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Abstract

This study examines the influence of Basel II capital regulations on the performance of Vietnamese banks between 2011 and 2019. Intermediation and operational efficiency scores are computed using Data Envelopment Analysis (DEA), and a two-period two-group difference-in-differences (DiD) framework is employed to assess the impact of Basel II capital regulations on the efficiency of a subset of banks. The findings indicate a positive and statistically significant increase in the average intermediation efficiency of banks which have adopted the new standards. To validate the DiD results, we conduct a series of placebo intervention tests on the pre-regulation sample and review the descriptive statistics of the treatment and control samples. The results indicate that treatment and control groups have comparable support (positivity), that the assumption of parallel trends is not violated, and that there are no pre-treatment effects on the policy's impact on the intermediation efficiency of treatment banks. The vast majority of our findings suggest that the implementation of Basel II capital regulations in Vietnam had a positive and economically significant impact on the intermediation efficiency of treatment banks.

Keywords: Basel capital standard, Banks, Efficiency, Difference-in-Differences, Vietnam

JEL Codes: G21, G28, C54

1. Introduction

The Basel Standards (i.e., Basel I, II and III) became internationally accepted standards and protocols during the 1990s and 2000s in both developed and developing countries (Ayadi *et al.*, 2016; Roulet, 2018). The main role of these capital standards is to prevent bank failures, safeguard customers, protect the real economy from harmful events and improve banking sector performance. However, it is also argued that applying such stringent regulations on bank capital may limit banking activities and consequently compromise their service and profit-making efficiencies. This may occur if banks engage in riskier activities in response to a higher regulatory environment; encouraging investment in areas that circumvent regulations (Chortareas *et al.*, 2012). While these regulations identify the amount and quality of capital that banks should hold, if the standards do not align with internal and external risks, they could unintentionally induce banks to hold either insufficient or excessive amounts of capital. If banks maintain reserve capital that is lower than the amount they need, this will increase the likelihood of bank failure. Conversely, a requirement to maintain excessive capital unnecessarily increases bank-level operational costs. Consequently, there are conflicting predictions in the literature regarding the impact of capital adequacy rules on bank performance (Barth *et al.*, 2008a).

While numerous studies have been published on the impact of capital regulations on bank performance in developed countries, only a few have examined developing countries. These investigations are, however, very important and this is especially the case for the relatively new and basic financial systems which exist in emerging economies. In such economies, the impact of Basel capital standards may have unintended consequences for banking systems, relative to those of more developed economies. According to Griffith-Jones and Spratt (2001), the Basel capital requirements were originally designed for OECD countries, but the risk-weights are crude and unfair for the financial systems of developing countries. Another challenge for such countries is the increased competitive pressure from internationally active banks which have: firstly, adopted internal risk rating systems; and secondly, further enhanced their current competitive advantages by employing more finely-tuned and lower capital requirements. Powell *et al.* (2004) state that the internal rating-based approach (IRB) in emerging countries may grant excessive autonomy to banks and increase regulators' monitoring costs. Furthermore, applying these standards is costly and deteriorates the financial ability of small banks because they must invest heavily in modern information and communications technology, build and maintain complex databases and establish

their own internal rating systems. Consequently, many developing countries adopt Basel standards selectively and partially to avoid a shock to their entire banking sector (Jones and Zeitz, 2017).

In 2017, the Alliance for Financial Inclusion (AFI) conducted a survey on the implementation of the Basel framework by AFI members, including central banks and other financial regulatory institutions from 90 developing countries. The survey included information on proportional applications of the standards and the main challenges these institutions encountered (AFI, 2019). Of the 39 jurisdictions which provided responses, 82% introduced Basel II standards of which 45% utilized the framework fully and 37% did so partially. Of the latter respondents, almost all (93%) implemented the Pillar 1 minimum capital requirements, 64% implemented the Pillar 2 supervisory review requirement and only 36% adopted the Pillar 3 market discipline requirements. Further, several developing countries including Egypt and China opted for a staggered approach to Basel framework implementation, where a subset of banks were selected to adopt the framework several years prior to its full implementation in the banking industry (AFI, 2019; Pessarossi and Weill, 2015).

Therefore, due to the variety of employed standards, the impact of these regulations on some developing countries remains ambiguous. This paper is the first to investigate the impact of the partial and experimental implementation of the Basel II framework on banking performance in Vietnam for the years 2011 to 2019. Data Envelopment Analysis is utilized to generate bank-level efficiency scores and a set of two-period and two-group and difference-in-differences regressions investigate average change in efficiency among banks selected to adopt the Basel II capital standards relative to control banks. The results suggest that the intermediation efficiency of the banks selected to adopt the Basel II capital regulations increased when compared to non-adopters. As well, we find that both equity growth and non-performing loans wield a positive effect on bank intermediation efficiency.

The paper is structured as follows: Section 2 provides background information on: (1) the evolution of Vietnam's banking system since joining the World Trade Organization (WTO) in 2006; and (2) the impact of the Basel capital standards on banking performance. Section 3 describes the methodology including DEA and regression models while Section 4 details the data of DEA inputs/outputs as well as explanatory variables. Section 5 discusses the empirical results and Section 6 concludes this paper with a summary of the main themes covered here.

2. Background

2.1 Overview of the Vietnamese banking sector since WTO entry

The entry of Vietnam into the WTO in 2006 marked a significant step in its economic and financial liberalization. A number of important sectors, including the banking system, required reorientation to facilitate foreign investor access. Several policies were implemented to liberalize the banking sector: (1) allowing foreign banks to establish subsidiaries in Vietnam; (2) permitting overseas investors to participate in domestic banks as minor shareholders; (3) partially and selectively privatizing state-owned commercial banks; and (4) transforming rural banks into national banks. This liberalization of the banking sector combined with the expansionary monetary policy conducted by the State Bank of Vietnam (SBV) led to a substantial rise in bank loans, resulting in a high annual growth rate of credit (about 35%) for the period 2006 to 2011.

During that time however, the quality of bank management did not increase in line with the increased level of default risk in the system (World Bank, 2014). Consequently, non-performing loans (NPLs) surged and led to persistent illiquidity and a credit crunch for Vietnamese banks (World Bank, 2014). World Bank (2019) states that significant gaps in the legal and supervisory framework of the SBV, including inadequate reinforcement and weak crisis management, were the main reasons for this failure. Therefore, the government issued Decision 254 in March of 2012 to establish a restructuring plan for the Vietnamese banking sector (Phuong *et al.*, 2017). This plan aimed to improve system liquidity, consolidate supervisor and regulatory frameworks, improve bank governance, and reduce the volume of NPLs as much as possible. Simultaneously, stringent regulations on loan classification, loan-loss provisioning and prudential ratios were established. Nonetheless, these regulations are still far from international standards and have provided limited progress in terms of resolving NPL proliferation and the high frequency of bank recapitalization.

To manage bad loans, the Vietnam Asset Management Company (VAMC) was established in July 2013, and was expected to purchase bad debts from banks at either book or market value (World Bank, 2014). In return, banks receive zero-interest bonds issued by the VAMC which could then be used to refinance loans through the SBV. However, banks are still obliged to maintain annual provisions equivalent to one-fifth of the bond value. To further restructure the banking sector, several other policies were issued by the Vietnamese National Assembly after 2016 including Resolution 42 which permitted banking authorities to systematically address the issue of NPLs and amended Credit Institutions Law, so that the SBV could intervene in the operations of unsound

banks. The government announced Decision 1058 in July of 2017, which detailed a plan to structure the banking system for the 2016 to 2020 period. Key objectives of the plan included: (1) issuing regulations that allow foreign investors to own the majority stakes in domestic banks and forcing these entities to implement the Basel II capital standards; (2) recapitalizing banks through stock and convertible bond issuance and increased profit retention; and (3) increasing the non-interest income generating capability of banks.

A new capital adequacy regulation which imitates Pillar 1 of the Basel II framework was also announced under Directive 41 of the SBV in December of 2016.[1] The Directive included bank guidelines for the implementation of the standards and the policy roadmap. Ten piloted banks were assigned by the SBV to implement the Basel II basic indicator approach and standardized approach by 2016 and 2019, respectively, while other banks were required to adopt the basic indicator approach by 2020 (World Bank, 2019). During this period, 10 other banks voluntarily implemented the Directive, increasing the number of experimental banks to 20. At the end of the period, 18 of all 20 piloted banks were approved by the SBV to apply the capital standard. A description of piloted banks with different ownership types is provided in Table 1.[2]

[TABLE 1 ABOUT HERE]

Generally, bank balance sheets have strengthened during the restructuring period. The data also indicates that the profits and quality of assets of large banks have improved, and this is supported by a strong economy and faster NPL disposal (World Bank, 2019). Resolution 42 and higher property prices increased the disposal of collateral and the resolution of bad debts. Amendments to the Law on Credit Institutions provided guidance to banks on their bankruptcy and restructuring options; improving their corporate governance. Despite the avoidance of a banking crisis in late 2011, the Vietnamese banking system remains vulnerable to structural and systemic risks. Although bank profitability, in general, has improved substantially in recent years, the ability of banks to retain their profits in order to increase capital is hampered due to their requirement to provide dividend payments to shareholders. Further, other factors such as the credit gap, thin capital

[1] The SBV issued several regulations on regulating banks' capital following the Basel I standards, including Decision 297 in 1999, Decision 457 in 2005, Circular 13 in 2010 and Circular 36 in 2014.
[2] Note that the data contained in Table 1 consists of descriptive statistics obtained from the SBV and is not the sample which is analyzed in this paper.

buffers and regulatory limits to private sector ownership amplify potential risks to the financial stability of the banking sector (World Bank, 2019).

2.2 Literature on capital standards and bank efficiency

The theoretical predictions on the impact of capital regulation on bank performance are mixed. According to Barth *et al.* (2008b) there are two general views. The first so-called 'public interest view' requires the government to act in the interests of the public and regulates banks to improve how they do business and to reduce the likelihood that their activities result in market failures. Under this view, capital adequacy requirements can play a crucial role in aligning bank incentives with those of their depositors and other creditors, which results in more careful lending and better performance. However, higher capital requirements can generate barriers to entry and increase regulatory costs for banks. The opposing 'private interest view' supports stringent regulations only if the benefits of regulation outweigh the costs. From the 'private interest view', capital regulation can discourage good bank performance if it is too inflexible, costly and has a deleterious impact on competition in the banking system. The popularity of the two views has resulted in the establishment of conflicting theoretical models which describe the impact of capital regulation on bank activities. Thus, the effect of capital regulation on bank efficiency remains an open empirical question. There are numerous empirical studies on the relationship between regulatory changes to capital standards and bank performance. Here we provide some examples of key cross-country studies in the literature and then shift our focus to single-country studies.

Using a sample of 715 commercial banks operating in 95 countries in 2003, Pasiouras (2008) measured bank technical efficiency using DEA and then regressed this efficiency variable on proxies of all three pillars of Basel II. This required the adoption of strict capital adequacy standards, the development of powerful supervisory agencies, and the creation of market disciplining mechanisms. The results suggest that only market discipline (the last pillar) exerts a significant impact on bank technical efficiency. Pasiouras *et al.* (2009) investigate the impact of regulations related to the three Pillars of Basel II, namely capital adequacy standards, official supervisory power, and market discipline mechanisms on the cost and profit efficiency of banks. To do this a dataset was employed, consisting of 615 publicly quoted commercial banks operating in 74 countries between 2000 and 2004. Their results suggest that while market discipline and supervisory power enhance both cost and profit efficiency, stricter capital regulation improves cost efficiency but undermines profit efficiency.

Barth *et al.* (2013) consider a panel of 72 developing and developed countries between 1999 and 2007 and find that greater capital regulation stringency is marginally and positively associated with bank efficiency while tighter restrictions on bank activities can compromise this efficiency. At the regional level, Chortareas *et al.* (2012) investigate the dynamics between regulatory and supervisory policies and various aspects of commercial bank efficiency and performance for a sample of 22 European Union countries between 2000 and 2008. Their results show that strengthening capital requirements and official supervisory power can improve efficiency, with these findings being more pronounced in countries with higher quality institutions. For developing countries, Triki *et al.* (2017) consider a dataset of 42 African nations between 2005 and 2010 and examine the relationship between regulatory frameworks and bank efficiency. Their findings suggest that small banks suffer when faced with increased transparency requirements and price control, while more stringent capital regulations only enhance the efficiency of large and low risk banks.

At the country level, using DEA, Hsiao *et al.* (2010) investigate the effect of the 'First Financial Restructuring' plan (FFR) on the operating efficiency of Taiwanese banks for the period 2000 to 2005. The FFR required banks to have a minimum capital adequacy ratio of 8% (consistent with the Basel II standard) and to reduce the rate of NPLs to fewer than 5% of total loans by the end of 2003. Their results suggest an improvement in bank efficiency in the post-reform period due to enhanced risk management practices and other benefits obtained from complying with the FFR. Nevertheless, the authors observe a deterioration in bank efficiency when comparing the reform (2002 to 2003) to the pre-reform period (2000 to 2001). Manlagnit (2015) apply Stochastic Frontier Analysis (SFA) to examine the impact of Basel II on the cost efficiency of Filipino banks from 2001 to 2011. The findings indicate that: firstly, cost efficiency is increasing in higher capital requirements; and secondly, powerful supervisors can in fact undermine efficiency. Furthermore, Manlagnit (2015) suggest that the level of market discipline does not explain variations in bank performance.

Pessarossi and Weill (2015) study the relationship between capital requirements and cost efficiency in China. Similar to what happened in Vietnam, the Bank of China adopted a partial approach to the implementation of the Basel II capital standards. For the years 2004 to 2008, the banking system in China changed from one in which less than 10% of the banks met the Basel II capital adequacy requirements to one in which there is near-full compliance. The findings in Pessarossi and Weill

(2015) strongly indicate that increased capital reduces bank cost efficiency. However, this study did not differentiate piloted banks from controlled banks in the sample. As a consequence, the overall improvement of Chinese banks between 2004 and 2008 may be due to endogenous factors rather than the new capital regulations. Despite numerous studies assessing the impact of compliance with Basel standards on bank efficiency, none have considered the difference between the full and partial compliance regimes. This paper evaluates the banking system in Vietnam and is the first to attempt examining the impact of partial compliance with the Basel capital standards on bank efficiency in an emerging market economy.

3. Methodology

3.1 Measuring technical efficiency with Data Envelopment Analysis

We consider a banking industry consisting of *N* firms and operating through *T* years. Under the assumption of no technological change during the considered period, balanced panel firm data is pooled, generating *n* firm-year observations ($n = N \times T$). Each firm uses p inputs to produce q outputs. Let $x \in \mathbb{R}_+^p$ and $y \in \mathbb{R}_+^q$ denote vectors of p inputs and q outputs, respectively. The production set of the industry can be defined as set out below:

$$\wp = \{(x, y) \in \mathbb{R}_+^p \times \mathbb{R}_+^q : x \; can \; produce \; y\} \quad (1)$$

We use the Farrell (1957) measure of input-oriented technical efficiency,[3] defined by:

$$\delta(x, y \in \wp) \equiv min\{\delta / (\delta x, y) \in \wp, \delta \leq 1\} \quad (2)$$

Under the assumption of free disposability of inputs and outputs and variable returns to scale, the DEA representation of the production set is:

$$\hat{\wp} = \left\{(x, y) \in \mathbb{R}_+^p \times \mathbb{R}_+^q : \sum_{k=1}^n z_k x_k^i \leq x^i, i = 1, \dots, p; \sum_{k=1}^n z_k y_k^j \geq y^j, j = 1, \dots, q; \; \sum_{k=1}^n z_k = 1, z_k \geq 0, k = 1, \dots, n\right\} \quad (3)$$

The DEA input-oriented estimator of δ can then be identified by solving the following model:

$$\hat{\delta} = \; Min \; \delta$$

[3] Input orientation is preferred in this study because during the restructuring period, Vietnamese banks were restricted in their operations and could not expand outputs as much as they would like. Consequently, to improve the production process in this environment, banks tended to minimize their inputs rather than expand outputs.

Subject to:

$$\sum_{k=1}^{n} z_k x_k^i \leq \delta x^i,\ i = 1, \ldots, p;$$

$$\sum_{k=1}^{n} z_k y_k^j \geq y^j,\ j = 1, \ldots, q;$$

$$\sum_{k=1}^{n} z_k = 1;$$

$$z_k \geq 0, k = 1, \ldots, n \quad (4)$$

This model produces bank-year intermediation and profit-oriented operating efficiency scores- the outcome variables for our regression analysis.

3.2 Regression models

This paper investigates the extent to which the application of the Basel II capital standards in Vietnam on pilot (treatment) banks influenced their intermediation and operating efficiency when compared to non-pilot (control) banks. The nature of the data and objectives of the paper therefore demand the application of an appropriate impact evaluation methodology. In this paper, we apply the widely-used two-period and two-group difference-in-differences (DiD) framework to analyze the average treatment effect on pilot (treatment) banks subject to the Basel II capital standards. Estimating DiD in out OLS model is equivalent to running a fixed effects model as group-level omitted variables are captured by the group-level fixed effects. The group-level fixed effects being the treatment/control group and the pre-regulation/post-regulation period. The standard errors are cluster-bootstrapped with 1000 replications given the small number of banks (28).

The non-experimental study of causal effects using the DiD approach has a long history in impact evaluation, dating to as early as the work of Snow (1855).[4] The more recent economics literature provides a litany of reviews and enhancements to this empirical framework, and examples here include Angrist and Krueger (1999), Bertrand *et al.* (2004), Imbens and Wooldridge (2009), Athey and Imbens (2017), Wing *et al.* (2018) and Gholipour *et al.* (2022). In this paper, the DiD method is applied to panel data and measures the treatment effect on pilot (treatment) banks by first observing bank efficiency (outcome variable) for pilot (treatment) banks before and after treatment

[4] Lechner (2011) provides a brief history of the application of the DiD approach to problems spanning numerous disciplines including epidemiology, psychology and economics.

exposure. Efficiency is then observed for the non-pilot (control) banks over both pre-regulation and post-regulation periods. The change in efficiency in the pilot (treatment) banks compared to that of non-pilot (control) banks provides a measurement of the average treatment effect on treated banks. The set-up of this two-period and two-group DiD regression framework using panel data is consistent with that outlined in Angrist and Pischke (2009), Lechner (2011) and Wooldridge (2012).

The general regression equation employed in this study is written as:

$$Bank\ efficiency_{ist} = \alpha + A_s + B_t + \beta P_{st} + \sum \gamma X_{ist} + \varepsilon_{ist} \quad (5)$$

where $Bank\ efficiency_{ist}$ is the outcome of bank *i* in group *s* (the treatment group) in year *t* and P_{st} is a dummy which takes the value of one for treatment observations in the post-regulation period. A_s and B_t are fixed effects for groups and time, respectively. X_{ist} denotes the vector of individual controls included in each regression, α is a constant and ε_{ist} is an error term. In this econometric specification, the coefficient on the P_{st} dummy measures the average treatment effect on treated banks.

4. Data

4.1 Inputs and outputs

Despite the substantial volume of literature on banking efficiency, there is an ongoing debate regarding the selection of input and output variables impacting bank efficiency (Kenjegalieva *et al.*, 2009). As Berger and Humphrey (1997) state, there is no one perfect approach to specify these variables and the specification depends largely on the availability of data and also the particular objective of a given study. According to Bergendahl (1998) commercial banks target five main objectives: profit maximisation, risk management, service provision, intermediation and good customer service. Grigorian and Manole (2006) simplify these goals by pooling them into two major functions: the profit maximization function (incorporating risk management); and a service provision function (combining intermediation and utilities for customers). Most studies, subsequently, have used the following approaches to specify banking inputs and outputs: the intermediation approach and the operating approach.

The intermediation approach, which was proposed by Sealey and Lindley (1977), mainly focuses on the efficiency with which banks can transform savers' deposits into varying maturities for

borrowers. Thus, banking studies generally consider the value of loans as a measurable output of bank services and labor, capital and various funding sources as inputs (Berger *et al.*, 1987; Wheelock and Wilson, 1999; Quaranta *et al.*, 2017; Ouenniche and Carrales, 2018). Unlike the intermediation approach, the profit-oriented operating approach, introduced by Drake *et al.* (2006), argues that the primary objective of a given bank is to maximize revenue generated and minimize operational costs. Hence this approach defines bank outputs as total revenue from lending and non-lending activities, and inputs as the total costs of borrowing and operating expenses (e.g., Avkiran, 1999; Sturm and Williams, 2004; Simper *et al.*, 2017; Shamsuddin, 2018).

This study employs both intermediation and operating approaches. Under the former, the inputs consist of labor cost, fixed assets, and deposits and the output variables are loans, investments and securities. Under the operating approach, interest expenses and non-interest expenses are the main inputs while the outputs include interest and non-interest revenue (Arjomandi *et al.* 2014; Thilakaweera *et al.*, 2016; Salim *et al.*, 2016; 2017; Phuong *et al.*, 2019).

[TABLE 2 ABOUT HERE]

4.2 Dependent variables

The DEA-estimated intermediation (*EFI*) and operating (*EFO*) efficiency scores are employed as our dependent variables in this study. Table 3 presents the means of these variables for the industry as well as both treated and control groups between 2011 and 2019. Compared to operating efficiency means, intermediation efficiency results reveal considerable fluctuations during the restructuring period (from 0.6924 in 2011 to 0.8943 in 2019).

[TABLE 3 ABOUT HERE]

4.3 Independent variables

To establish the treatment effect on pilot banks using a DiD approach, we include post-regulation (*Post*), treatment (*Treat*) and a *Post*Treat* interaction variable as part of our regression equations. *Post* is a dummy variable which takes a value of one if an observation occurs in the post-regulation period (2015 to 2019) and zero otherwise. *Treat* is a dummy variable which takes a value of one for all pilot (treatment) banks and zero otherwise. The *Post*Treat* interaction measures the efficiency impact of the Basel II capital standards on pilot (treatment) banks included in the sample. This interaction takes a value of one if a bank was either assigned by the SBV or voluntarily applied

the new standards since 2015 and zero afterwards.[5] The coefficient on this interaction measures the average treatment effect on treatment banks.

In addition to policy variables, we include a set of additional covariates in our regression analysis to control for differential trends not affecting treatment. To quantify the impact of equity growth on bank performance, the equity growth rate (*RE*) is included as a control variable in our regression analysis. Banks with poor quality risk management practices and high NPLs typically have lower profit efficiency. Given this scenario, they must increase their equity more rapidly, relative to other banks to mitigate their heightened level of risk.

An increasing level of NPLs as a proportion of total bank loans can undermine bank asset quality and impact on capital adequacy ratios. To meet the requirements of the Basel II capital standards, banks are required to reduce their proportion of NPLs. The loan-loss provisioning cost (*LLPR*) variable is included in regression models to proxy for the impact of NPLs on the efficiency of both treated and control bank groups. The relationship between profit efficiency and NPLs is expected to be negative given that a higher *LLPR* would increase total bank costs and reduce profit.

Agency theory offers opposing views on the impact of capital ratios on bank performance. On one hand, agency costs emerge from conflicts of interest between shareholders and debtholders, since shareholders have incentives to take steps that benefit themselves at the expense of debtholders and thus do not necessarily improve bank performance. Shareholders, in general, prefer investment in riskier projects than those preferred by debtholders (Myers, 1977; Jensen and Meckling, 1979). Under this view, as agency costs are increasing in the proportion of debt in the capital structure they are associated with lower capital ratios (*CAR*). In other words, a higher capital ratio would reduce shareholder-debtholder agency costs and positively impact on efficiency. Another driver of agency costs is the issue of asymmetric information between shareholders and managers, which can increase managerial moral hazard and thus diminish bank performance. Greater debt financing, and therefore a lower capital ratio, puts pressure on managers to work well because it reduces the amount of free cash flow available to them (Jensen, 1986). Debt requires managers to service regular interest payment obligations with the free cash flow available and thus moderate any tendency to shirk this responsibility. Further, managers are very motivated to avoid damage to one's career that can be associated with bankruptcy (Grossman and Hart, 1982). Therefore, higher

[5] Pilot (treatment) banks began implementing the new capital standards in 2015, following Document 1601 which was issued in March 2014 by the Banking Inspection and Supervision Office, a body of the SBV.

capital ratios can result in poorer bank management and seriously compromise efficiency. Due to the conflicting predictions in the literature, the relationship between capital ratios and efficiency remains an open empirical question.

5. Results and Analysis

5.1 Identification

The correct identification of a two-period and two-group difference-in-differences framework relies on assumptions of common support (positivity), parallel trends and the absence of pre-treatment (anticipatory) effects (Lechner, 2011; Wing *et al*., 2018; Fredriksson and Oliveira, 2019). Prior to presenting the findings from the main DiD regression analysis (Table 7), we assess the extent to which there is evidence to support our identification strategy.

[TABLES 4 AND 5 ABOUT HERE]

Table 4 presents descriptive statistics of the control variables (*RE*, *LLPR* and *CAR*) included in our regression analysis. The statistics presented suggest there are inconsequential differences in the summary values of these variables when comparing treatment and control groups. As a result, the figures presented imply a level of distributional overlap exists between treatment and control groups, and therefore common support, with respect to the two groups' characteristics. Further, Table 5 details the correlation between the control variables included in the regression analysis and indicates no strong correlations are evident between control variables. Suggested here is that it is unlikely that the results presented in Table 7 suffer from multicollinearity issues.

The parallel trends assumption suggests that *in the absence of treatment*, the outcome variable of interest for the treatment group would have a time-series that differs by a constant amount from that of the control group in the post-regulation period. Analyzing the outcomes of a treatment group in the post-regulation period in the absence of treatment, is of course, not possible because we cannot observe the counterfactual. Nevertheless, in this paper we adopt conventional methods to assess the strength of the parallel trends assumption including graphical and placebo intervention regression analysis.

[FIGURES 1 AND 2 ABOUT HERE]

Graphical analysis is presented in Figure 1 and Figure 2 and details the observed group-mean and linear trends of treatment and control groups with reference to intermediation (*EFI*) and operating (*EFO*) efficiency, respectively. Figure 1 indicates that the group-means and linear trends for the pre-regulation period are approximately parallel. This implies there is validity in assuming that the pre-treatment trends approximate the counterfactual trends that would have occurred without the treatment. For the post-regulation period, we observe a departure from parallel trends, with Figure 1 showing that the rate of increase in intermediation efficiency for the treatment group exceeds that of the control group by a significant margin. This finding supports our expectation of an increase in intermediation efficiency among treated banks in the post-regulation period relative to control banks. In contrast, Figure 2 suggests a non-constant difference in trends between treatment and control operating efficiency outcomes in the pre-regulation period. This graphic depiction of the trends in Figure 2 indicates a departure from parallel trends and thus suggests a weakened identification. As well, Figure 2 suggests that treatment and control groups follow similar group-mean and linear trends in operating efficiency for the post-regulation period, casting further doubt on the existence of an observable treatment effect on operating efficiency.

[TABLE 6 ABOUT HERE]

To further assess the parallel trends assumption and to examine our data for the existence of pre-treatment (anticipatory) effects, we conduct a set of placebo intervention tests on the pre-treatment sample. Table 6 presents the results from a set of placebo two-period two-group DiD regressions on the pre-regulation sample only. $Post_{2012}$ is a placebo policy dummy taking a value of one if an observation occurs between 2012 and 2014 and zero otherwise. Similarly, $Post_{2013}$ is a placebo policy dummy taking a value of one if an observation occurs between 2013 and 2014 and zero otherwise. The placebo policy dummies test for pre-treatment period anticipatory effects and aid in assessing the parallel trends assumption. If the coefficients on the *Post*Treat* interactions in each regression are statistically insignificant, this provides support for the non-existence of pre-treatment effects. Consistent with expectations, each of the coefficients on the *Post*Treat* interactions in Table 6, with the exception of regression (2) suggest the absence of pre-treatment effects. The coefficient on the $Post_{2012}$*Treat* interaction in regression (2) is marginally significant (at the 10% level) and implies a general lack of parallel trends with respect to operating efficiency observations between treatment and control groups in the pre-regulation period. These results

corroborate the findings from graphical analysis and suggest a weak identification of the policy impact on the operating efficiency of treatment firms.

In sum, the descriptive statistics for treatment and control samples indicate a degree of common support (Table 4) and distributional overlap between treatment and control group characteristics. The graphical analysis of treatment and control group-mean and linear efficiency trends (Figures 1 and 2) and a set of placebo intervention tests (Table 7) do offer support to the parallel trends assumption. They also provide evidence which suggests that there is an absence of pre-treatment (anticipatory) effects with respect to the impact of the introduction of the Basel II capital standards on intermediation efficiency. This, however, cannot be said for operating efficiency, where the results suggest a weaker degree of identification.

5.2 Results from the two-period two-group DiD regression analysis

Table 7 presents results derived from a set of regressions which apply a two-period two-group DiD framework and consider the impact of the introduction of the Basel II capital standards on bank intermediation and operating efficiency on pilot (treatment) banks. Table 7 is divided into two panels. Panel 1 and Panel 2 present results from regression analysis where the outcome variable is intermediation efficiency (*EFI*) and operating efficiency (*EFO*), respectively. While the intermediation approach to bank efficiency provides significant outcomes and will be analyzed in depth hereafter, profit-based efficiency is not explained by our models. This may be due to differences in the accounting standards adopted between treatment and control bank groups.

[TABLE 7 ABOUT HERE]

Regression (1) of Panel 1 presents the baseline DiD results excluding covariates, each covariate is then added individually to this baseline model as presented in Regressions (2) to (4) and Regression (5) presents the full model with all covariates. With respect to the main effect of concern the coefficients on each of the *Post*Treat* interactions in all regressions in Panel 1 of Table 7 are positive and statistically significant at the 5% level. This outcome indicates a positive average increase in intermediation efficiency (*EFI*) on treated banks compared to control banks following the introduction of the Basel II capital standards. The coefficient on the *Post*Treat* interaction in Panel 1 of Table 7 for the full model (Regression (5)) takes a value of 0.0737. It indicates that the Basel II capital standards increased intermediation efficiency by an average of 7.37% for treatment banks relative to control banks.

The positive impact of the experimental implementation of Basel II capital regulations on bank efficiency in Vietnam supports the 'public interest view', whereby the government acts to regulate banking activities to reduce the likelihood and impact of financial system failure on the economy. The accelerated growth of the Vietnamese economy and its financial system does not align with its outdated banking regulations and in fact, triggered turmoil in the banking system during the 2007-2012 period. This forced the State Bank of Vietnam to change the banking regulations so that they aligned with the reformed banking system and market-oriented economy. The implementation of Basel II capital regulations is divided into two phases. Partial implementation occurred between 2015 and 2019, while full implementation of the Basel II capital regulations commenced in 2020. Our results suggest a positive impact of the Basel II capital regulations on bank efficiency even in the 2015-2019 experimental phase.

The results in Table 7 support a positive relationship between equity growth and intermediation efficiency, in which banks with a higher rate of equity tend to be more efficient. Consistent with the regulations, Vietnamese banks are required to raise their capital commensurate with their risk level and engage in cost-saving activities due to the poor-performing Vietnamese stock market. Cost-saving activities require banks to cut operating costs such as those relating to fixed assets as well as labor. These two costs are important inputs for the intermediation approach to bank operations and the reduction of these costs increase bank efficiency under input-oriented methods for estimating efficiency. Intermediation efficiency is also found to be positively related to loan-loss provisioning costs, meaning that banks with a higher level of credit risk are more efficient. This can be explained by the rising pressure that the Basel II capital regulations impose on riskier banks. Subsequently, these banks were forced to accelerate their plans to reduce operating costs relative to other banks, resulting in a corresponding increase in bank intermediation efficiency.

6. Conclusion

The impact of capital reform on bank efficiency has been widely investigated in the banking literature. Nevertheless, this issue has been neglected in the context of developing countries where the Basel regulations are partially and/or experimentally implemented. This paper aims to contribute to this deficiency by investigating the influence of Basel II capital standard introduction in the emerging economy of Vietnam.

Using Vietnamese bank data for the period 2011 to 2019, this study finds no difference in operating (profit-oriented) banking efficiency between pre- and post-implementation of the Basel II capital regulations among the piloted banks. In contrast, it was discovered that the Basel II standards have a statistically significant and positive impact on the intermediation efficiency of piloted banks, demonstrating that the Basel standards improved intermediation services to customers. Additionally, equity growth and non-performing loans were found to positively impact intermediation efficiency as the introduction of the Basel II capital standards gave banks the incentive to reduce operating costs. Overall, these results indicate that the partial and selective implementation of the Basel II capital standards has had an economically significant and positive effect on the efficiency of Vietnam's banking system.

Table 1. Vietnamese bank ownership characteristics in June 2021 measured by charter capital (in billion VND)

	Sector		Treated banks		Proportion	
	Number	Charter capital	Number	Charter capital	Number	Charter capital
SOCBs	7	158,681	3	114,543	0.43	0.72
JSBs	28	318,829	15	224,168	0.54	0.70
FJVBs	11	50,685	2	10,612	0.18	0.21
Industry	46	528,195	20	349,323	0.43	0.66

Notes: SOCBs (State-Owned Commercial Banks) are totally or to a large extent owned by the State. JSBs (Joint Stock Banks) are owned by private investors. FJVBs (Foreign and Joint Venture Banks) are totally or to a large extent owned by foreign investors.

Source: The State Bank of Vietnam (SBV).

Table 2. Description of inputs and outputs for intermediation and operating approaches (values in million VND)

		Industry (N = 252)		Control group (N = 135)		Treated group (N = 117)	
		Mean	Std. Dev.	Mean	Std. Dev.	Mean	Std. Dev.
Intermediation approach							
Labor cost	Input	1,838,230	2,740,702	1,748,447	3,169,884	1,941,827	2,136,454
Fixed assets	Input	1,952,593	2,658,731	2,147,819	2,924,421	1,727,333	2,294,020
Deposits	Input	150,739,325	228,499,035	136,401,715	239,221,821	167,282,721	214,275,714
Loans	Output	127,615,317	210,326,124	117,275,074	220,031,651	139,546,367	197,868,434
Investments and Securities	Output	32,578,321	38,618,793	24,750,811	37,589,435	41,610,064	37,810,803
Operating approach							
Interest expenses	Input	8,125,620	11,365,110	7,239,910	11,959,818	9,147,593	10,545,640
Non-interest expenses	Input	3,830,364	5,358,211	3,308,667	5,633,798	4,432,321	4,953,660
Interest revenues	Output	13,396,522	19,092,078	11,269,017	19,712,117	15,851,336	18,041,536
Non-interest revenues	Output	2,113,107	3,438,870	1,563,760	3,062,359	2,746,968	3,728,297

Table 3. DEA efficiency scores (yearly means) of Vietnamese banking sector during the period 2011–2019

	2011	2012	2013	2014	2015	2016	2017	2018	2019
Intermediation efficiency (EFI) scores									
Control group	0.7116	0.7724	0.7971	0.7875	0.7451	0.8372	0.8632	0.8728	0.8548
Treated group	0.6732	0.6852	0.7833	0.7739	0.7278	0.8045	0.8655	0.9098	0.9337
Industry	0.6924	0.7288	0.7902	0.7807	0.7365	0.8209	0.8644	0.8913	0.8943
Operating efficiency (EFO) scores									
Control group	0.8588	0.7744	0.7174	0.7156	0.7379	0.7716	0.8092	0.7945	0.8197
Treated group	0.8743	0.8364	0.8075	0.8156	0.8145	0.8425	0.8672	0.8891	0.9044
Industry	0.8666	0.8054	0.7625	0.7656	0.7762	0.8071	0.8382	0.8418	0.8621
No. of banks per year	28	28	28	28	28	28	28	28	28

Table 4. Description of control variables

	RE	*LLPR*	*CAR*
Industry			
Mean	0.3063	0.0967	0.1063
Std.Dev.	0.5320	0.0887	0.0680
Min.	-0.1634	0.0017	0.0406
Max.	2.3619	0.7117	0.7983
Control group			
Mean	0.2752	0.0965	0.1192
Std.Dev.	0.5949	0.1034	0.0794
Min	-0.1256	0.0567	0.0420
Max	2.2215	0.7117	0.7983
Treated group			
Mean	0.3423	0.0971	0.0913
Std.Dev.	0.4459	0.0680	0.0478
Min.	-0.1634	0.0017	0.0406
Max.	2.3619	0.2794	0.3215

Notes: *RE* is the growth rate of equity, *LLPR* is the rate of loan-loss provisioning cost to the total cost and *CAR* is the capital ratio.

Table 5. Correlation matrix of control variables

	RE	*LLPR*	*CAR*
RE	1		
LLPR	-0.0367	1	
CAR	0.3804	-0.0652	1

Notes: *RE* is the growth rate of equity, LLPR is the rate of loan-loss provisioning cost to the total cost and *CAR* is the capital ratio.

Table 6. An analysis of placebo interventions to test for the existence of pre-treatment effects

Dependent Variable	*EFI*	*EFO*	*EFI*	*EFO*
	(1)	(2)	(3)	(4)
$Post_{2012}$	0.0258	**-0.0969*** **		
	(0.0436)	**(0.0293)**		
$Post_{2013}$			0.0068	**-0.0657***
			(0.0370)	**(0.0359)**
Treat	-0.0399	0.0220	**-0.0720****	0.0467
	(0.0488)	(0.0303)	**(0.0322)**	(0.0292)
$Post_{2012}$*Treat*	0.0058	**0.0727***		
	(0.0561)	**(0.0416)**		
$Post_{2013}$*Treat*			0.0752	0.0569
			(0.0468)	(0.0455)
Controls	Y	Y	Y	Y
Constant	**0.5597*****	**0.8098*****	**0.5748*****	**0.7763*****
	(0.0482)	**(0.0351)**	**(0.0403)**	**(0.0350)**
Observations	112	112	112	112
R^2	0.363	0.259	0.386	0.239

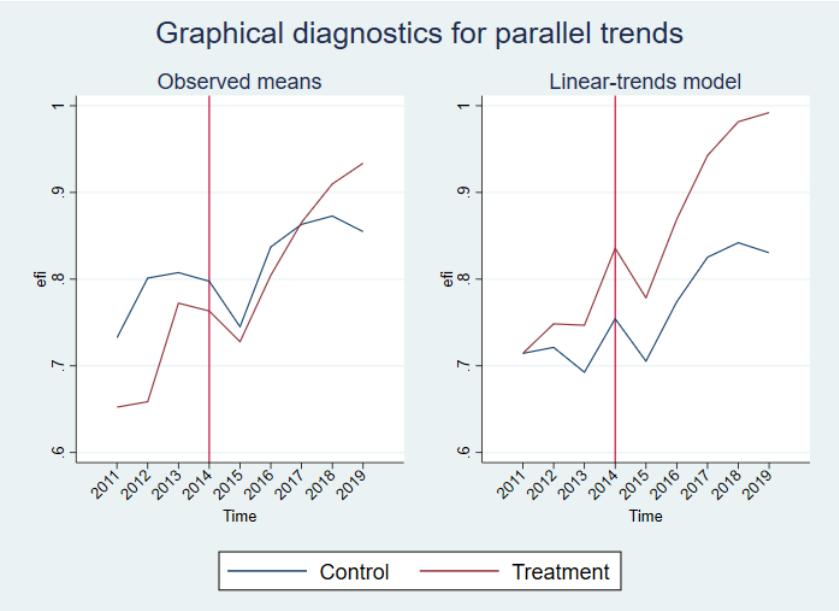
Notes: The table presents the results for the impact of placebo interventions on the intermediation and operating efficiency of treatment banks applying a two-period two-group DiD regression framework. It covers the pre-regulation period (2009 to 2014) observations only, since regression tests for the presence of anticipatory treatment effects. *EFI* is the intermediation efficiency for each bank-year. *EFO* denotes the operating efficiency for each bank-year. $Post_{2012}$ is a dummy variable which takes a value of one if an observation occurs between 2012 and 2014 and zero otherwise. $Post_{2013}$ is a dummy variable which takes a value of one if an observation occurs between 2013 and 2014 and zero otherwise. *Treat* stands for a dummy variable which takes a value of one for all treatment banks and zero otherwise. $Post_{2012}$*Treat* and $Post_{2013}$*Treat* are the main coefficients of interest and measure the treatment effect on banks treated with the placebo treatment. *Controls* include *CAR*, *RE* and *LLPR*, consistent with main analysis in Table 7. Given the small number of bank clusters in the sample (28 clusters) standard errors are cluster-bootstrapped with 1000 replications. *, ** and *** indicate significance at the 10%, 5% and 1% levels, respectively.

Table 7. The impact of the introduction of the Basel II capital standards on banks' intermediation and operating efficiency

Panel 1: Dependent Variable: *EFI*	(1)	(2)	(3)	(4)	(5)
Post	**0.0500***	**0.0525****	**0.0684*****	**0.0471***	**0.0674*****
	(0.0261)	**(0.0264)**	**(0.0265)**	**(0.0257)**	**(0.0258)**
Treat	**-0.0730****	**-0.0692****	**-0.0740*****	**-0.0694****	**-0.0665****
	(0.0297)	**(0.0297)**	**(0.0282)**	**(0.0283)**	**(0.0265)**
*Post*Treat*	**0.0866****	**0.0859****	**0.0813****	**0.0797****	**0.0737****
	(0.0380)	**(0.0364)**	**(0.0369)**	**(0.0371)**	**(0.0358)**
CAR		0.1217			0.1234
		(0.2411)			(0.2221)
RE			**0.0599*****		**0.0576*****
			(0.0184)		**(0.0167)**
LLPR				**0.4001*****	**0.3992*****
				(0.1074)	**(0.1134)**
Constant	**0.7847*****	**0.7688*****	**0.7580*****	**0.7476*****	**0.7059*****
	(0.0201)	**(0.0376)**	**(0.0214)**	**(0.0210)**	**(0.0357)**
Observations	252	252	252	252	252
R^2	0.112	0.115	0.153	0.166	0.207
Panel 2: Dependent Variable: *EFO*	(1)	(2)	(3)	(4)	(5)
Post	0.0202	0.0223	0.0111	0.0209	0.0139
	(0.0228)	(0.0232)	(0.0223)	(0.0234)	(0.0225)
Treat	**0.0620****	**0.0653****	**0.0625****	**0.0610****	**0.0651****
	(0.0261)	**(0.0264)**	**(0.0260)**	**(0.0259)**	**(0.0269)**
*Post*Treat*	0.0149	0.0143	0.0176	0.0168	0.0187
	(0.0310)	(0.0301)	(0.0308)	(0.0311)	(0.0301)
CAR		0.1048			0.1119
		(0.1547)			(0.1617)
RE			-0.0295		-0.0301
			(0.0241)		(0.0245)
LLPR				-0.1094	-0.1016
				(0.1651)	(0.1512)
Constant	**0.7664*****	**0.7527*****	**0.7796*****	**0.7765*****	**0.7746*****
	(0.0192)	**(0.0307)**	**(0.0194)**	**(0.0183)**	**(0.0283)**
Observations	252	252	252	252	252
R^2	0.093	0.096	0.108	0.099	0.117

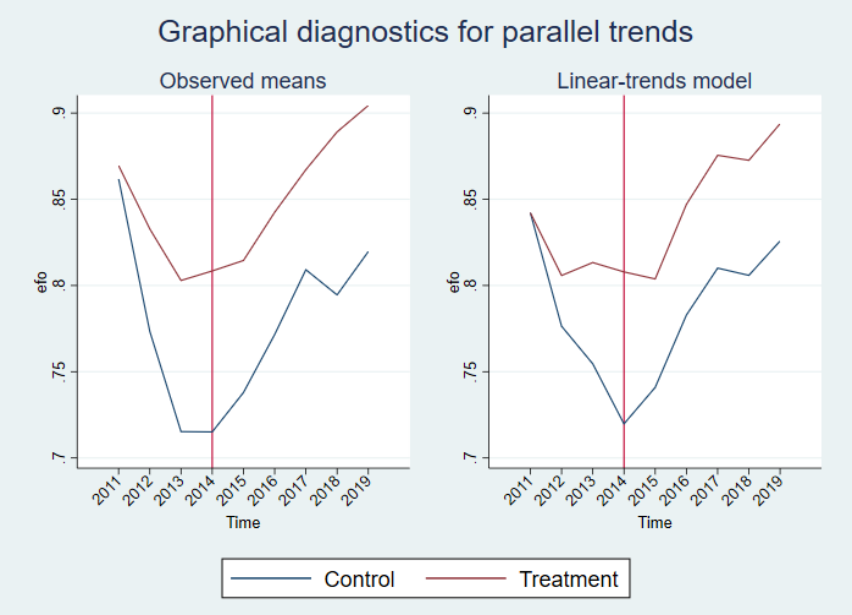
Notes: The table presents the results from a two-period two-group difference-in-differences regression and measures the impact of Basel II capital standards on the intermediation and operating efficiency of Vietnamese banks. Included variables are defined in detail in sub-sections 4.2 and 4.3 of this paper. Given the small number of bank clusters in the sample (28 clusters), standard errors are cluster-bootstrapped with 1000 replications. *, ** and *** indicate significance at the 10%, 5% and 1% levels, respectively.

Figure 1. Observed group-mean and linear trends of treatment and control groups: Intermediation efficiency (EFI)



Notes: This figure presents mean annual intermediation efficiency (EFI) for treatment and control groups. The line that intersects the x-axis differentiates the pre-regulation period from the post-regulation period.

Figure 2. Observed group-mean and linear trends of treatment and control groups: Operating efficiency (EFO)



Notes: This figure presents mean annual operating efficiency (EFO) for treatment and control groups. The line that intersects the x-axis differentiates the pre-regulation period from the post-regulation period.

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