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Determinants of central banks' financial strength: evidence from Central and Eastern European countries[1]

Barbara Pajdo[2]

Abstract: The central banks' financial strength supports financial stability. Now in a low interest rate world it should receive much more attention as many central banks had experienced financial difficulties mainly due to operating and valuation losses. The purpose of this paper is to investigate the determinants of central banks' financial strength and find the most appropriate measure of it. The empirical analysis is based on data from a ten-year panel for central banks from Central and Eastern European Countries that are members of the European Union (EU), but have not adopted the euro.

Keywords: central banking, financial strength, accounting framework, profit distribution.

JEL codes: E42, E58, E61, G28, M41.

Introduction

The financial position of a central bank is often treated as irrelevant because of the social nature of a central bank's objectives, its money issuing monopoly and its state ownership. However the central bank financial strength (CBFS) has become more relevant over the last years as central banks have brought inflation and nominal interest rates to low levels and balance sheet risks have increased. A deflation in the context of a low or zero interest rate environment is a serious problem and requires non-traditional approaches to policy, including cooperation between the central bank and the government. Many central banks in emerging or developing countries experienced recurrent losses due to relatively low inflation and the increasing accumulation of foreign exchange (FX) reserves. They use risky operations in order to overcome or prevent deflation. It raises concerns about the ability of central banks to cover the costs of providing

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[2] Narodowy Bank Polski, Accounting & Finance Department, Świętokrzyska 11/21, 00-919 Warszawa, Warsaw School of Economics, Collegium of World Economy, Al. Niepodległości 162, 02-554 Warszawa, Poland, barbara.pajdo@nbp.pl.

monetary services without depleting their capital. These trends point to the need for a greater understanding of the role of CBFS in making policy.

There is no bankruptcy procedure for a central bank. There is no institution that will judge if a central bank's debts exceed its liabilities and force it to reorganize or to be liquidated. Even if any private agent wants to settle a claim that it has on the central bank, or is willing to sell it a good or asset, then as long as the claim or price are denominated in units of currency, the central bank will always be able to pay. The central bank can print currency which is legal tender to settle any debts and buy any goods (Reis, 2015). Furthermore there are typically three reasons to measure a corporation's financial standing: to calculate the residual winding up value of the corporation, to assess its market value and to ascertain the weight of equity versus credit in the firm's funding. Hall and Reis (2015) state that none of those reasons applies to a central bank. Central banks cannot be liquidated because their creditors cannot make a run on the bank. Central banks also do not have a meaningful market value since their goal is not profit maximisation and shares in the bank are typically not traded. Finally the government owns the central bank and it often becomes creditor too.

The capitalization and profitability of central banks is a relatively new topic as only financial market turbulence shows consequences of a weak central bank balance sheet. As a result CBFS is now perceived not only as an issue in shaping a particular country's monetary policy but also as an issue with potentially global implications, including financial stability. Moreover the adoption of more transparent accounting standards, including fair value accounting, has revealed more volatility in equity. If a central bank depends on transfers from the government the latter has the opportunity to influence the central bank's policy, e.g. by attaching conditions to the transfers. Financial strength helps the central bank protect its independence, which is a crucial component of its credibility.

This study aims to present and examine how the CBFS could be measured. It focuses on a small group of countries with similar characteristics in order to be able to make comparisons that are more relevant. A comparative analysis was made amongst central banks from Central and Eastern European Countries[3] that are members of the EU, but have not adopted the euro, i.e. Bulgaria, Croatia, the Czech Republic, Hungary, Poland and Romania. Thus the analysis of financial strength is illustrated with the empirical panel models over the period 2005-2014 for six central banks. It focuses on the microeconomic and macroeconomic determinants of the CBFS. The sources are central banks' financial statements, national legislation and data available on the World Bank website. This paper is organised as follows: section 1 deals with the literature review of financial strength in central banks; section 2 reviews the legal and accounting

[3] Central and Eastern European Countries (CEECs) is an OECD term for the group of countries comprising Albania, Bulgaria, Croatia, the Czech Republic, Hungary, Poland, Romania, the Slovak Republic, Slovenia, and the three Baltic States: Estonia, Latvia and Lithuania.

framework under which central banks operate; section 3 describes the data and methodology used; section 4 presents the empirical results of the CBFS's econometric estimation and the last section includes a summary of the main results of the paper.

1. Central banks' financial strength in a literature context

A lot has been written by central bank experts in the past decade on central bank independence and its connection with the CBFS, sometimes with conflicting views. A number of studies have argued that financial weakness could impair the central bank's pursuit of price stability. Other studies have suggested that central banks can successfully operate with negative equity. The European Central Bank (ECB) indicated in its 2010 Convergence Report that the overall independence of a central bank would be jeopardized if it could not autonomously avail itself of sufficient financial resources to fulfil its mandate. However in all papers an open question remains as to how the financial strength of a central bank should be defined and what it should encompass as there are no representative measures and proxies of CBFS.

Pringle (2003) and Cargill (2006) stressed that capital in the traditional sense is a weak measure of CBFS because it did not take into account contingent liabilities, for example interventions to support the exchange rate or the need to bail out the financial sector. Stella (2005) defined financial strength as the central bank's ability to generate sufficient revenue to cover the costs of providing the monetary services that it committed to under a variety of macroeconomic events. A central bank could be regarded as financially strong if it could conduct operations in the present and future without incurring operating losses. For Archer and Moser-Boehm (2013) financial strength meant the capacity to continue performing the functions for which the central bank was responsible. Whereas Swiston et al. (2014) used the term CBFS to refer to a net income position and balance sheet that did not undermine the pursuit of its policy commitments. According to Buiter (2008) the central bank's conventional financial net worth or equity was the excess of the value of its financial assets over its non-monetary liabilities and its monetary liabilities. Pinter (2015) indicated that the higher the comprehensive net worth, consisting of effective equity (the difference between assets and liabilities of the balance sheet valued at market prices) and the net present value of future income, the less likely the policy insolvency and therefore the higher the structural financial strength of the central bank. Ize (2005) derived a concept of "core capital" (a function of the central bank's operating expenditures and the carrying cost of its international reserves) as the minimum capital needed by a central bank to ensure the credibility of its inflation target. Later in 2007 Ize measured CBFS using structural net income (net interest income, commis-

sions and fees). He found that the financially weaker central banks tend to tolerate higher rates of inflation.

Many other studies have analysed the relationship between CBFS and policy performance. For example, Stella (2002 and 2005) by using a wide sample of central banks over a period of three different years investigated whether a proxy for central bank strength was correlated with the attainment of price stability. He concluded that the central bank was financially strong if the resources possessed were sufficient to attain its fundamental policy objectives. His results confirmed the hypothesis that central banks with weak financial positions tended to be associated with higher inflation. Similarly Ueda (2004) cited evidence from developing countries where higher levels of inflation occurred in cases where central bank capital positions were weak. Bindseil et al. (2004) explored the role of central bank capital in ensuring the focus on price stability and developed a simple model of the relationship between a central bank's balance sheet and its inflation performance. In this model central banks always returned to profitability in the long run regardless of the starting levels of operating costs and capital. Kluh and Stella (2008) indicated that there was a negative relationship between CBFS and inflation outcomes. However this relationship appeared to be robust with respect to the conceptualizations of CBFS. Adler et al. (2016) supported the view that CBFS mattered for the conduct of monetary policy. They found that CBFS could be a statistically significant factor explaining large negative interest rate deviations from an estimated forward-looking Taylor rule. Perera et al. (2013) concluded that CBFS was vital to maintain price stability as there was a statistically significant and robust negative relationship between CBFS and inflation.

Central banks enjoy significant 'franchise value' through their monopoly to print money. Thus some researchers state that currency at the central bank plays a financial role very similar to capital. For example, Bini Smaghi (2011) argued that the privilege to issue legal tender gave central banks an additional financial buffer in the form of seigniorage income. The seigniorage income expected for the future constitutes an implicit financial buffer that needs to be considered when assessing the economic capital of a central bank. Technically a central bank does not require capital to conduct policy but it does need to generate enough revenue to cover the costs of providing monetary services as a financially weak central bank loses credibility with the public. Stella (2003) recognized that a higher level of financial strength reduced the probability that a treasury rescue would be needed, consequently increasing the credibility of the central bank to successfully achieve price stability.

Financial strength is forward-looking and focuses on the risks that the central bank incurs in committing to a specific policy target in spite of losses it may incur in so doing . There are examples of central banks with negative capital that have not suffered from credibility problem such as the Czech National Bank. Holub (2001) argued that the key question for a central bank's financial

stability was whether it was able to generate positive profits even with its own zero capital. Sometimes, especially when the negative net worth was brought about by valuation losses only, a central bank might work well even with negative capital, which in turn could be considered neither a signal of potential illiquidity, nor a signal of insolvency or limited credibility. On the other hand Dalton and Dziobek (2005) warned that failure to address on-going losses, or any ensuing negative net worth, would interfere with monetary management and might jeopardize a central bank's independence and credibility.

The relationship between CBFS and policy may differ across countries based not just on quantitative indicators but can also depend on accounting standards, expectations of the financial position in the future and institutional factors such as the relationship with the government and laws governing recapitalisation (Swiston et al., 2014). Holub (2001) analysed the relationship between capital and central banks' profits. He showed that the higher the profits, the higher was the net capital of central bank. Martinez-Resano (2004) stated that a central bank's balance sheet structure was relevant both on operational and financial independence grounds. Different operationally equivalent solutions might have different financial implications if they determined a different central bank risk-return profile. He pointed out that full, fair value accounting could be problematic for profit distribution purposes and some departure from standards was needed such as profit smoothing and priority on appropriation of central bank income for financial strength purposes. Another paper (Schwarz et al., 2014) provided evidence that accounting rules could be detrimental to financial strength. Although private shareholders are profit oriented, Bartels et al. (2016) found that central banks with private shareholders were neither more nor less profitable than purely public central banks. Del Negro and Sims (2015) stated that the possible need for fiscal support arose for a central bank with a large balance sheet composed of long duration nominal assets. Bholat and Darbyshire (2016) argued that if the CBFS, as registered in its financial statements, weakened, there might be a crisis of confidence in the central bank that could impact the whole of the economy.

Central banks need an adequate level of financial strength in order to finance their monetary policy operations and its operating costs out of its means whilst also possessing buffers of a general or specific nature that are adequate to absorb the materialisation of the risks to which it is exposed (Ingram, 2014). Vergote et al. (2010) assessed the financial strength of the ECB. They concluded that the ECB, like other central banks, required financial strength to credibly commit to a given nominal policy objective and contribute in a credible way to other potentially costly tasks of the Eurosystem such as financial stability interventions. Three arguments were presented as to why the financial strength was needed. First, a strong financial position helped the central bank to protect its independence from the government – a crucial component of its credibility. Second, it avoided the need or temptation to resort to printing money solely to

support its financial position, an act that would conflict with the ECB's price stability objective. Third, it avoided doubts about its willingness to incur costs that would weigh on its financial position, e.g. to perform its lender of last resort function in the case of financial instability.

Financial strength cannot be measured only by conventional balance sheet ratios. It is difficult to measure since it depends on the asset structure of the central bank, the cost of providing monetary services and the macroeconomic events that influence operating profit. Heterogeneity in accounting standards and institutional factors such as the relationship with the government and laws governing recapitalization also cause difficulty in defining financial strength. However it should be stated that the main factors affecting CBFS are primarily the central bank's function, the risks central banks face, applied accounting rules, including the possibility to set up rainy days provisions and also profit distributions and recapitalisation rules. To understand central bank finances it is first necessary to understand the role of central banks, thus next sections present main characteristics of selected central banks and components of their financial strength.

2. Central banks' functions, accounting frameworks and profit distribution rules

Central banks are typically conventional institutions having been established many years ago as part of the emerging identity of a country. The roles of central banks have evolved since their foundation. The original charters empowered the central banks to issue currency and provide banking services to the government. Subsequent reforms enlarged the mandate to include serving as a reserve bank and lender of last resort and eventually authority over monetary and exchange rate policy. The purpose of central banks has expanded from banker to the government, to banker to the banking system, to overall macroeconomic management. The need for financial strength depends on the possible risks related to the execution of the mandated tasks. Table 1 presents an overview of the current mandates of six selected central banks: the central bank of the Republic of Bulgaria – the Българска народна банка (BNB), the central bank of the Republic of Croatia – the Hrvatska Narodna Banka (HNB), the central bank of the Czech Republic – the Česká národní banka (CNB), the central bank of Hungary – the Magyar Nemzeti Bank (MNB), the central bank of the Republic of Poland – the Narodowy Bank Polski (NBP) and the central bank in Romania – the Banca Națională a României (BNR).

Maintaining a strong balance sheet and structural profitability helps to safeguard the CBFS, and can significantly reduce the possibility that a crisis will create difficulties in meeting central bank obligations. However nowadays there is no harmonization amongst central banks' accounting policies

Table 1. Central banks' functions in Central and Eastern European Countries

Function	BNB	HNB	CNB	MNB	NBP	BNR
Monetary and exchange rate						
Maintain price stability as a primary objective	×	×	×	×	×	×
Design and implement monetary policy	×	×	×	×	×	×
The exclusive right to issue banknotes and coins	×	×	×	×	×	×
Payment system management and oversight	×	×	×	×	×	×
International reserves management	×	×	×	×	×	×
Set the exchange rate policy	–	×	×	×	×	×
Financial system						
Maintain financial stability	×	×	×	×	×	×
Lender of a last resort	×	×	×	×	×	×
Regulate and supervise the banking system	×	×	×	×	–	×
The Central Credit Register	×	–	×	–	–	×
Government relations						
Bank of the state – provide bank account services	×	×	×	×	×	×
Support the economic policy of the government	–	–	×	×	×	–
No lending facilities to the government	×	×	×	×	×	×
Other functions						
International financial institutions relations	×	×	×	×	×	×
Statistics: collection and production	×	×	×	×	×	×
Economic research	×	×	×	×	×	×

Source: National legislation.

(see Table 2). International Financial Reporting Standards (IFRS) are written primarily for commercial entities that pursuit profit maximization or shareholder value in financial terms, its application to central banks is not straightforward (Sermon, 2005). This was the main reason for the creation of separate accounting standards determined by the Guideline of the ECB on the legal framework for accounting and financial reporting in the European System of Central Banks (ESCB). The income recognition and the creation of provision are a major source of discrepancy between IFRS and ESCB Guideline or National rules.

Table 2. Accounting framework of the Central and Eastern European central banks

Central bank	Accounting framework
Българска народна банка (BNB)	IFRS
Hrvatska Narodna Banka (HNB)	IFRS
Česká národní banka (CNB)	National rules
Magyar Nemzeti Bank (MNB)	National rules
Narodowy Bank Polski (NBP)	ESCB Guideline
Banca Națională a României (BNR)	ESCB Guideline

Source: Respective annual accounts for the financial year of 2014. "National rules" in this table refer to national GAAP or any kind of a dedicated legal act on central bank's accounting.

For all the central banks selected the government is at the same time shareholder, tax collector and lawmaker. Thus the Act set by government determines how the central bank should distribute surplus profits to government. In general three main methods of profit distribution to government can be distinguished. The first is where a fixed percentage of the annual profit has already been determined either by way of agreement or as codified in central bank law such as in the case of NBP (95% of the annual profit is remitted to central government) or at BNR (80% of net revenue is transferred, on a monthly basis, to the State budget). The second method is the distribution of the residual amount of net profit after having covered all costs, set up the necessary provisions and transferred the required amounts to reserves. The BNB, HNB and CNB follow the second method of profit distribution. The last method is the approach

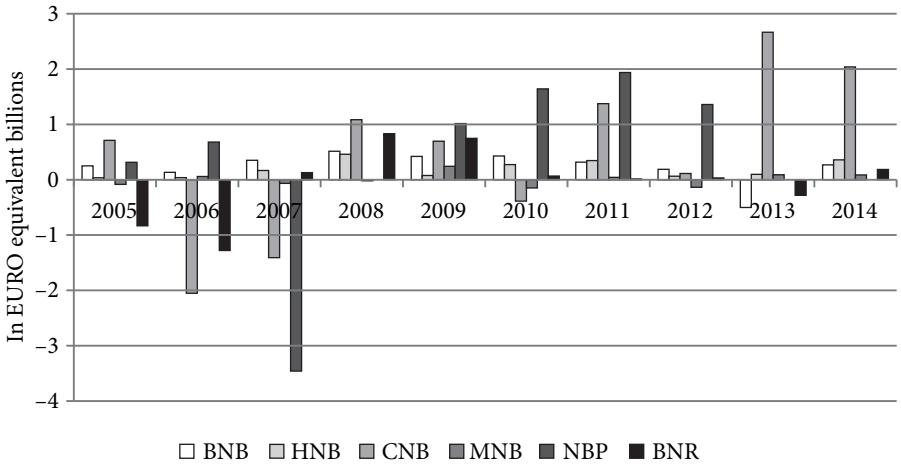

Figure 1. Development of the Central and Eastern European central banks' financial results for years 2005-2014

Source: Own constructions based on the central banks' financial statements.

adopted by the MNB. The Bank pays a dividend according to the decision of the General Meeting either from its profit for the year or from its retained earnings. The annual net profit less dividends is then transferred to a profit reserve.

Central banks need to avoid losses with a view to maintain their balance sheet strength and hence to support financial stability. However in recent years many central banks incurred losses (see Figure 1). The risk of incurring a loss in a central bank may result from securities' valuation at market prices, the open currency position, interest rate asymmetry and financial aid for commercial banks. Losses, especially if they continue for several years, could affect a central bank's reputation and credibility so they could also weaken the effectiveness of its monetary policy (Bunea et al., 2016).

Nevertheless, the principal source of finance to cover losses generated by central bank policy and other actions is the earnings from its operations, not the recapitalisation from the government.

3. Data and methodology

This study searches for the determinants of financial strength in central banks. Therefore the dependent variable is CBFS. Taking into account the complexity of the concept of CBFS and the difficulty of capturing it with a single indicator various measures of financial strength are applied. A measure of CBFS is defined based on the net equity that comprises statutory capital, reserves (including legal/statutory reserves or general reserve fund, revaluation reserves, retained earnings, other reserves and any loss carried forward), revaluation accounts and risk provisions equivalent to reserves.[4] The implementation of revaluation accounts and the building-up of the general reserve and special provisions further protect the central bank's capital to a great extent. Net equity may serve as a buffer for those risks that need to be borne by the central bank. Three different measures of CBFS are examined with a view to select an appropriate proxy for the main explanatory variables. Firstly, a ratio of net equity to total assets is selected as it was used in the previous studies (e.g. Kluh & Stella, 2008; or Pinter, 2015):

$$CBFS_{1,it} = \frac{net\ equity_{it}}{total\ assets_{it}}, \tag{1}$$

where subscript i denotes individual central bank and t represents year.

A ratio of net equity to total assets indicates the relative proportion of a central bank's assets financed by its own resources. This indicator gives an over-

[4] Provisions equivalent to reserves can only be created by the MNB for the off-balance sheet positions and by the NBP for FX rate risk.

view as to how well central banks are capitalized, at least officially (see Figure 2). Some central banks – such as those in Bulgaria and Croatia – report high levels of net equity relative to the size of their balance sheet. This was similar to the end of 2013 when the HNB, BNB reported the highest ratios of 12.6% and 12.5%, respectively. On the other hand the CNB has operated successfully with a relatively low net equity position. The CNB was in negative net equity from 1998 until 2013 and the BNR was in negative equity in 2006. In case of CNB the negative trend has reversed since 2007. In 2014 with respect to the net equity ratio the largest improvement was shown by the NBP (+7.7 percentage points) and the CNB (+5.0 percentage points).

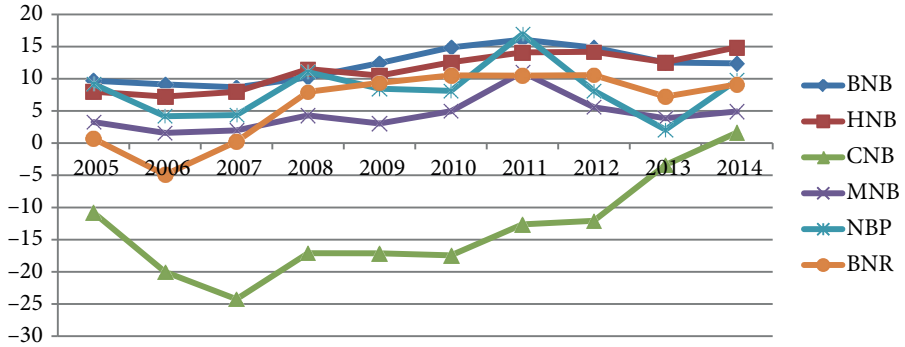

Figure 2. Development of the Central and Eastern European central banks' $CBFS_1$ for years 2005-2014 (in percentage)
Source: Own constructions based on the central banks' financial statements.

Although it is natural benchmark to start with formula (1), it may be too narrow in the central bank context. There is a remarkable diversity of net equity levels amongst central banks but in case of the BNB, MNB, NBP and BNR the revaluation accounts have constituted the major part of this . The revaluation reserves accounted for over 90% of net equity of the NBP, BNR and MNB in 2014. As the level of the revaluation accounts is not under the direct influence of the central banks in the subsequent measure of CBFS the revaluation accounts are excluded from the net equity (see also Figure 3):

$$CBFS_{2,it} = \frac{net\ equity_{it} - revaluation\ accounts_{it}}{total\ assets_{it}}, \qquad (2)$$

where subscript *i* denotes individual central bank and *t* represents year.

If revaluation accounts are excluded from net equity, apart from the CNB (2005-2013) and the BNR (2005-2008), the NBP also had negative capital in 2008 and 2013 (see Figure 3). In 2014 all central banks reported the growth in net equity excluding the revaluation accounts. The biggest improvement was

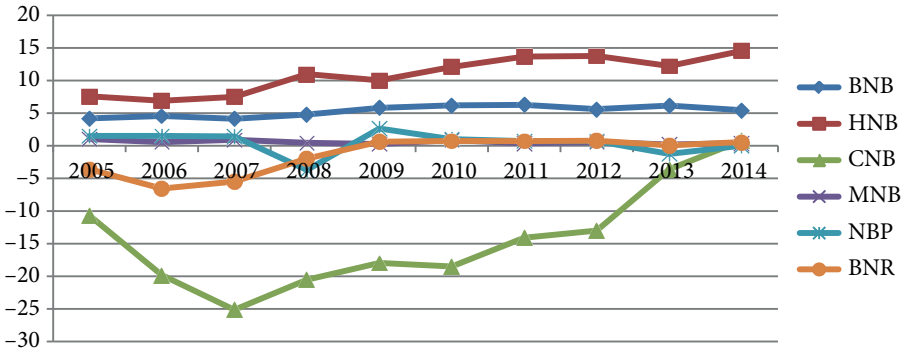

Figure 3. Development of the Central and Eastern European central banks' $CBFS_2$ for years 2005-2014 (in percentage)
Source: Own constructions based on the central banks' financial statements.

reported by BNR in that net equity excluding revaluation increased more than seven times. As at the end of 2014 the HNB and BNB had the highest net equity ratio excluding the revaluation accounts of 14.55% and 5.46% respectively (in 2013: 12.23%, 6.16% respectively). The largest improvement in that ratio was shown by the CNB (+2.8 percentage points).

The next ratio is a broader measure of financial strength that captures not just central bank net equity but also issued banknotes as a non-interest bearing liability, allowing the central bank to generate seigniorage:

$$CBFS_{3,it} = \frac{net\ equity_{it} + banknotes\ in\ circulation_{it}}{total\ assets_{it}}, \qquad (3)$$

where subscript *i* denotes individual central bank and *t* represents year.

$CBFS_3$ extends well beyond their accounting equity because the issued currency behaves in many respects like equity (and it typically grows over time, in spite of all financial innovation) rather than debt obligations. As banknotes in circulation bear no interest and are perpetual in character they provide a stable funding base for income generation. The inclusion of banknotes makes a large difference to the level of financial buffers available to central banks, especially in a case of the CNB (see Figure 4). It can be observed if we take this ratio for the assessment of financial strength there are no significant differences among central banks. This is also the most stable ratio over the period analysed and in all years for all central banks it is positive (minimum for the BNR in 2006 and maximum for the NBP in 2008, 13.45% and 58.22% respectively).

A set of potential explanatory variables was formulated based on the prior theoretical and empirical studies examining CBFS that were described in previous sections. Firstly, the bank specific variables were selected. They were obtained from the annual financial statements of the selected banks.

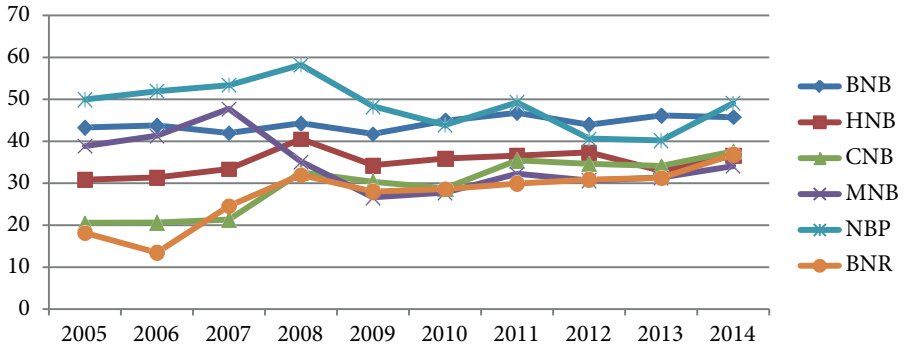

Figure 4. Development of the Central and Eastern European central banks' $CBFS_3$ for years 2005-2014 (in percentage)
Source: Own constructions based on the central banks' financial statements.

The accounting framework could be significant as the financial strength is influenced by income recognition rules. To capture it a 3-category variable is constructed based on the observations made of qualitative data in the financial statements. The variable is recoded into three proper dummies: *National rules* (used as reference category), *IFRS* ($IFRS_i$) and *ESCB Guideline* ($ESCB_i$).

The next factor shaping the dynamics of CBFS is the mechanism used to determine how much of the distributable income is transferred to the government and how much of it is added to financial buffers. Therefore the second variable is *the profit distribution ratio* ($DIST_{it}$) that measures how much of the profit is transferred to the government.

In case of CNB, NBP and BNR there is a distribution asymmetry as profits are shared with the government but losses are kept by the central bank. For other central banks automatic recapitalizations have effects similar to contingent distribution schemes. Thus *the recapitalisation* (REC_i) is the next considered variable. The binary form of data is used 1 if there is recapitalisation by the government and 0 in other case.

Both the global financial crisis response and the subsequent implementation of unconventional monetary policy led to significant increases in *the size of the central bank's balance sheet* ($SIZE_{it}$). It is measured in terms of natural logarithm of its total assets. The implicit assumption is that a higher balance sheet size entails higher risks. In the analysed period all central banks reported growth in balance sheet total, the largest in the NBP and MNB, by 168% and 136% respectively.

One of the main reasons for losses in central banks is the appreciation of the domestic currency versus foreign currency reserves. The unhedged foreign reserve positions are subject to exchange rate risk that can lead to negative financial results, particularly if they occur in a low interest rate environment, i.e. when other income is low. *A ratio of net foreign exchange reserves to total*

assets (FX/TA_{it}) is one of the FX risk indicators associated with central bank balance sheet position. Greater FX reserves should mean the need for greater net equity to provide buffers for volatility, for example if the domestic currency appreciated.

Although profitability is not a primary consideration for a central bank, profits and losses are important determinants of a central bank's finance. *A return on assets* (ROA_{it}) is an indicator of how profitable a bank is relative to its total assets. It reflects the capacity to generate sustainable profitability. Profitability is a central bank's first line of defence against unexpected losses as it strengthens its capital position. A central bank that persistently makes a loss will ultimately deplete its capital base. In 2014 the CNB, HNB and BNB reached the highest ROA and ROE. They had also the highest average ROA for the period of 10 years. In the case of NBP the financial results for 2008, 2013 and 2014 amounted to zero.

Higher financial risks mean lower profitability. Hence more central banks are under stress conditions. In a central bank the main source of income is interest income that arises primarily from monetary policy and investment activities. A low interest rate environment can drive the net interest income from foreign reserves down and depress the annual result. Thus *a ratio of net interest result to total result* ($\%R\_TR_{it}$) is selected.

Sufficient regular income should be provided in order to finance operating expenses such as operating expenses, including staff costs, administrative expenses, depreciation of fixed assets, banknotes production services. The next variable *the ratio of other expenses to total result* (EXP_TR_{it}) gives an idea as to how cost efficient management is.

In all central banks, statutory capital has not changed since 2005 but *a ratio of capital to net equity* (C_NE_{it}) is still decreasing from 12% in 2005 to 5% in 2014. This may be a sign of the need for a capital injection.

The appropriate amount of net equity for a central bank can vary greatly depending on not only the institutional settings but also the economic environment in which it operates. As there is a robust relationship between financial strength and macroeconomic outcomes, as many studies proved, the macroeconomic specific explanatory variables are also examined.

A central bank influences the level of inflation mainly by determining the official interest rates which define yields on monetary policy instruments. Thus *the reference interest rate* ($\%RATE_{it}$) set by central banks was selected from the central banks' websites. At present interest rates are very low and this may cause a deterioration of CBFS.

Some empirical studies find a negative relationship between CBFS and inflation. In order to verify this one of the explanatory variables is *inflation* ($INFL_{it}$). Inflation as measured by the consumer price index reflects the annual percentage change in the cost to the average consumer of acquiring a basket of goods and services that may be fixed or changed at specified intervals, such as

yearly. It is obtained from the International Financial Statistics and data files of International Monetary Fund.

To assess the possible impact of overall economic activity in a country on the CBFS the annual percentage growth rate of GDP at market prices based on a constant local currency is taken. *GDP growth* (ΔGDP_{it}) is expected to have a positive impact on the CBFS. The statistics for the growth of GDP are from the database World Development Indicators.

4. Empirical analysis of central bank financial strength

In order to review the above theoretical suggestions the econometric model of CBFS is developed using two of the presented categories of proxy variables above namely: (1) bank specific and (2) macroeconomic specific. The annual data of six central banks of Central and Eastern European countries are used and the sample spans the period 2005-2014. Thus there are 6 cross sectional units and 10 time periods. In all, therefore, we have 60 observations. Balanced panel data is obtained because the same time periods are available for all central banks.

Table 3. Descriptive statistics

Variable	N	Mean	Std Dev	Minimum	Maximum
$CBFS_1$	60	4.82421	9.69246	–24.25489	16.94868
$CBFS_2$	60	0.27129	8.52363	–25.13560	14.55316
$CBFS_3$	60	36.55577	9.19827	13.45315	58.22293
National rules/IFRS/ESCB	60	0.33333	0.47538	0.00000	1.00000
REC	60	0.50000	0.50422	0.00000	1.00000
ΔGDP	60	2.12992	3.66608	–7.38378	8.45898
INFL	60	3.59718	2.55426	–1.41812	12.34877
%rate	60	4.48217	2.97379	0.02000	10.25000
ROA	60	0.76747	2.59045	–7.32706	6.40460
C_NE	60	7.91105	12.34791	–3.62535	49.77770
FX_TA	60	63.00731	27.16416	7.23888	94.34432
exp_TR	60	–47.33593	192.49695	–1070.00000	573.22063
%r_TR	60	13.88837	211.53729	–951.74611	483.84804
SIZE	60	26.36449	1.88161	23.56744	30.16793
DIST	60	21.69379	32.72968	–6.36470	95.00000

Source: Own calculations in the SAS system.

To analyse this panel data two classes of panel estimator approaches are considered: fixed effects models and random effects models. With a fixed effects model, the effects of time invariant variables (such as the accounting framework or recapitalisation) cannot be estimated. Whereas their impact on dependent variable can be enumerated in a generalised least squares (GLS) procedure under the random effects approach. Additionally, since there are fewer parameters to be estimated with the random effects model and therefore degrees of freedom are saved, the random effects model should produce a more efficient estimation than the fixed effects approach. The Hausmann test is applied to select the appropriate estimation method.

Table 3 presents the descriptive statistics for all empirical variables used in this analysis. A high standard deviation for a ratio of other expenses to the total result and a ratio of the net interest result to total result shows that the data are widely spread. The average of the ratio of net equity to total assets ($CBFS_1$) is 4.8%. The highest mean is for $CBFS_3$ (with banknotes in circulation) at 36.6% with the deviation from the mean at 9.2% and the lowest mean is for $CBFS_2$ (without revaluation accounts) at 0.3% with the deviation from the mean at 8.5%. The $CBFS_3$ variable does not have the negative value for any of the central banks (see Table 4).

Table 4. Central bank financial strength classified by central bank

Central bank	$CBFS_1$			$CBFS_2$			$CBFS_3$		
	Mean	Min	Max	Mean	Min	Max	Mean	Min	Max
BNB	12.09	8.68	16.09	5.32	4.15	6.28	44.27	41.77	46.79
CNB	–13.32	–24.25	1.65	–14.25	–25.14	0.79	29.62	20.58	37.59
HNB	11.35	7.24	14.90	10.93	6.90	14.55	34.99	30.85	40.55
MNB	4.45	1.58	11.02	0.57	0.21	1.03	34.59	26.65	47.75
NBP	8.23	2.09	16.95	0.46	–3.71	2.64	48.49	40.21	58.22
BNR	6.13	–4.91	10.57	–1.41	–6.56	0.78	27.37	13.45	36.83
Total (all)	4.82	–24.25	16.95	0.27	–25.14	14.55	36.56	13.45	58.22

Source: Own calculations in the SAS system.

The highest CBFS is when IFRS is used for the preparation of the central banks' annual accounts whereas the lowest is when central banks apply national rules (see Table 5).

Table 6 presents the Spearman correlation coefficients for dependent variables and a set of potential explanatory variables along with their significance probabilities associated with correlations (p values). The correlations are presented in decreasing order of magnitude.

Table 5. Central bank financial strength classified by accounting framework

Central bank	$CBFS_1$			$CBFS_2$			$CBFS_3$		
	Mean	Min	Max	Mean	Min	Max	Mean	Min	Max
National rules	–4.43	–24.25	11.02	–6.84	–25.14	1.03	32.11	20.58	47.75
IFRS	11.72	7.24	16.09	8.13	4.15	14.55	39.63	30.85	46.79
ESCB Guideline	7.18	–4.91	16.95	–0.47	–6.56	2.64	37.93	13.45	58.22
Total (all)	4.82	–24.25	16.95	0.27	–25.14	14.55	36.56	13.45	58.22

Source: Own calculations in the SAS system.

The explanatory variables that are significantly correlated with each CBFS measure (p value < 5%) include: IFRS framework, the size of the central bank's balance sheet, the profit distribution ratio, a ratio of net foreign exchange reserves to total assets, return on assets and a ratio of capital to net equity. For every CBFS variable there is a negative correlation with the size of the central bank's balance sheet, which means the higher total of the balance sheet of central bank, the lower the financial strength. Whilst there is positive correlation with ROA, so the higher the profitability, the greater the financial strength. The variables that were not significantly correlated with the dependent variable have been eliminated i.e. the reference interest rate, a ratio of net interest result to total result, ESCB Guideline and inflation for $CBFS_1$, ESCB Guideline, GDP growth, a ratio of other expenses to the total result, the reference interest rate and inflation for $CBFS_2$, recapitalisation, inflation, a ratio of net interest result to the total result, ESCB Guideline, GDP growth and a ratio of other expenses to the total result for $CBFS_3$. Interestingly the results confirm the negative correlation between inflation and financial strength for each model, but inflation is not important for the explanation of any CBFS variables.

The canonical correlation analysis is used to determine whether the macroeconomic variables are related in any way to the bank specific variables. The correlation between macro and bank specific variables are moderate – the largest being –0.5254 between %RATE and FX_TA. There are larger within-set banking specific correlations, e.g. –0.7982 between IFRS and SIZE. However the first canonical correlation is 0.9047 which would appear to be substantially larger than any of the between-set correlations. To test the null hypothesis that the first set of macroeconomic variables is independent from the second set of bank specific variables Wilk's lambda is applied. As the Wilks' lambda $\Lambda = 0.0786$; $F = 6.37$ and $p < 0.0001$, it indicates rejection of the null hypothesis that there is no relationship between the two sets of variables and can conclude that the two sets of variables are dependent.

Table 6. Spearman Correlation Coefficients

	Correlation Coefficients, N = 60 Prob > |r| under H0: Rho = 0												
$CBFS_1$	IFRS	SIZE	DIST	FX_TA	REC	ΔGDP	ROA	C_NE	EXP_TR	%RATE	%R_TR	ESCB	INFL
	0.6308	−0.5678	0.46539	−0.4471	0.4331	−0.3033	0.2892	0.2784	−0.2581	0.1059	0.0727	0.0408	−0.0104
	< 0.0001	< 0.0001	0.0002	0.0003	0.0005	0.0185	0.0250	0.0312	0.0464	0.4208	0.5810	0.7568	0.9372
$CBFS_2$	IFRS	REC	DIST	SIZE	C_NE	FX_TA	%R_TR	ROA	ESCB	ΔGDP	EXP_TR	%RATE	INFL
	0.8166	0.6660	0.6319	−0.6271	0.6060	−0.5115	0.3919	0.3240	−0.2491	−0.2278	−0.2219	0.1905	−0.0800
	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	0.0020	0.0116	0.0550	0.0801	0.0884	0.1449	0.5436
$CBFS_3$	DIST	C_NE	ROA	SIZE	IFRS	FX_TA	%RATE	REC	INFL	%R_TR	ESCB	ΔGDP	EXP_TR
	0.4501	0.3363	0.2888	−0.2839	0.2838	0.2611	−0.2554	0.1675	−0.1576	0.1109	0.0817	0.0812	0.0503
	0.0003	0.0086	0.0252	0.0279	0.0280	0.0439	0.0489	0.2009	0.2291	0.3988	0.5351	0.5372	0.7027

Source: Own calculations in the SAS system.

After the elimination of the variables not significantly correlated with CBFS the specification for the regression analysis of panel data are formulated as follows:

$$CBFS_{1,it} = \alpha + \beta_1 IFRS_i + \beta_2 SIZE_{it} + \beta_3 DIST_{it} + \beta_4 FX\_TA_{it} + \beta_5 REC_i + \\ + \beta_6 \Delta GDP_{it} + \beta_7 ROA_{it} + \beta_8 C\_NE_{it} + \beta_9 EXP\_TR_{it} + \epsilon_i + \nu_{it}, \quad (4)$$

$$CBFS_{2,it} = \alpha + \beta_1 IFRS_i + \beta_2 SIZE_{it} + \beta_3 DIST_{it} + \beta_4 FX\_TA_{it} + \beta_5 REC_i + \\ + \beta_6 ROA_{it} + \beta_7 C\_NE_{it} + \beta_8 \%R\_TR_{it} + \epsilon_i + \nu_{it}, \quad (5)$$

$$CBFS_{3,it} = \alpha + \beta_1 IFRS_i + \beta_2 SIZE_{it} + \beta_3 DIST_{it} + \beta_4 FX\_TA_{it} + \beta_5 ROA_{it} + \\ + \beta_6 C\_NE_{it} + \beta_7 \%RATE_{it} + \epsilon_i + \nu_{it}, \quad (6)$$

where:

$CBFS_{1,it}$, $CBFS_{2,it}$, $CBFS_{3,it}$ – the dependent variables observed for entity i in time t,

α – the intercept,

β_s – the parameters to be estimated on the explanatory variables,

$SIZE_{it}$, $DIST_{it}$, FX_TA_{it}, ROA_{it}, C_NE_{it}, EXP_TR_{it} and $\%R\_TR_{it}$ – bank specific explanatory variables that vary over time,

$IFRS_i$ and REC_i – bank specific explanatory variables that do not vary over time,

ΔGDP_{it} and $\%RATE_{it}$ – macroeconomic explanatory variables that vary over time,

ϵ_i – the unobserved entity effect,

υ_{it} – the error term.

The separate regressions are conducted applying both fixed and random effects models. Each regression is conducted on the full sample of central banks independently for $CBFS_1$, $CBFS_2$ and $CBFS_3$. The Hausman's m statistic is calculated to differentiate between the fixed effects model and random effects model (see Table 7). If the test rejects the null hypothesis, then the random effects result is biased and the fixed effects model is the correct estimation procedure. In case of $CBFS_3$ the significant p value ($p < 0.0001$) means that the regressors are very likely correlated with the individual level errors, making the random effects results unreliable, thus the fixed effects model is selected. Whereas for $CBFS_1$ and $CBFS_2$ the random effects model is preferred because it is a more efficient estimator. The results of the panel estimations are presented in Table 7. This Table gives some basic statistics including the coefficient of determination and the root mean square error. The error degree of freedom is different as this depends on the number of estimated parameters.

Table 7. Regression analysis of panel data – The TSCSREG (Time Series Cross Section Regression)

Variable	Random effect estimates		Fixed effect estimates
	$CBFS_1$	$CBFS_2$	$CBFS_3$
CS1			–0.3423
			(7.3971)
CS2			12.9008*
			(7.0142)
CS3			7.4452
			(5.4500)
CS4			41.7665***
			(14.7969)
CS5			5.4548***
			(88.0796)
Intercept	–151.4900***	–78.5700	247.0673***
	(55.4037)	(48.0634)	(88.0796)
IFRS	37.9500*	23.2325	0
	(22.0295)	(15.6103)	
SIZE	5.6518***	–2.5266	–8.3179**
	(2.0635)	(1.7872)	(3.3337)
DIST	–0.0066	–0.00251	–0.0707**
	(0.0202)	(0.0191)	(0.0290)
FX_TA	0.0395	0.0896	–0.0214
	(0.0754)	(0.0677)	(0.1086)
REC	–14.7996	–3.2277	
	(19.4546)	(13.1976)	
ΔGDP	–0.0934		
	(0.1422)		
ROA	0.7754***	0.6162***	1.1126***
	(0.1988)	(0.1870)	(0.2860)
C_NE	–0.0905	0.0075	–0.1223
	(0.0798)	(0.0752)	(0.1218)
EXP_TR	–0.0006		
	(0.0026)		

Variable	Random effect estimates		Fixed effect estimates
	$CBFS_1$	$CBFS_2$	$CBFS_3$
%R_TR		–0.0020 (0.0024)	
%RATE			–0.7538* (0.4387)
Hausman test	2.28	3.43	45.98
p value	0.9430	0.7529	< 0.0001
Variance Component for Cross Sections	250.5135	103.3677	
Variance Component for Error	11.331	10.2403	
SSE	564.2990	523.6907	1128.6225
DFE	50	51	48
MSE	11.2860	10.2684	23.5130
Root MSE	3.3595	3.2044	4.8490
R-Squared	0.5225	0.3371	0.7739

Notes: Empty cells occur when a particular variable is not included in a regression. Standard error in parentheses. *Significant at 10%. **Significant at 5%. ***Significant at 1%.

Source: Own calculations in the SAS system.

The main result is that only some of the explanatory variables have a significant influence on the dependent variable. The coefficients represents the average effect of the explanatory variable over CBFS when this variable changes across time and between central banks by one unit. In all models there is a significant positive relationship between financial strength and profitability (measured as ROA). Thus a high ROA is a telltale sign of solid financial and operational performance not only for a commercial entity but also for a central bank. In the case of $CBFS_1$ IFRS framework, the size of the central bank's balance sheet and ROA positively influence financial strength. For $CBFS_2$ only ROA makes a significant positive contribution to the model. Fixed effect estimates for $CBFS_3$ suggest that the size of the central bank's balance sheet, the profit distribution ratio and the reference interest rate negatively influence financial strength, whereas only ROA has positive impact on financial strength.

Some of the views expressed earlier are not strongly supported. Interestingly the recapitalisation, a ratio of FX open position, GDP growth and a ratio of other expenses to total result are not significant in determining the financial strength of a central bank. A ratio of capital to net equity is also not signifi-

cant, but it could be thanks to robust legislative provisions and the availability of other financial buffers such as the building-up of the general reserve and special provision. Lower interest rates and respectively lower interest income to the total financial result means that higher financial strength is required. Thus the higher the capital and profits, the greater the CBFS. In the $CBFS_2$ model the IFRS framework variable is not statistically significant, although the parameter is quite large in absolute value.

Multicollinearity is verified as it may result in problems of assessing regression coefficients. Multicollinearity may be caused by the inclusion of a variable which is computed from other variables in the data set or by the repetition of the same kind of variable. It is examined by the correlation matrix between explanatory variables used in models and by the variance inflation factors (VIF) associated with each parameter estimate. If there is a multicollinearity between any two explanatory variables, then the correlation coefficient between these two variables is near to unity. In this case the correlations between explanatory variables are not high as all correlations are less than 80% and if we exclude a categorical variable less than 60%. If any of the VIF values exceeds 10 it implies that the associated regression coefficients are poorly estimated because of multicollinearity. For each variable in $CBFS_3$ all VIFs are below 5 and for each variable in $CBFS_1$ and $CBFS_2$ VIFs are less than 10 with the exception of the categorical variable IFRS however in this situation a high VIF can be safely ignored. For SIZE and REC in case of $CBFS_1$ and $CBFS_2$ VIFs are between 5 and 10 indicating that a high correlation may be problematic.

For $CBFS_1$ R-squared shows the amount of variance of dependent explained by selected explanatory variables, is 52%, for $CBFS_2$ R-squared is a rather low 34% and for $CBFS_3$ is 77%, so there is a reasonable fit in this model. Table 7 provides also the estimates for the variance components for random models. These estimates show a much smaller error component than the cross-section component suggesting that the model does not perform well in explaining the differences in the financial strength of various central banks at the same point in time. Overall mainly bank specific factors are found to be important in explaining CBFS as only the reference rate that has significant effect on the CBFS at a 90% confidence level.

Conclusions

Central banks should maintain a level of financial buffers that is related to the potential risk of their mandated functions. At present many central banks have accumulated large financial exposure due to their anti-crisis measures. CBFS should be the primary consideration of a central bank in order to achieve its overriding objectives, including financial stability. The empirical evidence of the determinants of CBFS is very limited. This study contributes to bridging

this gap. The added value of this analysis consists mainly in using a more recent panel data sample, enriching the set of variables which capture the central banks financial strength. Using a comprehensive cross-country panel data set with micro and macro level variables this paper presents the empirical results as to how central bank specific and macroeconomic specific factors affect CBFS. This paper explores the roots of CBFS. Research of this kind has not been conducted so far. The empirical study showed that the accounting framework applied, the size of the central bank's balance sheet, the profit distribution ratio, ROA and the reference interest rate significantly affect the CBFS. Amongst them the most significant was ROA meaning that central banks with more profitability tended to have a stronger financial position. This is consistent with the approach of some researchers (e.g. Kluh and Stella, 2008 or Perera et al, 2013) that use ROA as a measure of CBFS. The direction and effect of macroeconomic variables on the CBFS was inconclusive. It was found that inflation had a negative correlation with CBFS but that the relationship was not significant. In general it can be concluded from this empirical study that central bank specific factors are the most significant determinants of CBFS. However the canonical correlations between the set of macroeconomic variables and the set of bank specific variables might be the reason why there were no any significant macroeconomic variables in models $CBFS_1$ and $CBFS_2$.

A financially strong central bank supports the main central bank objectives and functions. Theoretically losses do not need to be compensated via capital injections, as losses carried forward from previous years have no direct impact on a central bank's capabilities but losses might harm a central bank's reputation. In this regard a CBFS is a signal of the credibility of its activities. On the other hand, financially weak central banks could undermine financial stability and call into question the credibility of their policies. As central banks must perform their policy functions which may generate losses they need for financial autonomy. Moreover financial autonomy needs arrangements with government. Furthermore the potential risk of losses in case of emergency liquidity assistance as lender of last resort also means the requirement for higher capital.

Sustainable financial strength can be jeopardized by profit distributions, which are not proper or even excessive, especially in case of a low capital level or weak recapitalisation possibilities.

Assessing the financial position of a central bank and the implications for its financial strength requires several interacting components to be considered. Although the central banks are not concerned with profit maximisation, they should be concerned with financial strength. Determining the CBFS requires comprehensive analysis, not only of the balance sheet and economic environment but also of the accounting rules, distribution of profits and recapitalisation rules and the bank's institutional status with the government. The preferred proxy is $CBFS_3$ as it takes into account not only the accounting treatment but

also the economic nature of the currency issued by central bank that behaves as a kind of quasi-capital.

Central banks, with their government, should jointly determine the adequate level of capital if there is a meaningful threat to the CBFS. Thus the assessment of financial strength is not a static one-off calculation but a dynamic process. As the applied studies of the effect of CBFS on the economy are very limited there is a need to conduct further theoretical and empirical research on the relationship between CBFS and macroeconomic outcomes. This study is a sound theoretical and methodological guide to the development of representative measures and proxies of CBFS. Beneficiaries of a financially strong central bank are not only the central banks themselves but also the whole financial system.

However broader conclusions in this study rely on six selected central banks and hence results may not be generalised for different economic and financial contexts. Additionally further robustness tests of results using alternative specifications would help to strengthen the conclusions drawn by this study.

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