of the new masters of the universe." *Financial Times* .

Shotter, J. (2014): "Support for 'Save Our Swiss Gold' initiative falls, poll shows." *Financial Times* .

Than, K. & G. Szakacs (2012): "ECB warns Hungary again over central bank independence." *Reuters* .

Thiele, C.-L. (2017): "Transparency - at least as valuable as gold." *World Gold Council: GoldHUB* .

Totaro, L. (2019): "Italian populists target huge gold reserves and some cry foul." *Bloomberg* .

Ullah, S., P. Akhtar, & G. Zaefarian (2018): "Dealing with endogeneity bias: The generalized method of moments (GMM) for panel data." *Industrial Marketing Management* **71**: pp. 69 – 78.

Vignaud, M. (2012): "Cour des comptes : quand Sarkozy liquidait un cinquième du stock d'or de la France." *Le Point* .

Walsh, C. (2007): "Inflation Targeting and the Role of Real Objectives." *Research and Policy Notes 2007/02*, University of California.

Weber, E. (2001): "Central bank gold holdings." *Economics Discussion / Working Papers 01-03*, The University of Western Australia, Department of Economics.

White, H. (1980): "A heteroskedasticity-consistent covariance matrix estimator and a direct test for heteroskedasticity." *Econometrica: Journal of the Econometric Society* pp. 817–838.

Wooldridge, J. (2012): *Introductory Econometrics.* ISBN 1-111-53104-8.

World Bank Data (2018): "Different variables."

World Gold Council (2017): "How much gold has been mined?" *About gold* .

World Gold Council (2018): "Quarterly gold and FX reserves." .

World Gold Council (2019): "The first central bank gold agreement." *Official institutions* .

Appendix A

Data visualization

A.1 Evolution of gold reserves by regions

In this section, the evolution of gold reserves of each country is represented by regions for years from 1972 to 2012. We see from the data that the most of the countries held relatively low level of reserves in gold. But we can also identify the countries that started to increase their gold reserves in last years (China, Japan, Venezuela, Japan, Germany, Italy, France etc.)

Figure A.1: Gold reserves by region - North America (1970 - 2012)

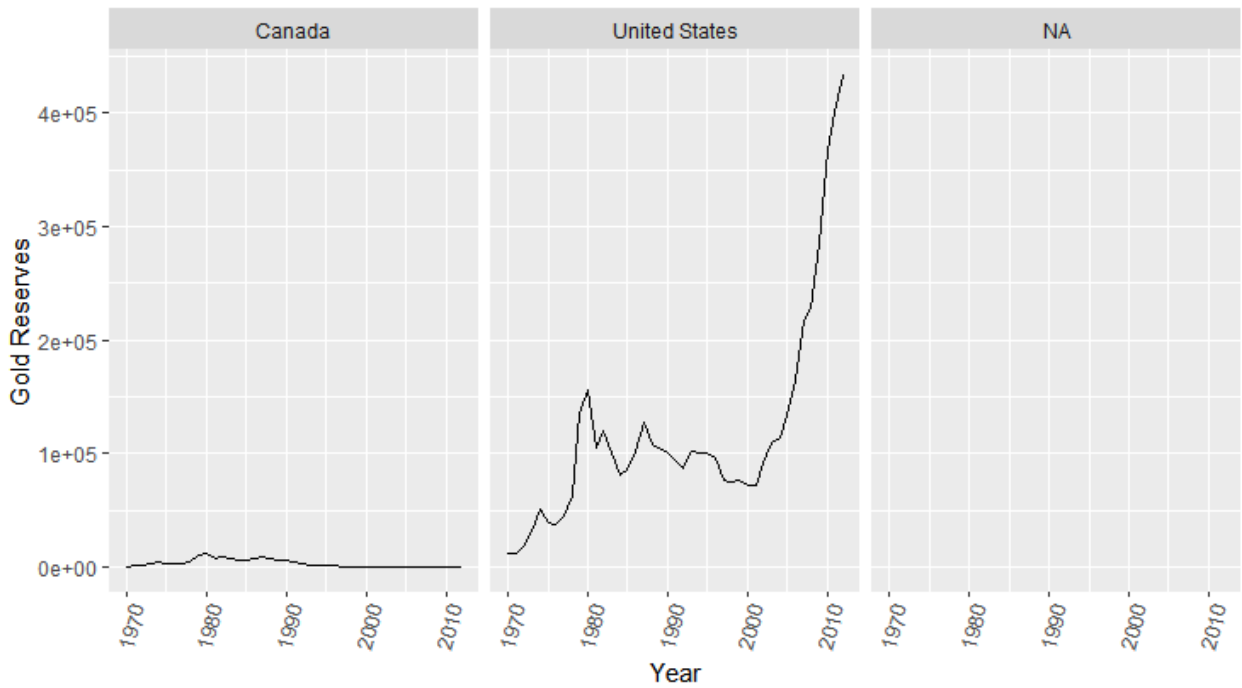


Figure A.2: Gold reserves by region - Europe (1970 - 2012)

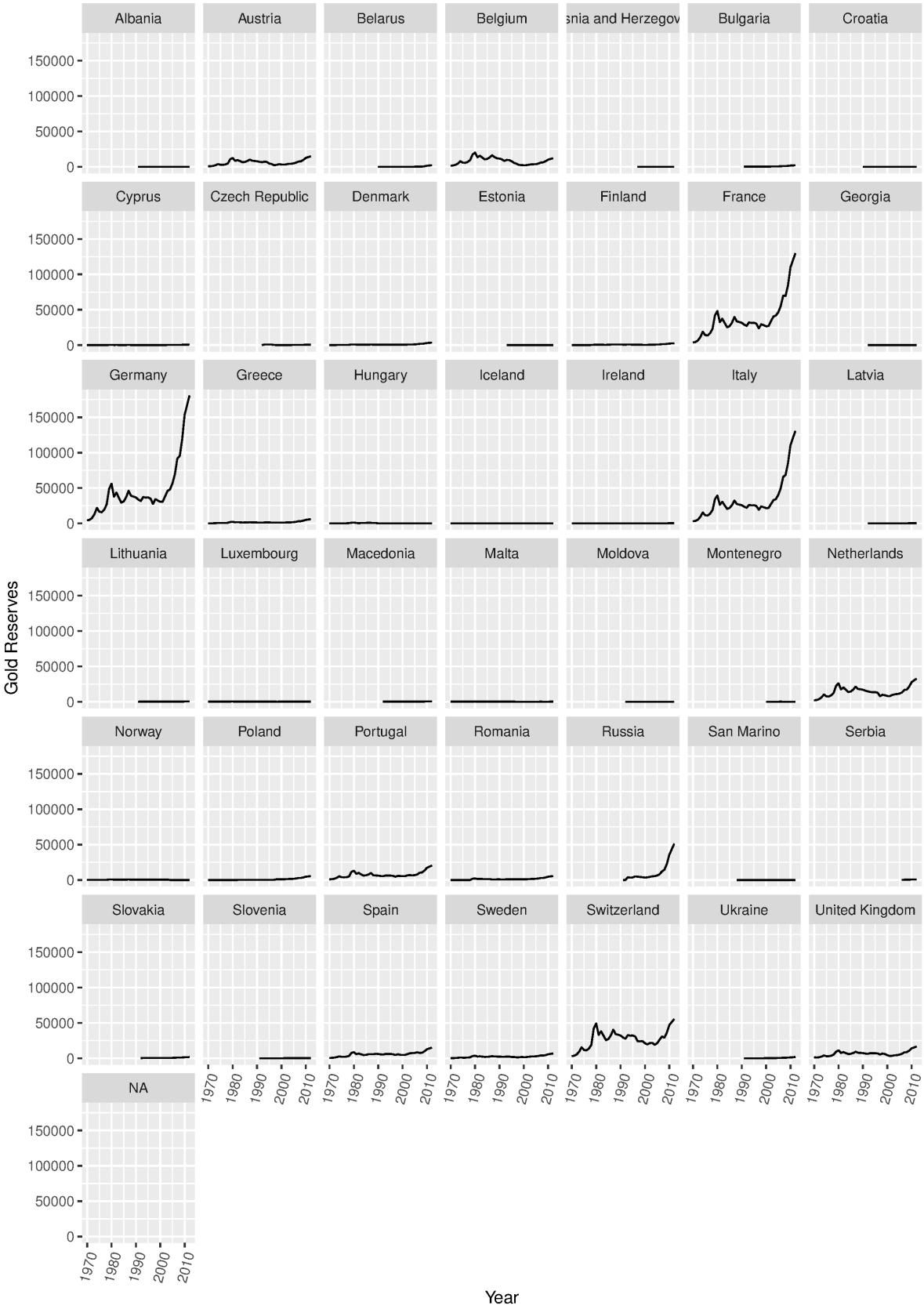


Figure A.3: Gold reserves by region - Asia (1970 - 2012)

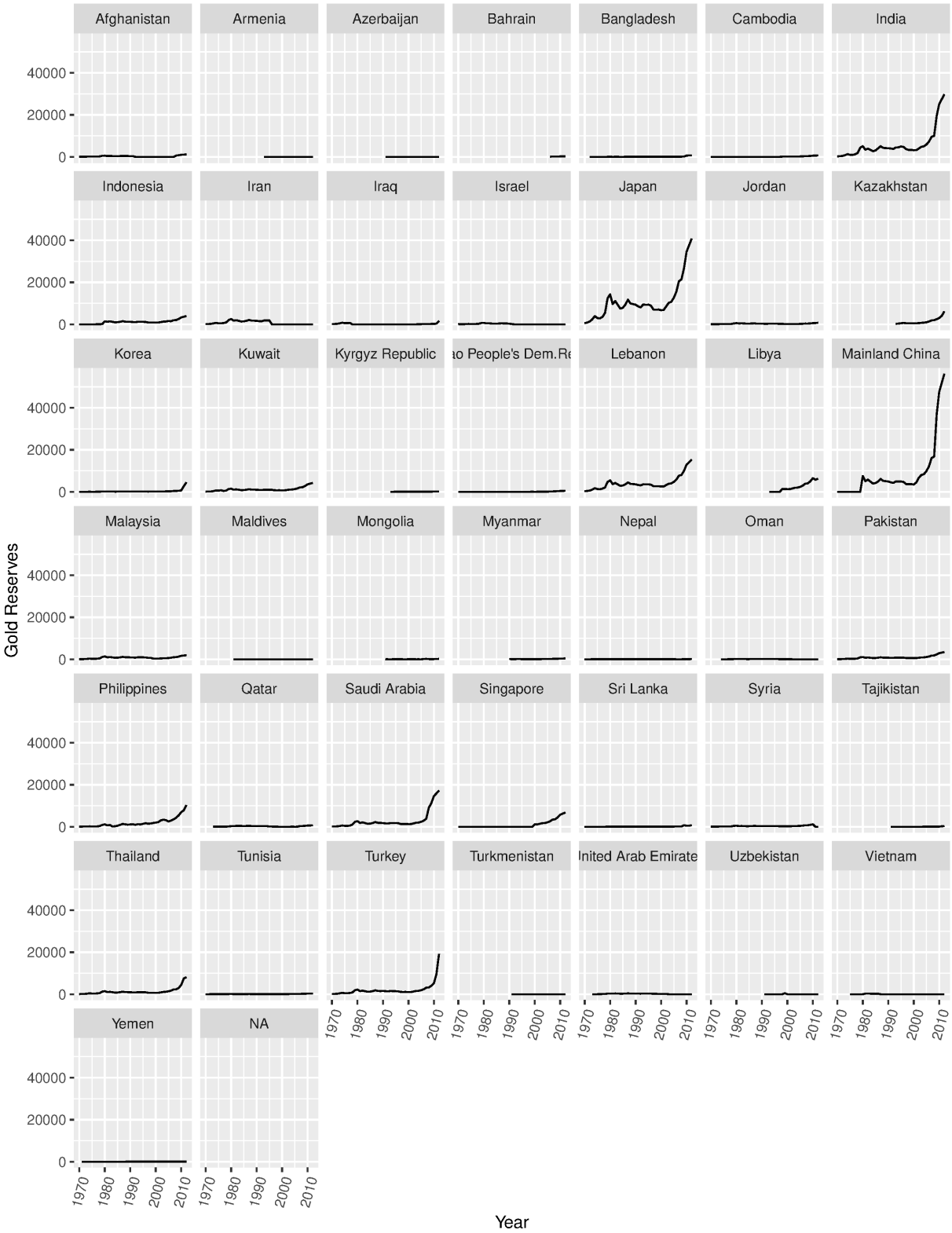


Figure A.4: Gold reserves by region - Africa (1970 - 2012)

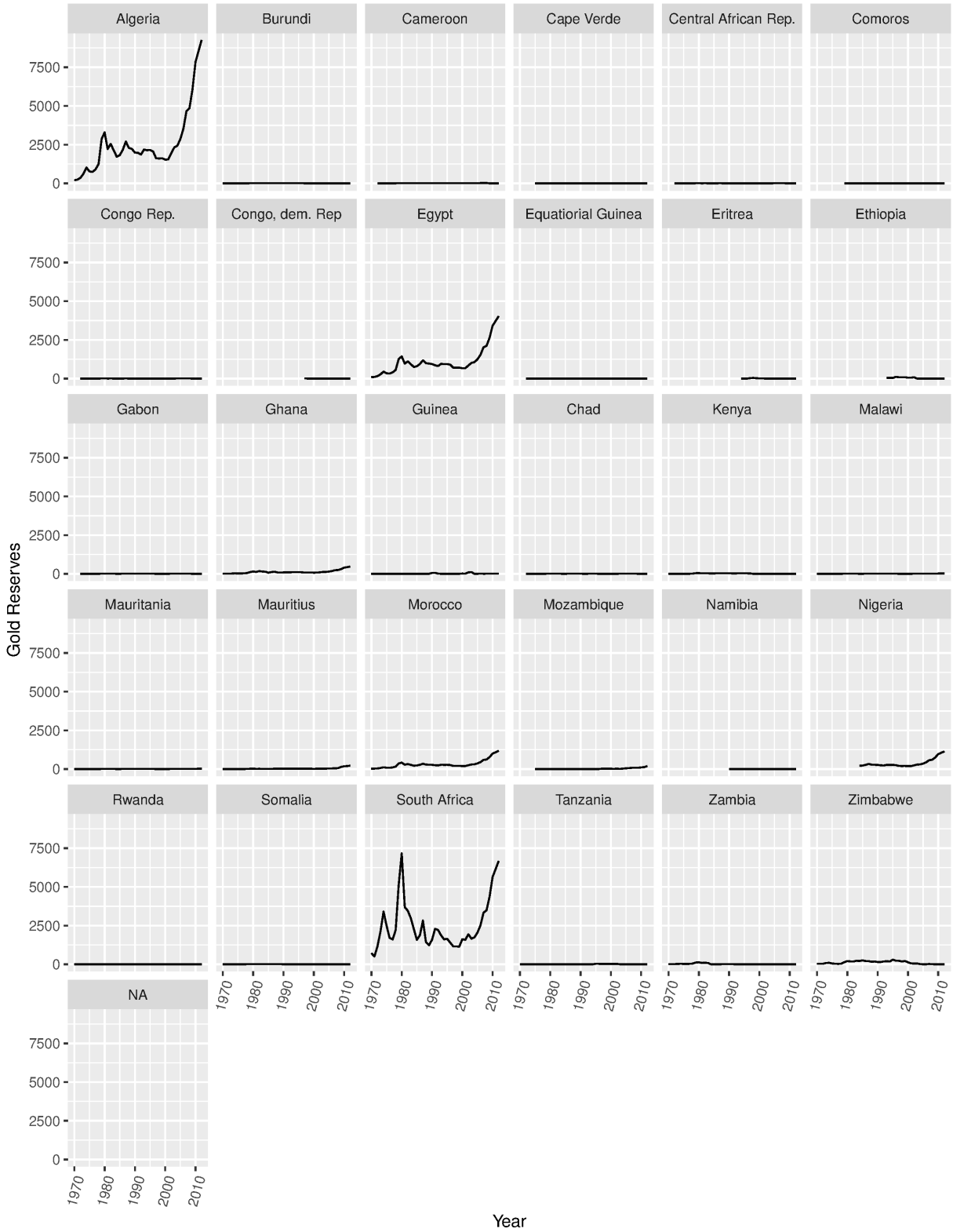


Figure A.5: Gold reserves by region - Australia, New Zeland and Oceania (1970 - 2012)

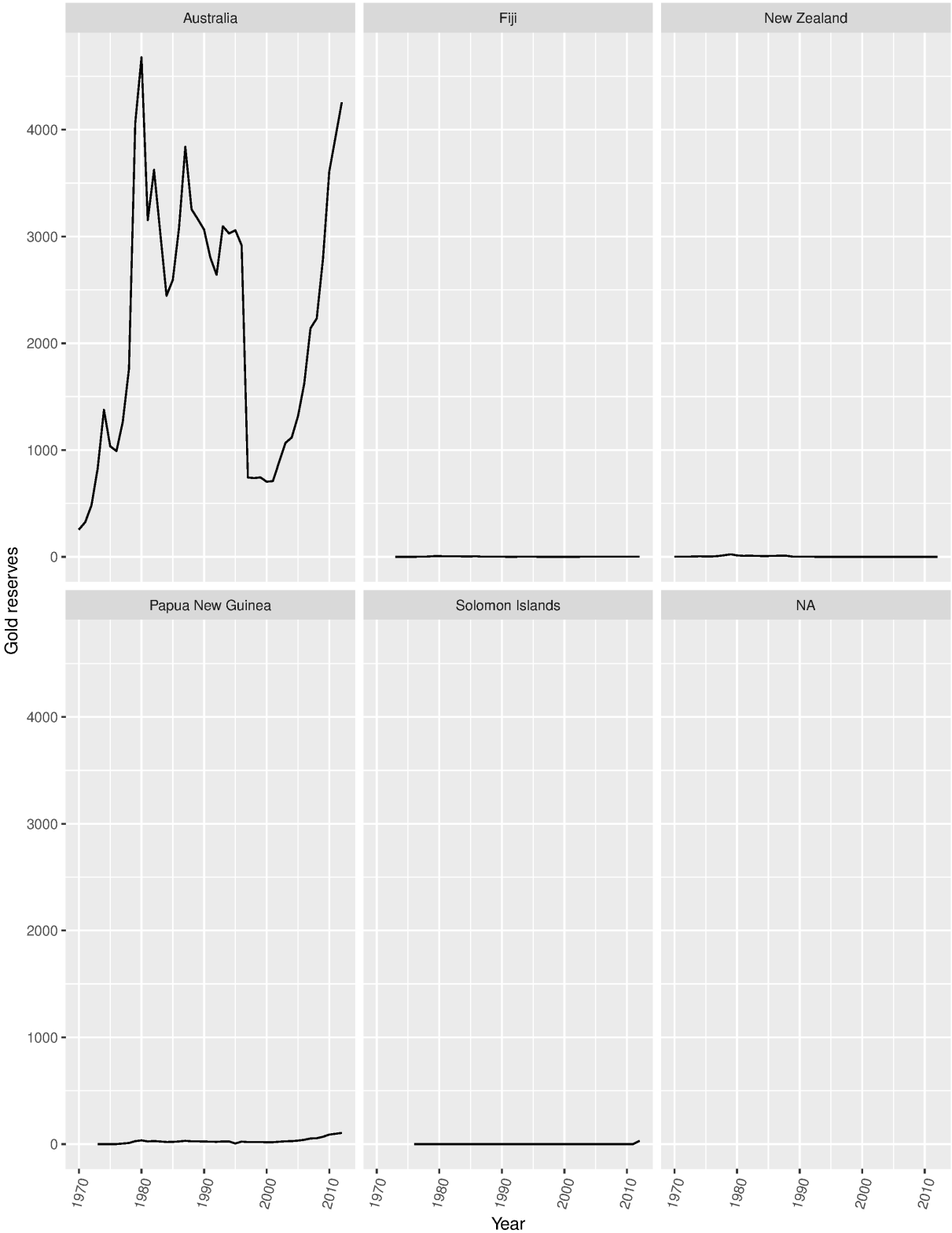
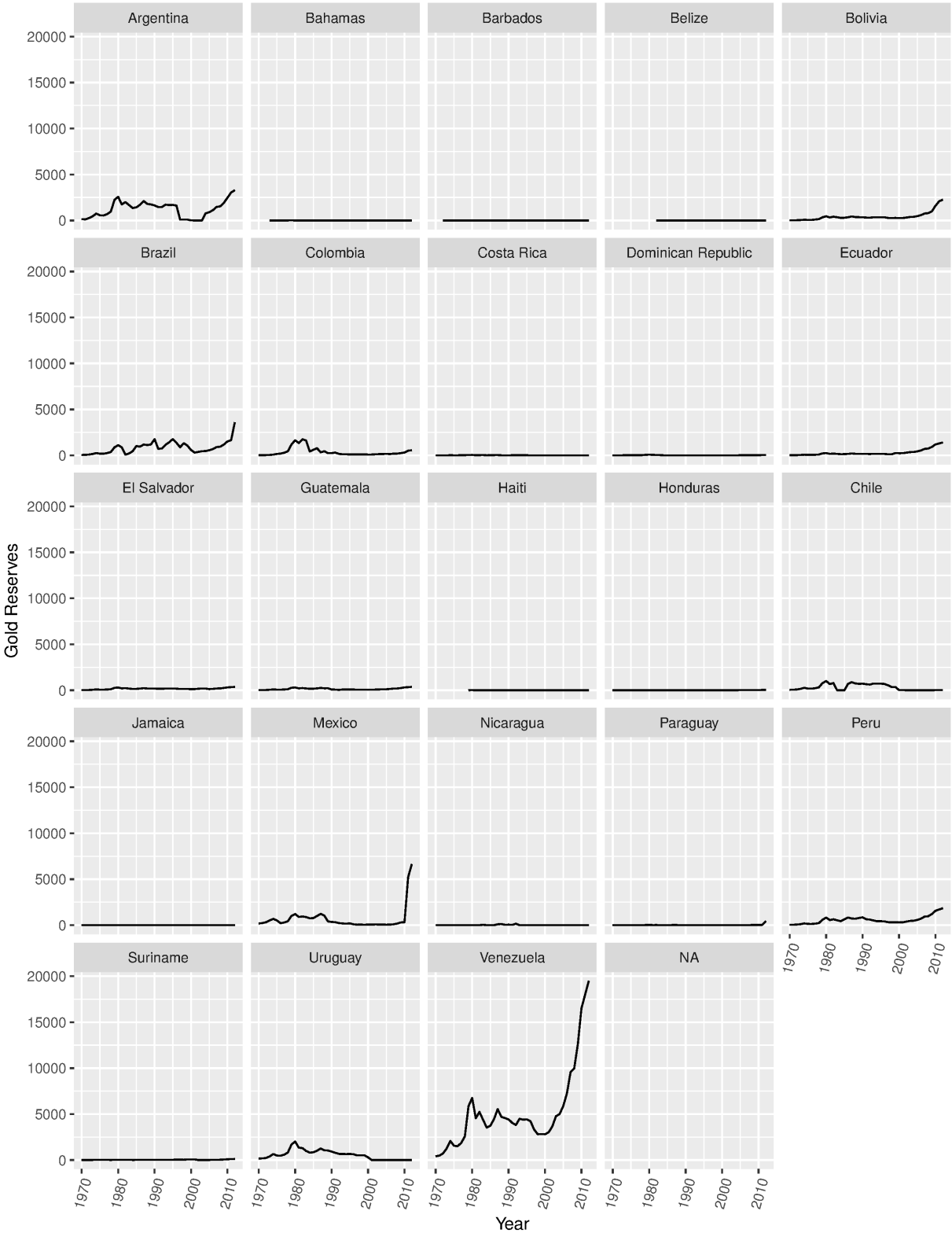


Figure A.6: Gold reserves by region - South and Central America (1970 - 2012)



A.2 Evolution of share of gold in total reserves by regions

In the following section, the evolution of share of gold within the total reserves of central banks is presented. Visibly, the evolution of this index is more variable than the absolute value of gold. There are countries, where share of gold decreased through years (for example Switzerland, Romania, Uruguay but interestingly also China). Within some countries, we can observe the increase of this index when the economic crisis of 2008-2009 hit the world (for example: Portugal, Greece or Ecuador).

Figure A.7: Share of gold in total reserves by region - North America (1970 - 2012)

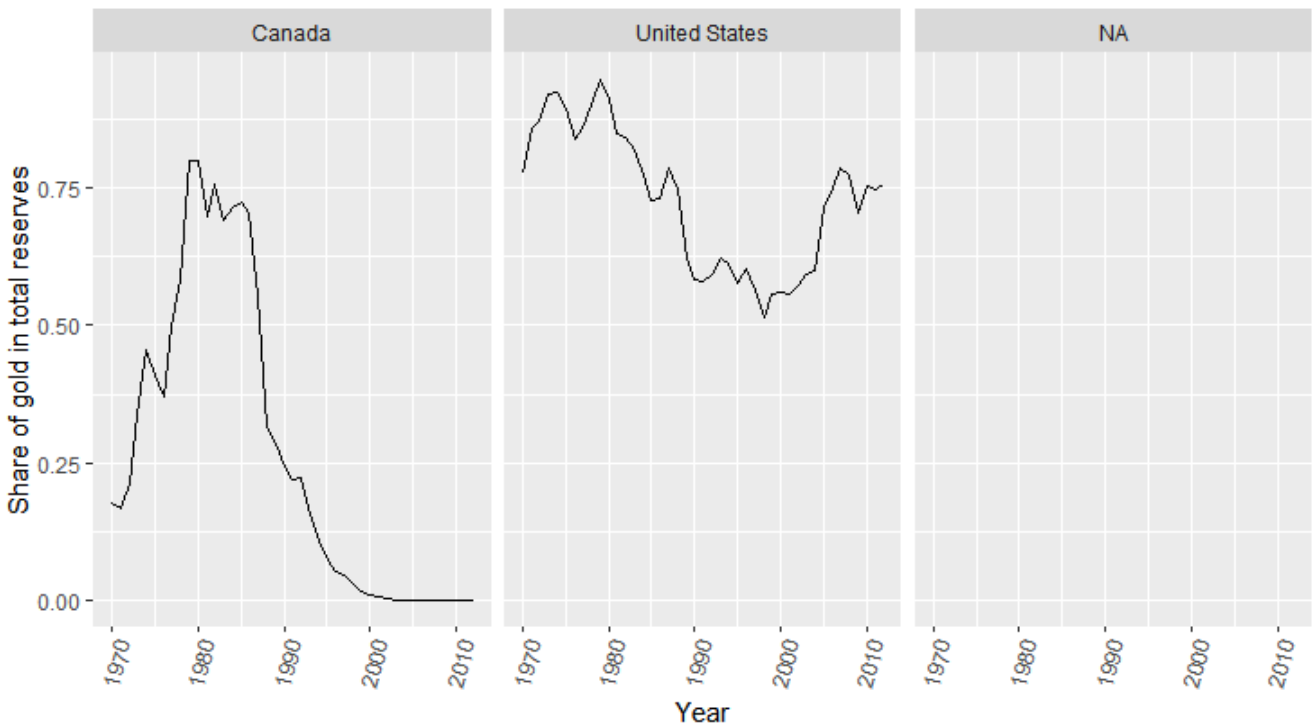


Figure A.8: Share of gold in total reserves by region - Europe (1970 - 2012)

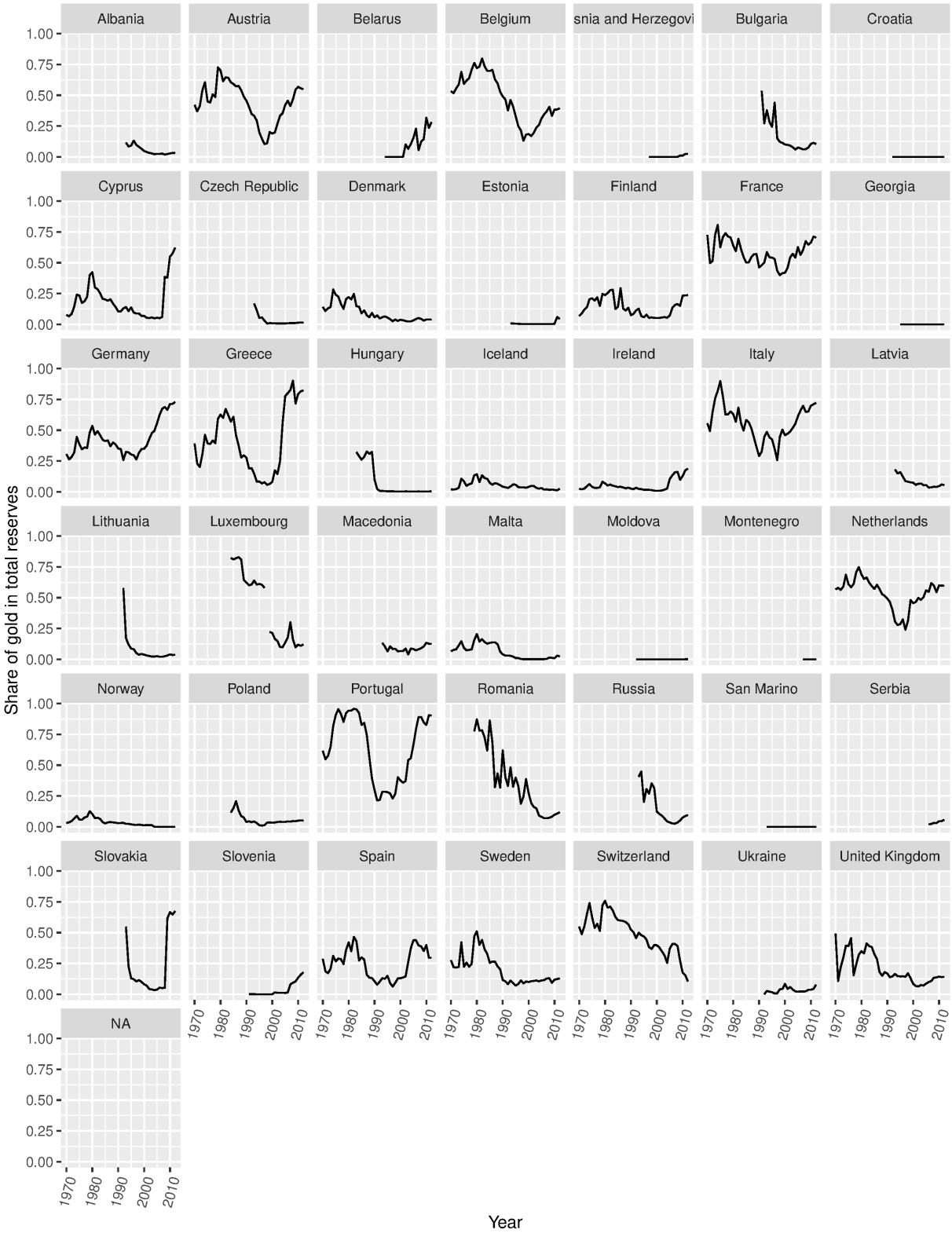


Figure A.9: Share of gold in total reserves by region - Asia (1970 - 2012)

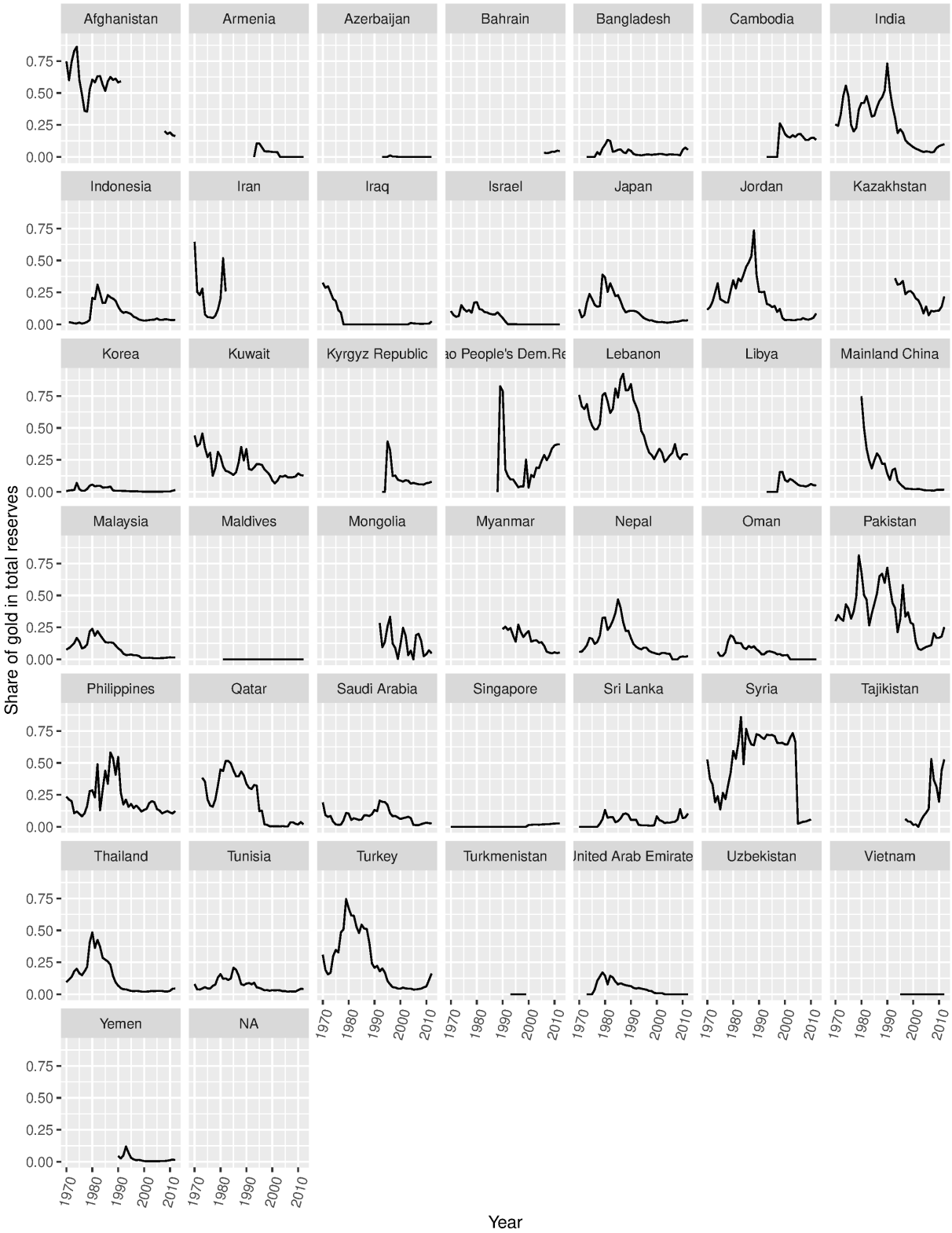


Figure A.10: Share of gold in total reserves by region - Africa (1970 - 2012)

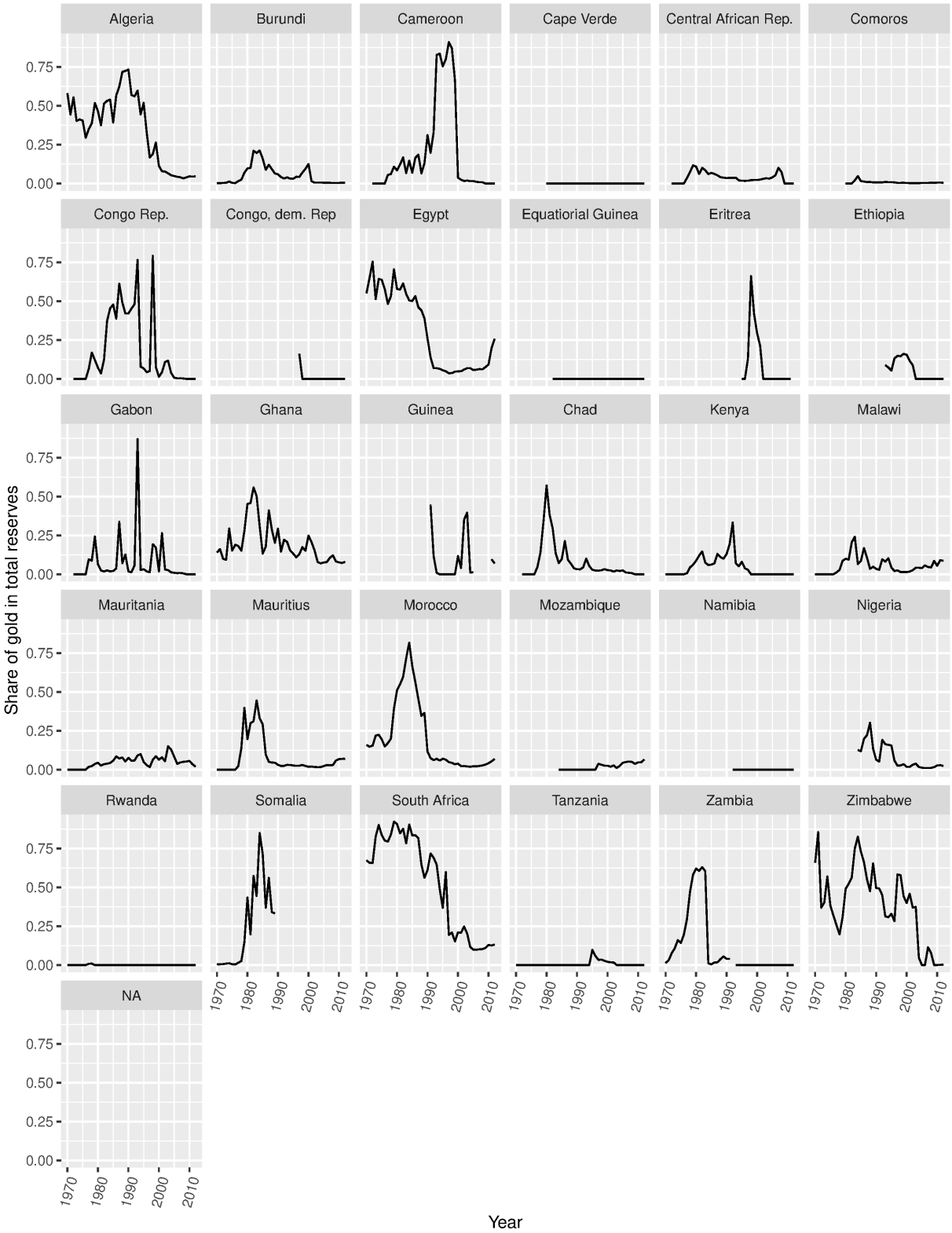


Figure A.11: Share of gold in total reserves by region - Australia and Oceania (1970 - 2012)

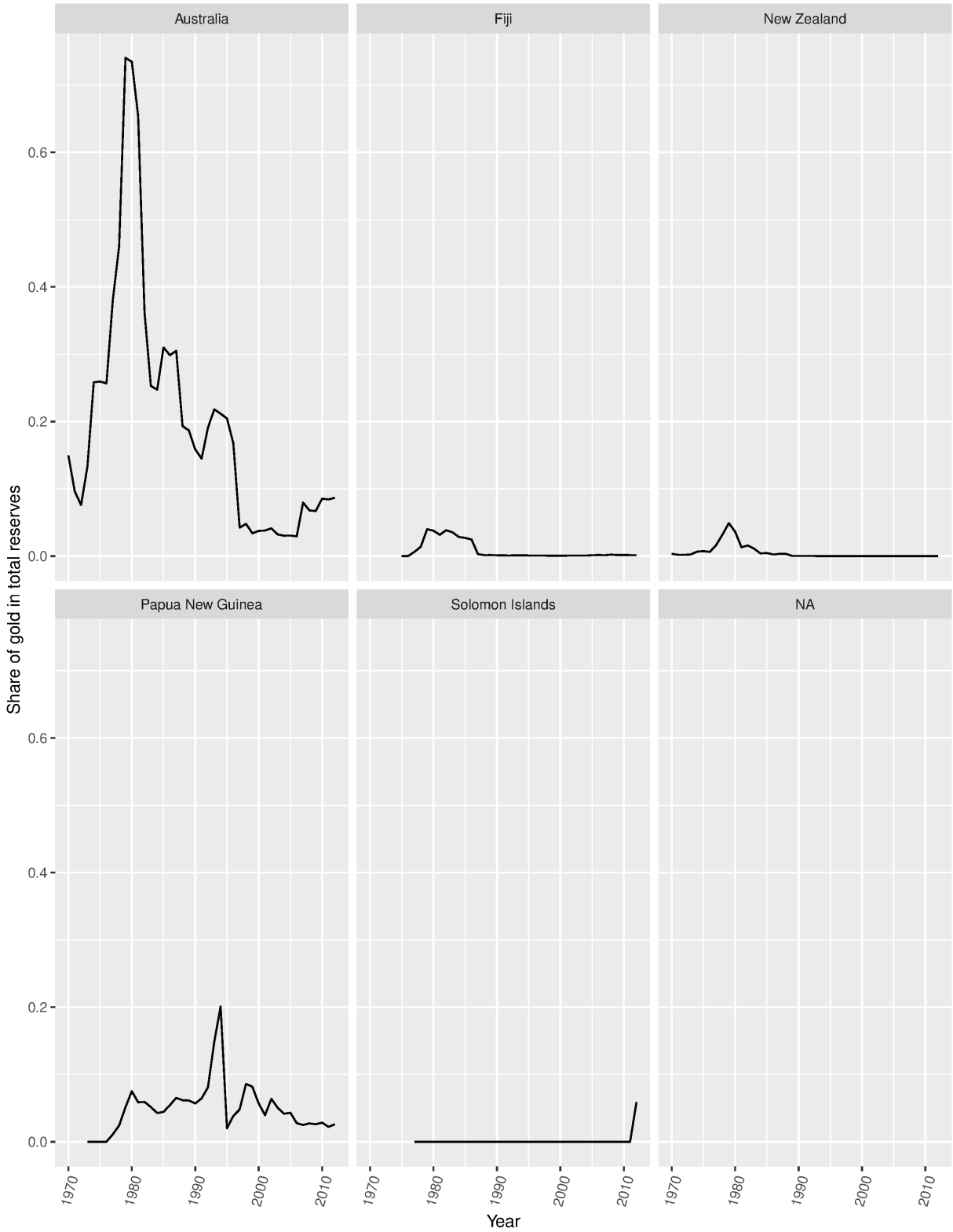
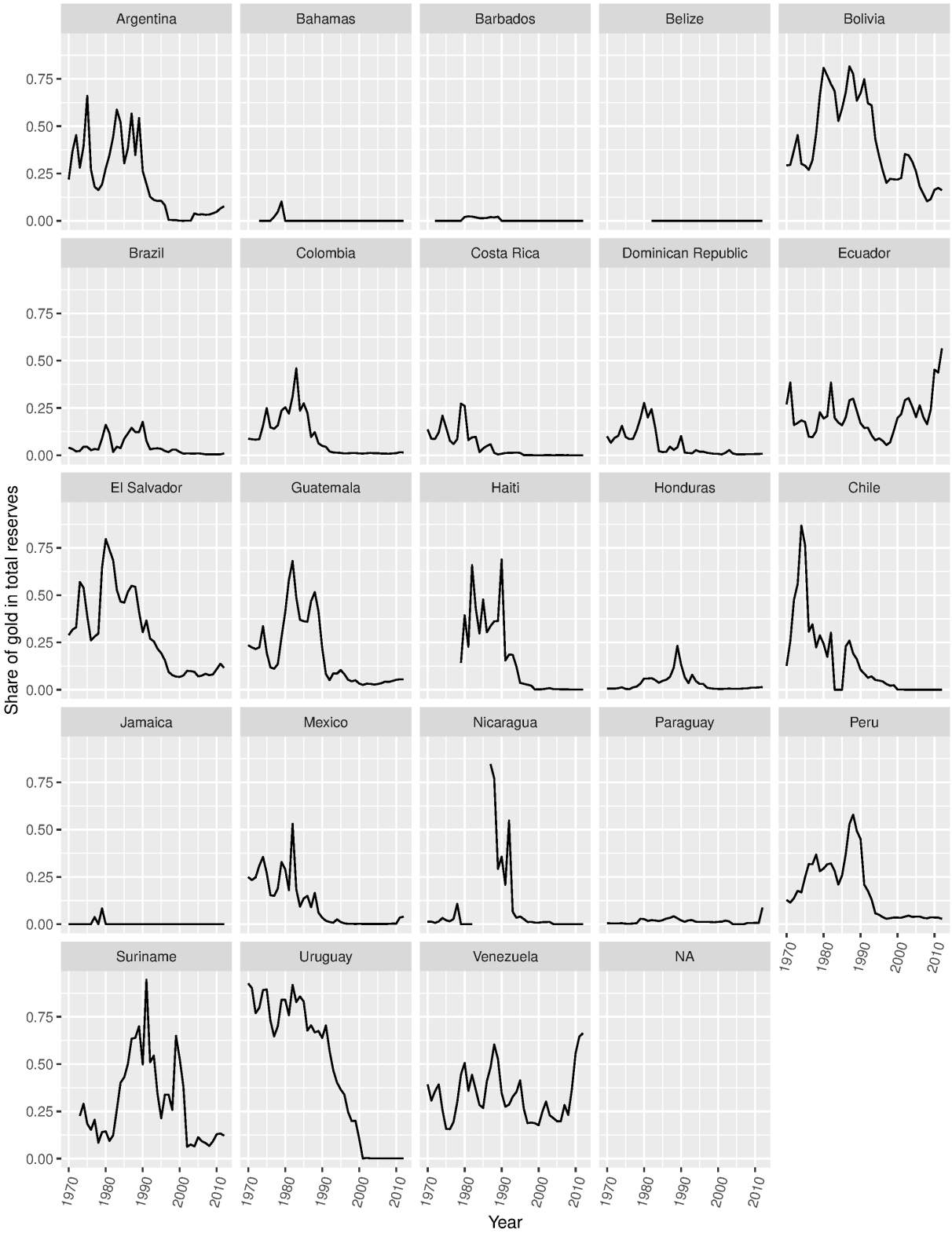


Figure A.12: Share of gold in total reserves by region - South and Central America (1970 - 2012)



Appendix B

Additional details about data

B.1 Coding for Exchange rate regime

Ilzetzki *et al.* (2017) constructed a data set qith fine and coarse de facto exchange rate arrangement classification. In this research, the fine classification is used.

- **1** No separate legal tender or currency union
- **2** Pre announced peg or currency board arrangement
- **3** Pre announced horizontal band that is narrower than or equal to +/-2%
- **4** De facto peg
- **5** Pre announced crawling peg; de facto moving band narrower than or equal to +/-1%
- **6** Pre announced crawling band that is narrower than or equal to +/-2% or de facto horizontal band that is narrower than or equal to +/-2%
- **7** De facto crawling peg
- **8** De facto crawling band that is narrower than or equal to +/-2%
- **9** Pre announced crawling band that is wider than or equal to +/-2%
- **10** De facto crawling band that is narrower than or equal to +/-5%
- **11** Moving band that is narrower than or equal to +/-2% (i.e., allows for both appreciation and depreciation over time)
- **12** De facto moving band +/-5%/ Managed floating
- **13** Freely floating
- **14** Freely falling
- **15** Dual market in which parallel market data is missing.

B.2 Correlation matrix

Table B.1: Correlation matrix

	LVAU	LVAW	%gold	lGDP	lGDPcap	CurA	ERR	broad money	infl	gov debt	imports	kaopen
LVAU	1	0.952	−0.249	−0.088	0.047	−0.093	−0.157	−0.102	−0.044	−0.018	0.043	0.134
LVAW	0.952	1	−0.218	0.002	0.115	−0.070	−0.131	−0.055	−0.042	−0.051	0.036	0.207
%gold	−0.249	−0.218	1	0.170	−0.067	−0.018	0.172	−0.013	0.066	0.050	−0.297	−0.025
lGDP	−0.088	0.002	0.170	1	0.581	0.268	0.362	0.449	−0.004	−0.187	−0.258	0.366
lGDPcap	0.047	0.115	−0.067	0.581	1	0.251	0.084	0.516	−0.032	−0.168	0.128	0.498
CurA	−0.093	−0.070	−0.018	0.268	0.251	1	0.028	0.090	−0.007	−0.174	−0.082	0.081
ERR	−0.157	−0.131	0.172	0.362	0.084	0.028	1	0.119	0.084	0.036	−0.154	0.056
broad money	−0.102	−0.055	−0.013	0.449	0.516	0.090	0.119	1	−0.035	0.159	0.261	0.348
infl	−0.044	−0.042	0.066	−0.004	−0.032	−0.007	0.084	−0.035	1	0.100	−0.045	−0.070
gov debt	−0.018	−0.051	0.050	−0.187	−0.168	−0.174	0.036	0.159	0.100	1	0.145	−0.032
imports	0.043	0.036	−0.297	−0.258	0.128	−0.082	−0.154	0.261	−0.045	0.145	1	0.168
kaopen	0.134	0.207	−0.025	0.366	0.498	0.081	0.056	0.348	−0.070	−0.032	0.168	1

B.3 Other considered control variables

B.3.1 Capital account openness

We introduce capital account openness represented by variable kaopen in the model, as Garriga (2010) used it as a control variable in her models. Generally, this variable was negatively associated with the CBI change in her models.

There are two measures available in the data set of Chinn & Ito (2006): kaopen and ka_open. The second one is normalized between 0 and 1. The measure is mainly indicating the presence of multiple exchange rates (k1), restrictions on current account transactions (k2), restrictions on capital account transactions (k3), and the requirement of the surrender of export proceeds (k4).

For kaopen, the highest value amount to 2.36 for 54 countries, who are perceived as the most financially open and the lowest is -1.91 for 12 least financially open countries. In overall, the data contains index for 182 countries for time period $1970-2016$.

The effect of kaopen reveals to be statistically significant (when including WGI) and the coefficient reached the expected negative sign in three models. However, it does not seem as suitable control variable for our model due to endogeneity issue, therefore we only report the results here in Appendix. In table B.2, we can observe the remarkable difference in the standard errors and in some cases also of the estimators compared to the baseline model. Several other models (similar to models in 6.3 and 6.4) provided us with the analogous outcome, i.e. impacting significantly standard errors. From the correlation matrix in the table B.1, we see that the kaopen is actually correlated significantly with the variables as logGDPcap and broad money. The statistical significance of these variables increase notably after including the kaopen in the model. Therefore, we decided not to include it in the baseline model, even though it looks like that it could be relevant explanatory variable for CBI.

Table B.2: Estimation results of baseline models with kaopen using FE method

	Dependent variable:			
	LVAW	LVAU	LVAW	LVAU
	(1)	(2)	(3)	(4)
% of gold	-0.102^{***}	-0.148^{***}	-0.041	-0.062^{**}
	(0.018)	(0.017)	(0.033)	(0.031)
kaopen	0.003	-0.001	-0.009^{**}	-0.014^{***}
	(0.002)	(0.002)	(0.003)	(0.003)
log GDP cap	0.051^{***}	0.041^{***}	0.032^{***}	0.025^{**}
	(0.008)	(0.007)	(0.011)	(0.010)
CurA to GDP	0.0001	-0.00003	0.001^{*}	0.0005
	(0.0003)	(0.0003)	(0.0004)	(0.0003)
ERR	-0.002^{**}	-0.0002	-0.001	-0.001
	(0.001)	(0.001)	(0.002)	(0.001)
inflation	-0.00001^{**}	-0.00001^{**}	-0.001^{**}	-0.001^{*}
	(0.00001)	(0.00001)	(0.0004)	(0.0003)
broad money	0.001^{***}	0.001^{***}	0.001^{***}	0.001^{***}
	(0.0001)	(0.0001)	(0.0002)	(0.0002)
VaA			0.033^{**}	0.027^{*}
			(0.015)	(0.014)
RoL			0.015	-0.014
			(0.019)	(0.017)
CoC			0.015	0.022
			(0.015)	(0.014)
Pol_Sta			-0.031^{***}	-0.031^{***}
			(0.008)	(0.008)
Gov_Eff			0.016	0.014
			(0.020)	(0.018)
RegQua			0.031^{*}	0.027^{*}
			(0.016)	(0.014)
Observations	2,532	2,532	1,329	1,329
R^2	0.055	0.057	0.065	0.062
Adjusted R^2	-0.005	-0.003	-0.039	-0.042
F Statistic	19.626^{***}	20.458^{***}	6.350^{***}	6.116^{***}
	(df = 7; 2381)	(df = 7; 2381)	(df = 13; 1195)	(df = 13; 1195)

Notes:
[1] The table reports linear models for panel data carried out using the "plm" package in R Studio. (Croissant & Millo 2008) The model within (fixed effects estimation) and two ways effects were used for estimation. The panel corrected robust standard errors ($PCSE_{BK}$) of Beck & Katz (1995) disclosed in brackets are clustered for groups (145 countries), weighted by HC0 scheme, that is suitable for large samples and calculated with the method arellano, that allows for heteroskedasticity and serial correlation.
[2] *, **, *** indicates significance at 10 percent ($p < 0.10$), 5 percent ($p < 0.05$) and 1 percent ($p < 0.01$), respectively.

B.3.2 Imports

As per paper of D'Amato *et al.* (2009) and other suggestions, we tried to control for openness of the economy by imports of goods and services (% of GDP)[1]. Data obtained from World Bank Data (2018) covers 264 countries and 59 years: from 1960 to 2018. In the data obtained, we observed that the imports are increasing in recent period (the highest persisting values are observed in Hong Kong (China), Luxembourg, Singapore and Malta through last years, but there are some extreme cases as for example in Virgin Islands (US) in 2008 when the imports reached 4x value of GDP).

We achieved positive and statistical significant parameter of imports to GDP, in relation to CBII in basic models. This result is in conformity with the previous results of D'Amato *et al.* (2009), who discovered that economy openness is positive and significant determinant of CBII.

However, a similar concern as in the case of kaopen occurs, we suspect the endogeneity issue. Furthermore, the variable imports is considerably correlated with the main studied variable share of gold in total reserves (see B.1). Including the imports in the model had also a notable effect on standard errors and estimators of explanatory and control variables as in case of kaopen (see the table B.3). Therefore, again we decided not to use this indicator of country's openness as a control variable and we only report the results here in Appendix.

[1] *"Imports of goods and services represent the value of all goods and other market services received from the rest of the world. They include the value of merchandise, freight, insurance, transport, travel, royalties, license fees, and other services, such as communication, construction, financial, information, business, personal, and government services. They exclude compensation of employees and investment income (formerly called factor services) and transfer payments."* as defined by World Bank Data (2018)

Table B.3: Estimation results of baseline models with imports using FE method

	Dependent variable:			
	LVAW	LVAU	LVAW	LVAU
	(1)	(2)	(3)	(4)
% of gold	-0.098^{***}	-0.143^{***}	-0.036	-0.064^{*}
	(0.018)	(0.017)	(0.043)	(0.038)
log GDP cap	0.055^{***}	0.043^{***}	0.036^{***}	0.027^{**}
	(0.008)	(0.007)	(0.012)	(0.011)
CurA to GDP	0.0003	0.0002	0.001	0.0005
	(0.0003)	(0.0003)	(0.0004)	(0.0004)
imports	0.001^{***}	0.001^{***}	-0.00001	-0.0002
	(0.0003)	(0.0002)	(0.0004)	(0.0004)
ERR	-0.003^{***}	-0.001	-0.001	-0.001
	(0.001)	(0.001)	(0.002)	(0.001)
inflation	-0.00002^{***}	-0.00001^{***}	-0.001	-0.0004
	(0.00001)	(0.00001)	(0.0005)	(0.0004)
broad money	0.001^{***}	0.001^{***}	0.001^{***}	0.001^{***}
	(0.0002)	(0.0001)	(0.0002)	(0.0002)
VaA			0.027^{*}	0.016
			(0.016)	(0.015)
RoL			0.026	0.002
			(0.021)	(0.019)
CoC			0.025	0.027
			(0.020)	(0.018)
PolSta			-0.036^{***}	-0.040^{***}
			(0.011)	(0.010)
GovEff			-0.00001	-0.00001
			(0.00001)	(0.00001)
RegQua			0.042^{***}	0.036^{***}
			(0.013)	(0.012)
Observations	2,542	2,542	1,225	1,225
R^2	0.064	0.064	0.066	0.062
Adjusted R^2	0.004	0.004	-0.041	-0.046
F Statistic	23.228^{***}	23.211^{***}	6.015^{***}	5.562^{***}
	(df = 7; 2389)	(df = 7; 2389)	(df = 13; 1098)	(df = 13; 1098)

Notes:
[1] The table reports linear models for panel data carried out using the "plm" package in R Studio. (Croissant & Millo 2008) The model within (fixed effects estimation) and two ways effects were used for estimation. The panel corrected robust standard errors ($PCSE_{BK}$) of Beck & Katz (1995) disclosed in brackets are clustered for groups (145 countries), weighted by HC0 scheme, that is suitable for large samples and calculated with the method arellano, that allows for heteroskedasticity and serial correlation.
[2] *, **, *** indicates significance at 10 percent ($p < 0.10$), 5 percent ($p < 0.05$) and 1 percent ($p < 0.01$), respectively.

B.3.3 Government debt

With elevated levels of government debt, the government has less incentives to fight the inflation, as with the higher inflation the value of debt in real terms is decreasing. Therefore, the monetary policy in these countries should be passed on the independent central bank in order to ensure credible monetary policy. The concept was already tested by Haan & Hag (1995) and even though their research did not lead to statistically significant relation, we considered the government debt as a control variable.

Government debt to GDP has a positive and statistically significant coefficient across all specifications of the model, as presented in B.4. This results it not in accordance with previous results of Haan & Hag (1995), however it supports the theory. With 1 percentage point increase in gov_debt across time and between countries, the CBII is expected to increase by 0.0004, according to baseline models.

Eventually, we decided not to include the government debt to GDP as control variable due to same issue as already describe in the sections B.3.2 and B.3.1. Even thought gov_debt is statistically significant in all the models, as visible in the table B.4, the estimation results are doubtful as the standard errors decreased significantly for most of the control variables (logGDP per capita, ERR, broad money).

Table B.4: Estimation results of baseline models with government debt using FE method

	Dependent variable:			
	LVAW	LVAU	LVAW	LVAU
	(1)	(2)	(3)	(4)
% of gold	-0.135^{***}	-0.178^{***}	-0.064	-0.086^{**}
	(0.020)	(0.019)	(0.040)	(0.040)
log GDP cap	0.051^{***}	0.039^{***}	0.046^{***}	0.036^{***}
	(0.008)	(0.007)	(0.011)	(0.010)
CurA to GDP	0.0002	0.0002	0.001^{*}	0.001^{*}
	(0.0003)	(0.0002)	(0.0004)	(0.0003)
gov_debt	0.0004^{***}	0.0004^{***}	0.001^{***}	0.0005^{***}
	(0.0001)	(0.0001)	(0.0001)	(0.0001)
ERR	-0.003^{***}	-0.001	-0.001	-0.002
	(0.001)	(0.001)	(0.001)	(0.001)
inflation	-0.00001	-0.00001	-0.001^{**}	-0.0004
	(0.00001)	(0.00001)	(0.0003)	(0.0003)
broad money	0.001^{***}	0.001^{***}	0.001^{***}	0.001^{***}
	(0.0002)	(0.0001)	(0.0002)	(0.0002)
VaA			0.026^{*}	0.017
			(0.015)	(0.014)
RoL			0.020	-0.005
			(0.021)	(0.019)
CoC			0.026	0.029^{*}
			(0.018)	(0.016)
Pol_Sta			-0.031^{***}	-0.034^{***}
			(0.009)	(0.008)
Gov_Eff			-0.00001	-0.00001
			(0.00001)	(0.00001)
RegQua			0.036^{**}	0.031^{**}
			(0.014)	(0.013)
Observations	2,433	2,433	1,226	1,226
R^2	0.062	0.069	0.073	0.067
Adjusted R^2	-0.001	0.006	-0.035	-0.041
F Statistic	21.570^{***}	24.052^{***}	6.603^{***}	6.072^{***}
	(df = 7; 2279)	(df = 7; 2279)	(df = 13; 1098)	(df = 13; 1098)

Notes:
[1] The table reports linear models for panel data carried out using the "plm" package in R Studio. (Croissant & Millo 2008) The model within (fixed effects estimation) and two ways effects were used for estimation. The panel corrected robust standard errors ($PCSE_{BK}$) of Beck & Katz (1995) disclosed in brackets are clustered for groups (145 countries), weighted by HC0 scheme, that is suitable for large samples and calculated with the method arellano, that allows for heteroskedasticity and serial correlation.
[2] *, **, *** indicates significance at 10 percent ($p < 0.10$), 5 percent ($p < 0.05$) and 1 percent ($p < 0.01$), respectively.

Appendix C

Additional tests

C.1 Cross sectional dependence

In order to confirm the results of Pesaran CD test, we also test the models for cross-sectional dependence by Breusch-Pagan LM. As in the Pesaran CD test, under H_0 there is no cross-sectional dependence in the models. As per results reported C.1 the BP LM test confirmed the results of Peseran CD test. We fail to reject the null hypotheis and therefore we need to consider the presence of cross-sectional dependence in the models.

Table C.1: Breusch-Pagan LM test for cross-sectional dependence in panels

	statistic	p.value	parameter	alternative
Model 1	40651.326	0	6292	cross-sectional dependence
Model 2	40811.193	0	6292	cross-sectional dependence
Model 3	24264.080	0	5965	cross-sectional dependence
Model 4	24326.004	0	5965	cross-sectional dependence

C.2 Unit roots test

The null hypothesis suggests that all the panels in data set contain a unit root. We fail to reject the null hypothesis, and thus we have to consider non-stationarity, in case of dependent variables: LVAW, LVAU, cuk_ceo, cuk_obj, cuk_pol, cuk_limlen and control variable log GDP per capita.

Table C.2: Fisher-type unit-root test based on Phillips-Perron tests

	Number of panels	Avg number of periods	Modified inv. chi^2 statistic	P-value
lvaw_garriga	144	33,11	-4,9177	1
lvau_garriga	144	33,11	-5,0184	1
cuk_ceo	144	33,11	-4,417	1
cuk_obj	142	33,36	-2,6052	0,9954
cuk_pol	144	33,11	-5,3823	1
cuk_limlen	143	33,2	-5,1833	1
% of gold	145	34,5	17,3601	0
log GDP cap	144	34,65	0,8213	0,2057
log GDP	144	34,67	1,7669	0,0386
CurA to GDP	140	27,99	16,6007	0
ERR	145	36,95	28,5578	0
inflation	138	32,16	67,1032	0
broad money	122	33,83	11,9255	0
VaA	145	13,88	21,475	0
RoL	145	13	24,3578	0
CoC	144	13,88	26,9322	0
Pol_Sta	145	13,81	52,928	0
RegQua	144	13,84	28,9172	0
GovEff	144	13,83	30,1081	0

Note: The table reports the Fisher-type unit-root test based on Phillips & Perron (1988) tests suitable for unbalanced data set from software Stata 13.(Gould 2013) The test conducts unit-root tests for each panel separately and than combine the outcome in an overall statistic as proposed by Choi (2001). The time trend was considered and 4 lags when calculating the test statistic.

C.3 Robust Wald test for coefficients

In order to get robust statistics of several models, we performed Wald-style chi-square test for coefficients. Under H_0 coefficients are jointly zero, thus we could consider them irrelevant. In our case, we use this test as an addendum to

F-statistic reported under each model. The statistics of Wald test reported in Table C.3 use robust standard errors, the same type of errors as in all estimation using fixed effects method.

We can observe that in most of the cases the Wald test signal similar implications as in the case of F-statistic reported, but the significance level is usually higher. For the baseline models, Wald test offers comparable results, only in case of Model 3 and Model 4, we can only reject the null hypothesis on higher significance level (at 5%, not 1% as for F-statistic). As for the estimation the models on different periods, we fail to reject the null hypothesis of slope coefficients of regression being jointly zero for earlier period (1970-1991). We reject the null hypothesis of Wald test for models testing low and high income countries at 5% significance level and for all models estimating the relation of components of CBII but one. We fail to reject the null hypothesis in case when cuk_ceo is considered as dependent variable.

Table C.3: Wald-style Chi-square Test

	Chisq statistic	p.value	parameter	linked to
Baseline models				
Model 1	27.611	0.0001	6	Table 6.1
Model 2	24.514	0.0004	6	
Model 3	25.425	0.0129	12	
Model 4	21.939	0.0382	12	
Evolution in time models				
LVAW (1992-2012)	15.900	0.0143	6	Table 6.2
LVAU (1992-2012)	14.735	0.0224	6	
LVAW (1970-1991)	6.314	0.3889	6	
LVAU (1970-1991)	3.070	0.8001	6	
Low vs High income countries models				
LVAW - High Income country	13.047	0.0423	6	Table 6.3
LVAU - High Income country	15.207	0.0187	6	
LVAW - Low Income country	18.964	0.0042	6	
LVAU - Low Income country	16.287	0.0123	6	
Models with different components of CBII				
cuk_ceo (1)	9.789	0.1338	6	Table 6.5
cuk_obj (2)	13.123	0.0411	6	
cuk_pol (3)	11.784	0.0670	6	
cuk_limlen (4)	29.376	0.00005	6	

Appendix D

Overview of models

D.1 Model 1

The baseline equation takes the following form:

$$LVAW_{i,t} = \lambda_t + \beta Shareofgold_{i,t} + \delta X_{i,t} + \varepsilon_{i,t} \tag{D.1}$$

where $LVAW_{i,t}$ is the central bank's independence weighted index in country i and year t. λ_t is a country-specific intercept (fixed effect). $Shareofgold$ is the portion of gold in total reserves of a central bank in country i at the year t. $X_{i,t}$ represents a vector of economic and financial variables for country i at the year t, including logarithm of GDP per capita, Current account scaled by GDP, Exchange rate regime indicator, Inflation and Broad money.

D.2 Model 2

$$LVAU_{i,t} = \lambda_t + \beta Shareofgold_{i,t} + \delta X_{i,t} + \varepsilon_{i,t} \tag{D.2}$$

where $LVAU_{i,t}$ is the central bank's independence weighted index in country i and year t. λ_t is a country-specific intercept (fixed effect). $Shareofgold$ is the portion of gold in total reserves of a central bank in country i at the year t. $X_{i,t}$ represents a vector of economic and financial variables for country i at the year t, including logarithm of GDP per capita, Current account scaled by GDP, Exchange rate regime indicator, Inflation and Broad money.

D.3 Model 3

$$LVAW_{i,t} = \lambda_t + \beta Shareofgold_{i,t} + \delta X_{i,t} + \gamma Z_{i,t} + \varepsilon_{i,t} \tag{D.3}$$

where $LVAW_{i,t}$ is the central bank's independence weighted index (also measured by $LVAU_{i,t}$ - its unweighted form) in country i and year t. λ_t is a country-specific intercept (fixed effect). $Shareofgold$ is the portion of gold in total reserves of a central bank in country i at the year t. $X_{i,t}$ represents a vector of economic and financial variables for country i at the year t, including logarithm of GDP per capita, Current account scaled by GDP, Exchange rate regime indicator, Inflation and Broad money. Alternatively, $Z_{i,t}$ is added in the baseline model and it represents a vector of political and governance variables for country i at the year t from world governance indicators, such as Voice and Accountability, Political Stability, Government Effectiveness, Regulatory Quality, Rule of Law, Control of Corruption.

D.4 Model 4

$$LVAU_{i,t} = \lambda_t + \beta Shareofgold_{i,t} + \delta X_{i,t} + \gamma Z_{i,t} + \varepsilon_{i,t} \tag{D.4}$$

where $LVAU_{i,t}$ is the central bank's independence weighted index in country i and year t. λ_t is a country-specific intercept (fixed effect). $Shareofgold$ is the portion of gold in total reserves of a central bank in country i at the year t. $X_{i,t}$ represents a vector of economic and financial variables for country i at the year t, including logarithm of GDP per capita, Current account scaled by GDP, Exchange rate regime indicator, Inflation and Broad money. Alternatively, $Z_{i,t}$ is added in the baseline model and it represents a vector of political and governance variables for country i at the year t from world governance indicators, such as Voice and Accountability, Political Stability, Government Effectiveness, Regulatory Quality, Rule of Law, Control of Corruption.

Appendix E

Additional models specifying baseline model

In this section, we report models that were not included in the main part of the thesis in order to keep concentrated on the main points of attention. Therefore, we disclose here the alternates of the baseline models, mostly the baseline models including world governance indicators.

E.1 Fixed effects estimations

Table E.1: Estimation results for low and high income countries using the FE method including WGI

	Dependent variable:			
	LVAW	LVAU	LVAW	LVAU
	High Inc country	High Inc country	Low Inc country	Low Inc country
% of gold	0.221	0.134	−0.137	−0.128
	(0.139)	(0.112)	(0.087)	(0.086)
log GDP cap	0.048	0.010	−0.002	−0.003
	(0.036)	(0.029)	(0.032)	(0.032)
CurA to GDP	−0.0003	−0.00003	−0.0003	−0.0002
	(0.001)	(0.001)	(0.001)	(0.001)
ERR	0.006**	0.004	−0.003	−0.002
	(0.003)	(0.003)	(0.003)	(0.003)
inflation	−0.001	−0.0004	−0.001	−0.001
	(0.001)	(0.001)	(0.0004)	(0.0004)
broad money	0.0004	0.0005	0.001	0.001
	(0.001)	(0.0004)	(0.001)	(0.001)
VaA	0.054	0.043	0.050*	0.046
	(0.039)	(0.032)	(0.029)	(0.028)
RoL	0.027	0.039	−0.035	−0.068*
	(0.054)	(0.043)	(0.041)	(0.041)
CoC	0.049	0.042	0.018	0.026
	(0.041)	(0.033)	(0.034)	(0.033)
Pol_Sta	0.012	0.012	−0.034*	−0.036*
	(0.021)	(0.016)	(0.019)	(0.019)
Gov_Eff	0.00001	0.00001	−0.00002	−0.00002
	(0.00003)	(0.00002)	(0.00002)	(0.00002)
RegQua	−0.007	−0.009	0.042	0.041
	(0.041)	(0.033)	(0.030)	(0.029)
Observations	569	569	670	670
R^2	0.089	0.079	0.066	0.065
Adjusted R^2	−0.074	−0.085	−0.081	−0.082
F Statistic	3.905***	3.443***	3.398***	3.368***
	(df = 12; 482)	(df = 12; 482)	(df = 12; 578)	(df = 12; 578)
Note:				*p<0.1; **p<0.05; ***p<0.01

Table E.2: Estimation results of different components using the FE method including WGI

	Dependent variable:			
	cuk_ceo	cuk_obj	cuk_pol	cuk_limlen
% of gold	0.068	−0.067	−0.228**	−0.011
	(0.055)	(0.090)	(0.108)	(0.103)
log GDP cap	−0.004	0.004	0.034	0.046
	(0.021)	(0.032)	(0.039)	(0.031)
CurA to GDP	0.001*	0.0004	0.00002	0.001
	(0.001)	(0.001)	(0.001)	(0.001)
ERR	−0.004**	−0.0001	0.001	−0.001
	(0.002)	(0.003)	(0.004)	(0.004)
inflation	−0.001	−0.0001	−0.0001	−0.001**
	(0.0003)	(0.001)	(0.001)	(0.001)
broad money	0.001	0.001**	0.001	0.001*
	(0.0004)	(0.001)	(0.001)	(0.001)
VaA	0.022	0.006	0.017	0.044
	(0.021)	(0.032)	(0.040)	(0.034)
RoL	−0.096***	−0.038	0.001	0.081*
	(0.030)	(0.046)	(0.056)	(0.047)
CoC	0.019	0.036	0.061	0.009
	(0.024)	(0.037)	(0.046)	(0.039)
Pol_Sta	−0.014	−0.015	−0.065***	−0.033
	(0.012)	(0.019)	(0.024)	(0.021)
Gov_Eff	−0.00001	−0.00001	−0.00003	−0.00002
	(0.00001)	(0.00002)	(0.00002)	(0.00002)
RegQua	0.019	−0.017	0.077*	0.056
	(0.022)	(0.034)	(0.042)	(0.036)
Observations	1,356	1,351	1,356	1,340
R^2	0.069	0.024	0.057	0.073
Adjusted R^2	−0.035	−0.084	−0.048	−0.030
F Statistic	7.537***	2.499***	6.188***	7.896***
	(df= 12; 1219)	(df= 12; 1215)	(df= 12; 1219)	(df= 12; 1205)

Notes:
[1] The table reports linear models for panel data carried out using the "plm" package in R Studio (Croissant & Millo 2008). The model within (fixed effects estimation) and two ways effects were used for estimation. The panel corrected robust standard errors ($PCSE_{BK}$) of Beck & Katz (1995) disclosed in brackets are clustered for groups (145 countries), weighted by HC0 scheme, that is suitable for large samples and calculated with the method arellano, that allows for heteroskedasticity and serial correlation.
[2] *, **, *** indicates significance at 10 percent ($p < 0.10$), 5 percent ($p < 0.05$) and 1 percent ($p < 0.01$), respectively.

E.2 Generalized Method of Moments estimation for panel data

Table E.3: GMM estimation results with dependent variable LVAU

	Dependent variable:			
	LVAU			
lag(LVAU, 1:2)1	−0.096	−0.230	0.083	0.009
	(0.138)	(0.188)	(0.145)	(0.150)
lag(LVAU, 1:2)2	0.190	0.184	0.189	0.060
	(0.158)	(0.154)	(0.173)	(0.171)
% of gold	0.026		0.026	−0.037
	(0.036)		(0.055)	(0.056)
log GDP cap	0.007	−0.001		0.017
	(0.013)	(0.019)		(0.044)
CurA to GDP	0.0003*	0.0003**	0.0003*	0.0002
	(0.0001)	(0.0001)	(0.0002)	(0.0002)
ERR	−0.0001	−0.001	−0.001	0.0005
	(0.001)	(0.001)	(0.001)	(0.001)
inflation	−0.00000	−0.00000	−0.00000	−0.00000
	(0.00000)	(0.00000)	(0.00000)	(0.00000)
broad money	0.0003**	0.0003*	0.0001	
	(0.0001)	(0.0002)	(0.0001)	
lag(% of gold, 0:1)0		0.029		
		(0.024)		
lag(% of gold, 0:1)1		−0.036		
		(0.041)		
lag(log GDP cap, 0:1)0			−0.012	
			(0.015)	
lag(log GDP cap, 0:1)1			0.0004	
			(0.018)	
lag(broad money, 0:1)0				0.0003
				(0.0003)
lag(broad money, 0:1)1				0.0002
				(0.0001)
Observations	2577	2573	2567	2565

Notes:
[1] The table reports generalized method of moments estimation for panel data carried out using the "plm" package in R Studio (Croissant & Millo 2008). The twoways effect, when the model is estimated in first differences and time dummies are included, was employed. We used two-step estimation, as in that case the standard covariance matrix should be robust to panel-specific autocorrelation and heteroskedasticity. Standard errors are reported in brackets.
[2] *, **, *** indicates significance at 10 percent ($p < 0.10$), 5 percent ($p < 0.05$) and 1 percent ($p < 0.01$), respectively.

Table E.4: Estimation results using GMM - different lags of dependent variable

	Dependent variable:			
	LVAW	LVAU	LVAW	LVAU
	(1)	(2)	(3)	(4)
lag(LVAW, 1)	−0.294			
	(0.351)			
lag(LVAU, 1)		0.074		
		(0.150)		
lag(LVAW, 1:3)1			−0.333	
			(0.397)	
lag(LVAW, 1:3)2			0.006	
			(0.306)	
lag(LVAW, 1:3)3			0.176	
			(0.220)	
lag(LVAU, 1:3)1				−0.177
				(0.153)
lag(LVAU, 1:3)2				−0.036
				(0.083)
lag(LVAU, 1:3)3				−0.012
				(0.099)
% of gold	0.036	−0.065	−0.008	0.024
	(0.060)	(0.040)	(0.051)	(0.032)
log GDP cap	0.033	0.00003	0.005	0.007
	(0.024)	(0.016)	(0.026)	(0.017)
CurA to GDP	0.0002	0.00003	0.0002	0.0001
	(0.0002)	(0.0001)	(0.0003)	(0.0002)
ERR	−0.0001	−0.0001	0.00003	0.0003
	(0.001)	(0.001)	(0.001)	(0.001)
inflation	−0.00000	−0.00000	−0.00000	−0.00000
	(0.00000)	(0.00000)	(0.00000)	(0.00000)
broad money	0.001**	0.0002	0.0003	0.0003*
	(0.0003)	(0.0002)	(0.0002)	(0.0002)
Observations	2608	2608	2539	2539

Notes:
[1] The table reports generalized method of moments estimation for panel data carried out using the "plm" package in R Studio (Croissant & Millo 2008). The twoways effect, when the model is estimated in first differences and time dummies are included, was employed. We used two-step estimation, as in that case the standard covariance matrix should be robust to panel-specific autocorrelation and heteroskedasticity. Standard errors are reported in brackets.
[2] *, **, *** indicates significance at 10 percent ($p < 0.10$), 5 percent ($p < 0.05$) and 1 percent ($p < 0.01$), respectively.

E.2.1 Tests for GMM models in Appendix

All the tests are performed on robust standard errors. Sargan test shows under the null hypothesis that the over-identifying restrictions are valid. In all our cases we fail to reject the null hypothesis, so we consider that the over-identifying restrictions are valid.

The Arellano - Bond test for autocorrelation has a null hypothesis of no autocorrelation and is applied to the differenced residuals. The test for AR (1) process in first differences usually rejects the null hypothesis. The test for AR (2) in first differences is more important, because it detects autocorrelation in levels (Mileva 2007). We cannot reject the null hypothesis for the test AR (1) in none of here disclosed models. However, in the model in column (2) in Table E.4, we have to consider autocorrelation of second order.

The Wald tests for coefficients tests if the coefficients are simultaneously equal to zero, ie if coefficient is relatively small to its standard error. We fail to reject the null hypothesis, and thus we can state the Wald test is confirming what we see in the model - that none of the coefficient seems to be statistically significant. Only in one case - the model reported in column (4) of Table E.3 we reject the null hypothesis at level 5%. In this model the coefficient of share of gold is negative, however the LDV is positive, which is not expected sign.

We reject the null hypothesis of Wald test for time dummies in all but one model[1]. In such situation, we do not want to exclude the time dummies from the model.

[1] We fail to reject the null hypothesis for time dummies in column (1) in E.4.

Table E.5: Test statistics related to Table E.3

	Models:			
	column (1)	column (2)	column (3)	column (4)
Sargan test	17.265	20.678	19.193	22.495
p-value	*1*	*1*	*1*	*1*
Autocorrelation test (1)	0.476	0.877	-0.538	0.052
p-value	*0.634*	*0.381*	*0.591*	*0.959*
Autocorrelation test (2)	-1.335	-1.370	-1.165	-0.380
p-value	*0.182*	*0.171*	*0.244*	*0.704*
Wald test for coefficients	12.072	11.684	8.171	17.361
p-value	*0.148*	*0.232*	*0.517*	*0.043*
Wald test for time dummies	130.632	66.343	101.988	133.858
p-value	*≈ 0.00*	*0.006*	*≈ 0.00*	*≈ 0.00*

Table E.6: Test statistics related to Table E.4

	Models:			
	column (1)	column (2)	column (3)	column (4)
Sargan test	16.387	23.416	22.489	22.330
p-value	*1*	*1*	*1*	*1*
Autocorrelation test (1)	0.823	-0.623	0.704	0.993
p-value	*0.411*	*0.533*	*0.481*	*0.321*
Autocorrelation test (2)	-1.901	-2.173	-0.337	-0.005
p-value	*0.0573*	*0.030*	*0.736*	*0.996*
Wald test for coefficients	10.284	9.098	3.145	3.744
p-value	*0.173*	*0.246*	*0.958*	*0.927*
Wald test for time dummies	44.572	106.350	71.235	90.677
p-value	*0.324*	*≈ 0.00*	*0.001*	*≈ 0.00*