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The Impact of Central Bank Independence on Stock Market Volatility

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The new paradigm in monetary policymaking gives accent to central banks' Independence. It is widely accepted that in modern monetary policymaking, central banks have three key goals: price stability, output stability, and financial stability. Recent studies on central bank independence mainly investigate the effects of central bank independence on economic stability. But the effectiveness of central bank independence on financial stability after the 2008 financial crises is controversial. This paper investigates the impacts of central banks' independence on stock market volatility as a measure of financial stability. By using panel data for 53 selected countries, in the 2004-2012 period, the results imply a positive relationship between central bank independence and stock market volatility. The findings are consistent with central bank credibility paradox.

Keywords: Stock Market Volatility, Central Bank Independence Index, Central Bank Independence Paradox
JEL Classification: E52, E58, G1

1 Introduction

In modern monetary policymaking, central banks have three key goals, i.e., price stability, sustainable economic growth and, the financial stability that mostly obtained through the stabilization of long term interest rates to achieve an efficient system of payments and the prevention of financial crises. In the twentieth century, Central bank was established for the management of the gold standard and for obtaining financial stability. After World War I, central banks were concerned about unemployment, real activity, and the price level, a critical factor in central banking history has been maintaining central bank independence. Since the late 1980s, many central banks have achieved more independent status, and the related revisions of the central bank laws generally have led to a greater emphasis on price stability (Berger and Kibmer, 2013). One of the reasons for the expansion of central bank independence's idea was originated from the success of German central bank (as one of the most

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independent central banks in the world), in maintaining low inflation rate for several decades, so that during 1970-90 the average inflation rate of German economy was 3.8 percent, while other western economies were experiencing high inflation rates. The second reason for this idea was sophisticated literature in political economy and empirical studies, emphasizing in separation and independence of monetary institutions from political affiliation. In the 20th century, the central banks regained their independence in the 1990s to implement deflationary policies. It is to mention that independence levels vary from country to country (Dincer and Eichengreen, 2014)

Economic theory suggests that central bank independence besides maintaining price stability has substantial social benefits associated with low and stable inflation. In addition, several empirical studies like Alesina and Summers (1993), Cukierman (2008), de Haan et al (2008), Carlstorm and Fuerst (2009), Alpanda and Honig (2009), Alesina and Stella (2010), Klomp and de Haan (2010), Arnone and Romelly (2013) and Dincer and Eichengreen (2013) have shown that this benefits of central bank independence come about without apparent economic costs like more output volatility or reduction in economic growth. Moreover, before the recent global financial crisis, some economists believed that central bank independence would guarantee the stability of the financial system by maintaining low inflation and price stability. In this context, even though price stability has no long-run relationship with financial stability, but it is expected that the upcoming institutional changes by curbing the inflation rates tend to a stable financial system (Berger and Kibmer, 2013).

Financial systems instability and the banking crises led central banks to finance banks insolvency. Then, several rules were designed to prevent crises. In the 1970s, the instrument was created for deregulation and competition. Asset price bubbles led to an economic recession — the central bank by providing needed funds to protect the banking system. Therefore, the main future challenge for central banks was that balancing the three policy goals. The primary purpose of price stability requires central banks independence and transparency. The stable economic growth related to the low inflation environment of the last decades. The more credible monetary policy actions tend to fewer inflation expectations and price instability. Following the financial crisis of 2007, it appears that the majority of central banks provided the required funds for the real economy by implementing unconventional monetary policies.

The recent financial crisis has shown that price level stabilization is a necessary but not a sufficient condition to ensure economic stability. Independent central banks following an inflation targeting regime seemed to be the optimal institutional arrangement to face the issue of inflation. But, central banks should also focus on financial stability. With the fall out of the global financial crisis in 2008, doubts arose about the impact of price stability as a consequence of central bank independence on financial stability. The financial crisis reveals that financial instability could harm other economic growth, for example, economic growth declined by -2.88 percent for the US, -4.18 percent for the UK, -5.61 percent for Germany and -2.94 percent for France a year after the financial crisis. This phenomenon attracted attention to the impact of the central bank's monetary policies on financial stability. Berger and Kibmer (2013) argue that an independent central bank in the boom period by increasing the interest rate can curb inflation rate and potentially severe financial instability in the future. In other words, independent central banks consistently try to control prices without considering the possibility of a future financial crisis. Besides, Borio and Lowe (2002) indicate that a credible low inflation policy reduces the probability of the occurrence of a next economic downturn and encourage investors to engage in further borrowing and lending, respectively, thus driving up asset prices and private indebtedness. A credible monetary policy could, therefore, render the financial system, paradoxically, more vulnerable to adverse economic shocks (Berger and Kißmer, 2013).

Recent empirical researches indicate that there is a strong correlation between financial development and economic growth. Developed financial markets facilitate the production of goods and services by easing investment and allocating savings in the economy. Developed financial markets in collaboration with other institutions in the marketplace provide lenders and borrowers needs and enhance economic performance. On the other side, the linkage between financial markets and other economic sectors makes the economy more vulnerable to shocks originated from financial markets. Independent and credible central banks by forming investors' expectations have a substantial impact on the financial markets.

Nevertheless, despite the importance of the central bank independence on the financial market stability, few pieces of research have studied this relationship, and the results are quite mixed. Some studies like Garcia Herrero and del Rio (2003), Čihák (2007), Klomp and de Haan (2009) indicate that central bank independence increase financial market stability and decrease the probability of financial crisis, the other studies like Berger and Kibmer (2013)

and Papadamou, Sidiropoulos and Spyromitros (2017) theoretically and empirically show that the central bank independence could cause instability in banking system as well as stock markets. Regarding these mixed results, there are still doubts about the impact of the central bank independence on financial markets and hence needs more investigations. Thus this paper tries to fill this gap.

This empirical study investigates the impact of central bank independence on stock market volatility as a measure of financial instability in selected countries. To this end, the CBI index measured by Garriga (2016) is employed. Garriga (2016) used Cukierman, Web, and Neyapti (1992) method to calculate the CBI index. This index evaluates 16 characteristics of the central bank in four clusters and calculates the CBI index by a weighted average of these 16 characteristics

The advantage of Garriga CBI index is broad range of countries included in his sample (182 countries during 1970-2012), comparable to other studies like Cukierman, Web and Neyapti (1992), Pollilo and Guillen (2005), Neyapti and Dincer (2008), Sadeh (2011), Bodea and Hicks (2014) which reduces the restriction of sample size. Following Papadamou et al. (2017), stock market volatility is calculated by the standard deviation of the monthly stock market index for each country. Following other studies, e.g., Mun (2007) and Umutlu et al. (2010), five other explanatory variables such as GDP growth, market capitalization, foreign direct investment, exchange rate volatility and GDP per capita added to empirical model. The sample consists of 53 countries (30 developed and 23 developing countries) for the 2004-2012 period.

The remainder of this paper is organized as follows. Section 2&3: literature review and prior empirical studies, section 4: data and methodology, section 5: model estimation and section 6: conclusion and policy recommendations.

2 Literature Review

2.1 Central Bank Independence

Previous studies in central bank context introduce different aspects of central bank independence and define it in different ways, though all of these definitions implied a unique concept. This concept suggests that central banks' objectives and actions should be free from any concerns. On the other word, independence is inherent in the role of the central bank in the economy, and the emergence of central banks was the consequence of needs for separation of the monetary system from political affairs. Deblle and Fischer (1994) studied two different aspects of central bank independence, goal

independence, and instrument independence. Goal independence is defined as freeness of central bank in choosing monetary policy objectives, while instrument independence clarifies central bank independence in the selection of instruments to perform these objectives. Most economists believe that central bank must be independent in choosing an instrument, not targets, because, in a democratic system, the central bank should be accountable to the people, so people's representatives (e.g. politician) must define central bank's goals. Grilli et al. (1991) divide central bank independence into political and economic freedom. Political independence indicates how central bank is allowed to peruse its objectives free from politicians, while economic independence is its autonomy to run monetary policies. A central bank is independent when it freely executes monetary policy based on economic rules, not political aims.

Beyond the definition of central bank independence, to study the impact of central bank independence on macroeconomic variables (e.g., economic growth, inflation, etc.), economists designed some measures that can be categorized in two groups, de jure and de facto CBI indices. De jure CBI indices are legal-based measure, and de facto CBI indices are actual-based measure (e.g., central bank governor turnover). Several de jure CBI indices are designed by economists like Bade and Parkin (1988), Alesina and Summers (1993), Eijffinger and Schaling (1996), but the most precise and prominent index is introduced by Cukierman, Webb, and Neyapti (1992). This index evaluates 16 characteristics of the central bank in four clusters and calculates CBI index by a weighted average of these 16 characteristics

Cukierman et al. (1992) coded legal central bank independence by following two principles. First, they coded only a few narrow but relatively precise legal characteristics. Second, they used only the written information from the charters, and additional information on how the law is applied was deliberately left out. These principles make it possible to rank central banks by their degree of independence in various legal dimensions with relatively few subjective judgments and to focus on concrete details of the law rather than on a broader but more impressionistic view of it. The legal characteristics of the central bank are grouped into four clusters of issues: 1. the appointment, dismissal, and term of office of chief executive officer of the bank. 2. The policy formulation which concerns the resolution of conflicts between the executive branch and the central bank over monetary policy and the participation of the central bank in the budget process 3. The objectives of the central bank. 4. limitation on the ability of the central bank to lend to the public sector. The clusters were built up from 16 different legal variables, each code

on a scale of 0 (lowest level of independence) to 1 (highest level of freedom). After coding the variables, the CBI index is measured by using the weighted average of these variables. Table 4 (Appendix 1) illustrates these 16 legal variables in four clusters, description of variables and their weights (Cukierman et al., 1992).

2.2 The Mechanism of the Impact of Central Bank Independence on Stock Market Volatility

There are two opposing economic theories about central bank independence's effect on financial stability. The first view states that central bank independence increases financial stability through low inflation and stable prices (e.g., Bernanke, 2010 and Arnone et al., 2009). In this respect, an independent central bank improves financial stability in two ways. First, the central bank could precautionary alarm market participants about a possible future crisis. Thus investors alter their behaviors and expectations before the crisis. Moreover, if the central bank is charged to administrate the financial system, it can take actions against future turmoil in the financial markets, while a dependent central bank is not flexible to take those actions. Besides, a dependent central bank could increase moral hazard by bailing out distressed financial institutions. Second, restricting the influence of politicians on the central bank policy removes the problem that a financial crisis can be used as an issue in the re-election campaign of the independent government. Keefer (1999) shows that the longer it takes before the next election takes place, the higher the costs of a financial crisis will be. Hence, while the independent government tries to signal its competence by solving the financial crisis just before the elections, the risk and costs of possible financial crisis will be increased (Klomp and de Haan, 2009).

On the other hand, the opposing view with emphasis on central bank credibility paradox asserts that central bank independence fosters financial instability. This view argues that an independent central bank with credible monetary policy anchors inflation expectations and long-term prices and wages. These endogenous responses to credible monetary policy may make prices less sensitive to demand pressure for some time, resulting in cost and price stickiness and temporarily boosting firms' profit. At the same time, the highly credible monetary policy reduces the degree of uncertainty in the economy and decrease the probability that market participants assign to the occurrence of a sustained economic downturn. Then, lower uncertainty translates into higher asset prices and increased demand for lending and

borrowing, causing asset and credit bubbles and making the financial system more vulnerable to an economic downturn.

Furthermore, a high degree of credibility of monetary policy would give little reason for the central bank authorities to tighten policy if they respond only to clear signs of inflationary pressures. Paradoxically, these responses to credible monetary policies increase the probability that latent inflation pressures manifest themselves in the development of imbalances in the financial system, rather than immediate upward pressure on higher goods and services prices. Failure to respond to these imbalances, either using monetary policy or another instrument, may ultimately increase the risk of both financial instability and subsequently deflation (Borio and Lowe, 2002).

In the sequence of this view, Papadamou et al. (2017) developed Smets (1997) macroeconomic model to show the negative impact of central bank independence on stock market volatility. Smets model characterized the economy in three following equations:

$$\pi_t = \pi_t^e + \gamma y_t - \varepsilon_t^\pi, \qquad \gamma > 0 \tag{1}$$

$$y_t = -\theta r_t + \delta q_t + \varepsilon_t^d, \qquad \theta, \delta > 0 \tag{2}$$

$$q_t = \rho E_t q_{t+1} + (1-\rho) E_t d_{t+1} - r_t + \varepsilon_t^q \tag{3}$$

Equation (1) describes the augmented Philips curve, where π_t denotes the inflation rate, π_t^e inflation expectations, y_t output, and ε_t^π supply shock. Equation (2) describes the aggregate demand of the economy that is negatively related to the real interest rate (r_t) and positively to stock prices. A wealth effect (denoted by q_t) is incorporated in the aggregate demand to capture the role of asset prices in the transmission mechanism of monetary policy and ε_t^d represents demand shock. Finally, equation (3) denotes real stock prices which can be decomposed into the expected capital gain ($E_t q_{t+1}$), the expected dividend gain ($E_t d_{t+1}$, assumed to be a proportion of y_t), the effect of real interest rate, and time-varying risk premium (ε_t^q). For simplicity, it is considered the expected value of future stock prices can be expressed by $E_t q_{t+1} = \beta q_t$.

The Rogoff-type central bank minimizes the following loss function:

$$L = \frac{1}{2} E[\pi^2 + b(y-k)^2] \tag{4}$$

In equation (4), b is the weight associated with the output objective k relative to the inflation objective (supposed to be zero), and E denotes expectation operator. In this system equation first, the public forms its

inflationary expectations, then shocks occur (ε_t^{π}, ε_t^{d} and ε_t^{q}), the central bank sets its monetary policy, and finally, firms decide their level of production (y) and price level (p). The coefficient b denotes the importance of production objectives relative to inflation objectives. The less amount of b represents a more independent central bank. Assuming that the central bank currently anticipates what the public thinks, the minimization of the central bank's problem leads to the following optimally condition:

$$\pi = -\frac{b}{\gamma}(y-k) \tag{5}$$

Substituting equation (1) and (2) in equation (5) and rearranging the terms, gives the real interest rate as follows:

$$r = \frac{1}{\theta}\frac{\gamma}{b+\gamma^2}\pi^e + \frac{\delta}{\theta}q + \frac{1}{\theta}\varepsilon_d - \frac{1}{\theta}\frac{\gamma}{b+\gamma^2}\varepsilon_\pi - \frac{1}{\theta}\frac{b}{b+\gamma^2}k \tag{6}$$

Also substituting equation (2) and (6) in equation (1), using optimal condition (5) gives expected inflation, inflation, and output as follows:

$$\pi^e = \frac{b}{\gamma}k \tag{7}$$

$$\pi = \frac{b}{\gamma}k - \frac{b}{b+\gamma^2}\varepsilon_\pi \tag{8}$$

$$y = \frac{\gamma}{b+\gamma^2}\varepsilon_\pi \tag{9}$$

Finally, substituting equations (7), (8), and (9) in equation (3) gives stock price, equation (10):

$$q = \frac{\gamma}{b+\gamma^2}\left[\frac{(1-\rho)\theta\alpha+1}{(1-\rho\beta)\theta+\delta}\right]\varepsilon_\pi + \frac{1}{(1-\rho\beta)\theta+\delta}(\theta\varepsilon_q - \varepsilon_d) \tag{10}$$

Eventually taking variance from stock price (equation 10) gives stock price volatility:

$$Var(q) = \left(\frac{\gamma}{b+\gamma^2}\right)^2\left[\frac{(1-\rho)\theta\alpha+1}{(1-\rho\beta)\theta+\delta}\right]^2\sigma_{\varepsilon_\pi}^2 + \left(\frac{1}{(1-\rho\beta)\theta+\delta}\right)^2\left(\theta^2\sigma_{\varepsilon_q}^2 + \sigma_{\varepsilon_d}^2\right) \tag{11}$$

Equation (11) represents stock market volatility that is related to exogenous shocks (supply, demand, and risk premium shocks). Additionally, coefficient b has a negative relationship with stock market volatility that proves the negative impact of central bank independence on stock market volatility as a proxy for financial instability (Papadamou et al., 2017).

3 Empirical Studies

Despite the importance of central bank independence's effect on financial stability, a few studies gave attention to this issue and studied this relationship. Some empirical studies found a positive relationship between central bank independence and financial stability. Garcia Herrero and Del Rio (2003) using data for 79 selected countries for 1970-1999 period, found that central bank monetary policies that stabilize inflation reduce the probability of banking crisis. In developing countries, exchange rate stabilization policies foster banking system stability, and finally, central bank independence minimizes the possibility of a banking crisis. Klomp and de Haan (2009) investigated the impact of central bank independence on the banking system as a proxy for financial stability. Their sample consisted of 75 countries for the 1985-2005 period, and the results indicated that central bank independence, especially political independence decreases banking system instability.

On the contrary, Borio and Lowe (2002) investigated the relationship between the monetary system and price stability and financial stability using macro-data for 34 countries during 1960-2000 period and indicated that price stability increases the probability of financial crisis through investors' expectations and asset price bubbles channel. Förch and Sunde (2012) investigated the effect of central bank independence on stock market return in emerging economies. They found an overall positive impact, but the economic autonomy of the central bank appears to be more relevant than political independence. These results show that central bank independence could cause stock price bubble and possibly a financial crisis. Yazdani et al. (2015) investigate the impact of central bank independence on the financial stability in the emerging countries for the 1980 – 2012 period. The results indicate that the central bank independence is associated with more financial stability in selected countries.

Finally, Berger and Kibmer (2013) and Papadamou et al. (2017) in two different settings show theoretically and empirically that central bank independence could increase financial instability.

4 Data and Method

4.1 Data

The primary data sources in this study are World Bank, St. Louis Federal Reserve, OFX and investing websites, and Harvard dataset. The data for

monthly stock indices are extracted from the investing website[1], also monthly data for exchange rates are cached from St. Louis Federal Reserve[2] and OFX[3] websites. CBI index is calculated for 182 countries by Garriga (2016) based on Cukierman et al. method and presented in the Harvard data set[4]. Despite the large sample of Garriga CBI index, the restriction of monthly stock indices' information, constrains the sample into 53 developed and developing countries for the 2004-2012 period. The other five variables (GDP growth, GDP per capita, FDI, Interest rate, and Market capitalization to GDP) are extracted from World Bank dataset[5].

4.2 Empirical Model

The study's empirical model to test the effect of central bank independence on stock market volatility is based on Papadamou et al. (2017) work, as follows:

$$Stock\_\text{volatility}_{i,t} = \beta_0 + \beta_1 CBI_{i,t} + \beta_2 GDP\_growth_{i,t} + \beta_3 Market\_Cap_{i,t} + \beta_4 FDI_{i,t} + \beta_5 Exch\_volatility_{i,t} + \beta_6 Interest_{i,t} + \beta_7 \log(GDPPC)_{i,t} + \varepsilon_{i,t} \quad (12)$$

The independent variable in the model is stock volatility as a proxy for financial instability. It is measured by the standard deviation of monthly stock market index return for each country, each year. The variable of interest is the CBI index introduced by Cukierman et al. (1992) and its four clusters of central bank characteristics. Based on the theoretical model, it is expected that the CBI index affects the stock volatility positively. The six other explanatory variables are considered in the model as previous studies show that these variables have a significant impact on stock volatility. Curto and Marques (2013) indicated that stock volatility is counter-cyclical, so stock volatility is higher in recession than in a boom period. Therefore, it is expected that GDP growth hurts stock volatility. According to Umutlu et al. (2010), stock market capitalization (Market Cap, as a percent of GDP) as a proxy for financial market development has a negative and significant impact on stock volatility. Foreign direct investment (FDI, as a percent of GDP) represents economic and financial integration. Choe et al (1999) indicated that foreign investors

[1] www.Investing.com
[2] https://fred.stlouisfed.org
[3] www.ofx.com
[4] https://dataverse.harvard.edu
[5] www.data.worldbank.org

increase market volatility. Exchange rate volatility (Exch_Volatility, a standard deviation of monthly exchange rate for each year) and interest rate (Interest) have direct impact on stock volatility as Mun (2007), and Papadamou et al. (2017) showed. Finally, GDP per capita (Log(GDPPC), in natural logarithm) is considered to control the effect of economic development on stock volatility.

5 Model estimation

Panel data models are used to estimate equation (12) and test the study hypothesis. Before that, the stationary test is required to be sure about the results of the estimation. Non-stationary variables could cause false regression. Thus Levin, Lin, and Chu (LLC) test is applied to check stationary of variables. Table (1) presents the results of the LLC test. The results show that all variables are stationary at a 5% significance level.

Table 1
LLC Stationary Test of Variables

Variables	Level	
	statistics LLC	Probe
Stock_volatility	-6.590	0.000
GDP_growth	-9.429	0.000
Market_Cap	-6.787	0.000
FDI	-8.700	0.000
Exch_volatility	-212.400	0.000
Interest	-10.047	0.000
Log(GDPPC)	-4.853	0.000
CBI	-2.043	0.020

After checking for stationary of variables, it is needed to choose proper estimation settings. Therefore, F-limer and Hausman test are applied. Table (2) represents the results.

Table 2
F-Limer and Hausman Tests

F-Limer test			
Models	F-statistic	Probe	Result
Model 1	3.407	0.000	Panel
Model 2	3.552	0.000	Panel
Model 3	3.367	0.000	Panel
Model 4	3.572	0.000	Panel
Model 5	3.529	0.000	Panel
Hausman test			
Models	Chi-square statistic	Probe	Result
Model 1	21.125	0.004	Fixed effect
Model 2	21.307	0.003	Fixed effect
Model 3	19.537	0.006	Fixed effect
Model 4	20.765	0.004	Fixed effect
Model 5	19.760	0.006	Fixed effect

The results of F-Limer tests for all five models show that the null hypothesis is rejected at a 5% significance level, and a panel regression model is selected for all models. Besides, Hausman tests for all models indicate that the best model specification is fixed effect. According to these results, all models are estimated with panel fixed effect setting. The results of estimations are presented in table (3).

Table 3
Estimation Results

	Independent variable: Stock_volatility				
Explanatory variables	Model 1	Model 2	Model 3	Model 4	Model 5
CEO independence	0.030*** (12.262)	-	-	-	-
Policy formulation independence	-	0.025*** (6.546)	-	-	-
Objectives independence	-	-	0.016*** (5.751)	-	-
Limitations on lending to the government	-	-	-	0.041 (0.651)	-
CBI	-	-	-	-	0.076*** (2.676)
GDP_growth	-2.266*** (-7.813)	-2.266*** (-7.829)	-2.267*** (-7.851)	-2.266*** (-7.761)	-2.266*** (-7.861)
Market_Cap	-0.015*** (-3.941)	-0.015*** (-3.950)	-0.015*** (-3.940)	-0.015*** (-4.012)	-0.015*** (-4.033)
FDI	0.032** (2.210)	0.032** (2.200)	0.031** (2.197)	0.032** (2.232)	0.032** (2.229)
Exch_volatility	0.180*** (3.345)	0.180*** (3.346)	0.179*** (3.367)	0.177*** (3.416)	0.181*** (3.331)
Interest	0.210*** (3.651)	0.210*** (3.652)	0.209*** (3.644)	0.207*** (3.622)	0.211*** (3.670)
Log(GDPPC)	0.001 (0.123)	0.001 (0.135)	0.002 (0.163)	0.000 (0.052)	0.001 (0.074)
Constant	0.028 (0.233)	0.030 (0.246)	0.030 (0.246)	0.025 (0.198)	-0.002 (-0.094)
R-squared	0.625	0.625	0.625	0.623	0.627
Adjusted R-squared	0.572	0.572	0.572	0.570	0.574

*, ** and *** represents 10, 5 and 1 percent significance level
Parentheses represent t-student statistics

Table (3) displays the results of the 5 models' estimations. Models 1-4 test the impact of central bank independence's characteristics (CEO independence, policy formulation independence, objectives independence and limitation on lending to the government), while model 5 examines the impact of overall CBI index on stock volatility. The results show that the coefficient of overall CBI index is positively significant at 1% level. Moreover, coefficients of 3 out of 4 characteristics of central bank independence (CEO independence, policy formulation, and objective independence) are significant at 1% level. It means the central bank independence has a significantly positive impact on stock volatility, but political independence appears to be more relevant than economic autonomy. Based on central bank credibility

paradox, an independent central bank with credible monetary policy reduces economic uncertainty and the probability that market participants assign to the possible economic downturn.

On the other hand, in the short run, stable prices (due to the existence of an independent central bank) tend to price and wage stickiness, which results in increased demand and firm's profitability. It leads to stock overvaluation and asset bubbles in financial markets. The excess demand after the disappearance of optimism of the market about the future tends to blast the asset bubbles and cause financial instability. The result of this study is consistent with central bank credibility paradox and empirical findings of Borio and Lowe (2002), Berger and Kibmer (2013) and Papadamou et al. (2017).

The coefficient of GDP growth, as expected, is negative and statistically significant at 1% level in all 5 models. This result shows that stock volatility in the boom period is lesser than in recessions, as Curto and Marquetz (2013) stated that stock volatility is counter-cyclical. Also, Hamilton and Lin (1996) argued that output volatility relatively is higher in recessions than in boom periods, then the financial market faces a more volatile situation in recessions. The coefficient of stock market capitalization is significantly negative in all 5 models at 1% significance level. It implies that stock market development by increasing the depth of market, reduces stock volatility. Foreign direct investment as it is used a proxy for foreign investment in stock market (because the lack of data) has positive and significant coefficient at 5% significance level for all 5 models that means foreign investment in stock market increases stock volatility. Choe et al (1999) indicated that foreign investors have herding behavior in the stock market that leads to more stock volatility. Also, Dornbusch and Park (1995) argued that trades of foreign investors are affected by past returns, so that they buy when prices have increased and sell when they have fallen, leads to herding behavior. The coefficient of exchange rate volatility is positively significant at 1% level, shows that stock market is highly correlated with exchange rate's market. Also, Interest rate's coefficient is statistically significant in 1% level and shows a positive impact on stock volatility, while the coefficient of GDP per capita is not statistically significant at any significance level, that mean it has no effect on stock volatility.

6 Conclusion and Policy Recommendation

This study empirically investigated the impact of central bank independence on stock volatility by using panel data for 53 selected countries for the 2004-2014 period. The results indicate that central bank independence has a positive

and significant impact on stock volatility. This effect is mostly due to CEO, policy formulation, and real autonomy. Besides, GDP growth and stock market capitalization hurt stock volatility, while FDI, exchange rate volatility and interest rate have a positive impact on stock volatility.

These days, the financial system is one of the most crucial sectors in the economy that highly interconnected to the other sectors. Therefore, their stability is a prime concern for the economy. In contrast with conventional belief, this study shows that central bank independence increases financial instability. Consistent with central bank credibility paradox, price stability does not lead to financial stability, but price and wage stickiness that caused by an independent central bank foster financial instability from two channels. First, the credibility of an independent central bank reduces economic uncertainty and the probability that market participants assign to the possible economic downturn, leading to more lending and borrowing and credit boom. Second, an increase in demand in the economy would result in a firm's profit in short-term and creates stock bubbles and makes financial markets more vulnerable to adverse economic shocks.

However, central bank independence guarantees price stability and low inflation but could foster financial instability. As the results showed, central bank independence, especially policy formulation and objective independence increase financial instability, thus monetary authorities should consider financial stability besides price stability in policymaking and choose an optimum level of central bank independence. Also, central bank authorities should warn investors about possible future crisis and economic downturn, while investors adjust their expectations. Furthermore, concerning the impact of exchange rate volatility on stock volatility, the central bank should control extreme exchange rate volatility to prevent stock market instability.

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Appendix 1

Table 4
Variables of Legal Central Bank Independence

Variable number	Description of variable	Weight	Numerical coding
1	Chief executive officer (CEO)	0.20	
	Term of office		
	Over 8 years		1.00
	6 to 8 years		0.75
	5 years		0.50
	4 years		0.25
	Under 4 years or at the discretion of appointer		0.00
	Who appoints CEO?		
	Board of the central bank		1.00
	A council of the central bank board, executive branch, and legislative branch		0.75
	Legislature		0.50
	Executive collectively (e.g., the council of ministers)		0.25
	One or two members of the executive branch		0.00
	Dismissal		
	No provision for dismissal		1.00
	Only for reasons not related to policy		0.83
	At the discretion of the central bank board		0.67
	At legislature's discretion		0.50
	Unconditional dismissal possible by legislature		0.33
	At executive's discretion		0.17

	Unconditional dismissal possible by executive		0.00
	May CEO hold other offices in government?		
	No		1.00
	Only with the permission of the executive branch		0.50
	No rule against CEO holding another office		0.00
2	Policy formulation	0.15	
	Who formulates monetary policy?		
	Bank alone		1.00
	Bank participates but has little influence		0.67
	Bank only advises the government		0.33
	Bank has no say		0.00
	Who has the final word in resolution of conflict?		
	The bank, on issues clearly defined in the law, as its objectives		1.00
	Government, on policy issues not clearly defined as the bank's goals or in case of conflict within the bank		0.80
	A council of the central bank, executive branch, and legislative branch		0.60
	The legislature, on policy issues		0.40
	The executive branch on policy issues, subject to due process and possible protest by the bank		0.20
	The executive branch has unconditional priority		0.00
	Role in the government's budgetary process		
	Central bank active		1.00
	The central bank has no influence		0.00
3	Objectives	0.15	
	Price stability is the primary or only objective in the charter and the central bank has the final word in case of conflict with other government objectives		1.00
	Price stability is the only objective		0.80
	Price stability is one goal, with other compatible objectives, such as a stable banking system		0.60
	Price stability is one goal, with potentially conflicting objectives, such as full employment		0.40
	No objectives stated in the bank charter		0.20
	Stated objectives do not include price stability		0.00
4	Limitations on lending to the government		
	Advances (limitation on non-securitized lending)	0.15	
	No advances permitted		1.00
	Advances permitted, but with strict limits (e.g., up to 15 percent of government revenue)		0.67
	Advances permitted, and the limits are loose (e.g., over 15 percent of government revenue)		0.33
	No legal limits on lending		0.00

Securitized lending	0.1	
Not permitted		1.00
Permitted, but with strict limits (e.g., up to 15 percent of government revenue)		0.67
Permitted, and the limits are loose (e.g., over 15 percent of government revenue)		0.33
No legal limits on lending		0.00
Terms of lending (maturity, interest, amount)	0.10	
Controlled by the bank		1.00
Specified by the bank charter		0.67
Agreed between the central bank and executive		0.33
Decided by the executive branch alone		0.00
Potential borrowers from the bank	0.05	
Only the central government		1.00
All levels of government (state as well as central)		0.67
Those mentioned above and public enterprises		0.33
Public and private sector		0.00
Limits on central bank lending defined in	0.025	
Currency amounts		1.00
Shares of central bank demand liabilities or capital		0.67
Shares of government revenue		0.33
Shares of government expenditures		0.00
Maturity of loans	0.025	
Within 6 months		1.00
Within 1 year		0.67
More than 1 year		0.33
No mention of maturity in the law		0.00
Interest rates on loans must be	0.025	
Above minimum rates		1.00
At market rates		0.75
Below maximum rates		0.50
Interest rate is not mentioned		0.25
No interest on government borrowing from the central bank		0.00
Central bank prohibited from buying or selling government securities in the primary market?	0.025	
Yes		1.00
No		0.00