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Impact of bank ownership and financial liberalisation on banking efficiency: The case of Vietnam

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Abstract

Employing a sample of Vietnamese banks covering the period 2005 to 2015, this study investigates the influence of bank ownership and financial liberalisation measures on banking efficiency and contributes to the literature in two important respects. First, this paper broadens our understanding of the liberalisation process in the banking sector of a developing transition economy. Second, it sheds light on the long-term and dynamic impact of partial liberalisation measures on the efficiency of its banking system and implications for the country's economic growth and development. A bootstrapped data envelopment analysis (DEA) is employed to measure bank efficiency, and key findings indicate that: (1) state-owned banks outperformed all other ownership types, indicative of their ongoing privileged and dominant position in the banking sector; (2) privatisation of state-owned banks, where it occurred, exerted a positive influence on bank efficiency; (3) rural-to-urban private bank transformation decreased bank efficiency; (4) foreign strategic investor involvement that resulted in minority foreign ownership exerted an insignificant impact on domestic bank efficiency; (5) business group ownership of banks improved their provision of intermediation services but deteriorated bank operating efficiency.

JEL Classifications: D24, G21

Keywords: bank efficiency; financial liberalisation; ownership type; business environment; Vietnam; DEA; generalised difference-in-differences.

1. Introduction

Transition towards market oriented economies by the formerly centrally planned European and Asian nations in the late 1980s and early 1990s triggered the adoption of economic liberalisation policies. Foremost among these was financial liberalisation focused on transforming state dominated banking systems from single to two-tier structures, increasing competition and transforming state to private ownership in the sector. Banking system liberalisation, however, varied among transition economies in terms of both scope of coverage and speed of implementation. Generally, two broad approaches emerged. The first involved full liberalisation without limits with all banks treated equally regardless of ownership (public, private and foreign), and publicly-owned banks no longer dominated the market nor were used as vehicles for the enactment of state policies. This type of liberalisation (the so-called 'big bang' approach) was adopted in many of the former transition countries of Central and Eastern Europe, where transformation to a competitive and primarily privately controlled banking sector has largely been implemented (Bonin *et al*., 2005a; 2005b; Fries and Taci, 2005; Havrylchyk, 2006; Kraft *et al.*, 2006; Karas *et al*., 2010; Bonin and Schnabel, 2011). The second approach involved gradual and incremental liberalisation, where state-owned banks remained as dominant players and key policy facilitators, while retaining competitive advantages in terms of implicit government guarantees, less risk and access to cheaper funding. A gradual liberalisation approach has been prevalent in the banking systems of countries such as China, Russia and Vietnam.

The aim of this study is to examine and evaluate the impact of the gradual or incremental approach to banking sector reform adopted by Vietnam on the efficiency of various categories of banks based on ownership type in this country. Improving banking sector efficiency is critical for the promotion of economic growth in countries with a predominantly bank-based financial system, as is the case in Vietnam (Hasan *et al*., 2009; Koetter and

Wedow, 2010). For transition economies more generally, Koivu (2002) provides evidence to suggest that banking sector efficiency is particularly important in facilitating economic growth in transition countries. Evidence as to which type of bank ownership best drives efficiency is, however, mixed. Levine (2001) argues that economic growth is most effectively achieved through international financial liberalisation that enables foreign banks to have greater access to the domestic market, while La Porta *et al.* (2002) argue that state ownership of banks slows financial development. On the other hand, Andrianova *et al.* (2012) argue that long run economic growth is improved by government ownership of banks. The discriminatory nature of the banking reforms adopted in Vietnam, specifically against domestic private and foreign-owned banks, and resulting banking sector distortions and inefficiencies, has the potential, therefore, to adversely impact the future growth and development of the economy.

The structure of the paper is as follows. Section 2 reviews the Vietnamese banking sector after the abandonment of central planning and adoption of market oriented reform measures. Section 3 provides an overview of the banking efficiency-ownership type literature for the case of transition economies. The bank efficiency measurement methodology adopted, including DEA and double bootstrap DEA, is presented in Section 4. Section 5 describes the data and specifies inputs/outputs. Section 6 describes the explanatory variables used in the regression models and presents an analysis of the empirical results, while Section 7 highlights key findings and policy implications.

2. The Vietnamese banking sector

At its sixth National Congress in December 1986, the Communist Party of Vietnam made a decisive step to abandon central planning and adopt, instead, a socialist market-oriented system. This became known as ‘Doi Moi’ (renovation) (Harvie and Hoa, 1997; Beresford,

2008). Accordingly, the mono-bank system, which only served the needs and demands of the state sector, was split into a two-tier banking system with the State Bank of Vietnam (SBV) playing the key role of central bank on one tier and state-owned commercial banks (SOCBs) as lenders on the other. The new system also permitted the entry of private banks in the form of joint-stock banks (JSBs) and a limited presence of overseas investors in joint-venture banks. The JSBs faced many difficulties not only in terms of financial capacity but also in terms of managerial capability. During the 1990s a large proportion of SOCB loans were allocated to inefficiently operating SOEs; a legacy of the period of central planning and which continues to persist until today (Oh, 1999; Beresford, 2008; World Bank, 2014).

The East Asian Financial Crisis (EAFC), and its exposure of institutional and structural weaknesses, resulted in economic slowdown between 1998 and 2000, and provided further impetus for reform of the Vietnamese banking sector (Kovsted *et al*., 2005). Reform measures included: building a robust regulatory and supervisory framework; improving the quality of domestic banks, focusing especially on SOCBs through the separation of policy lending from commercial lending; writing off bad loans; bank recapitalisation, technical support and the enhancement of risk management strategies. Despite this series of reform measures, the banking sector remained largely 'off limits' to overseas investors. Indeed, during the pre-WTO entry period (i.e. pre 2007), overseas investors were only allowed to take part in the banking sector through a limited presence in joint-venture banks or through participation in a limited number of bank branches in Vietnam. Overseas investors were also not permitted to open 100 per cent foreign-owned banks or participate in domestic banks as shareholders. This was to change, however, as a requirement for Vietnam's entry into the WTO on 11 January 2007. The composition of the Vietnamese banking sector by different bank ownership types after WTO entry and up to December 2016 is summarised in Table 1.

<TABLE 1 ABOUT HERE>

The entry of Vietnam into the WTO resulted in an increased presence of foreign banks from April 2007 and allowed wholly foreign-owned banks to participate in the banking sector (Pincus, 2009). These foreign banks were now allowed to receive deposits and lend in Vietnamese dong, but their operations remained largely confined to major commercial centres such as Ho Chi Minh City and Hanoi. This entry also prompted additional reforms aimed at enhancing the competitiveness and efficiency of domestic banks. Reforms included allowing for the partial privatisation of SOCBs and providing foreign investors with rights to purchase equity in domestic banks. Total foreign investment in Vietnamese joint-stock commercial banks, however, was limited to 30 per cent of each bank's chartered capital.

Opening the banking market to foreign investment generated concerns over the competitiveness of domestic banks.[1] Both SOCBs and JSBs faced difficulties from low efficiency, out-of-date technology and limited capital. The government's *2006 Decree 141* increased the required minimum notional capital levels of all credit institutions (IMF, 2012; NAEC, 2012) with the objective of increasing domestic bank resources and size, stating that any commercial banks that could not conform to the stipulated levels by the end of 2010 would be forced to merge, reduce the scope of their activities, or have their bank licence revoked. As a result, all small domestic JSBs faced an uphill battle to increase their capital levels by up to 10 times in a five-year period (NAEC, 2012). Calling for equity participation from large banks, private business groups and SOEs became a logical source of funds which, as a consequence, resulted in numerous and complex cross-ownerships involving JSBs (IMF, 2012; NAEC, 2012). Most loans by these banks were subsequently allocated to related parties, rather than to the most profitable projects (Pincus, 2009; Nguyen *et al*., 2014). A lack of regulation relating to cross-ownership and the limited capability of supervisory

[1] There was a general reluctance by the authorities to engage in banking sector liberalisation, particularly in terms of the privatisation of state-owned banks and the entry of foreign-owned banks. But these were conditions for entry into the WTO.

departments worsened this situation. Under pressure from the need for all domestic banks to increase their capital capability, the SBV substantially loosened its regulations when permitting thirteen rural banks to transform into urban banks during the period 2006–2007 (NAEC, 2012). In 2005, the total capital of these banks was estimated at 165 billion Vietnamese dong (VND), or 13.75 billion VND on average for each bank. With the introduction of *Decree 141*, each urban bank had to achieve a chartered capital level of at least 1,000 billion VND by the end of 2008 and of at least 3,000 billion VND by the end of 2010.

Overall, the Vietnamese banking sector was significantly transformed by these reforms during the post-WTO entry period. As a result it is important to examine the effects of these reforms on bank efficiency performance while at the same time identifying any additional policy measures that could further improve bank efficiency in Vietnam.

3. Literature review

DEA is a non-parametric method which has been used in various areas to measure efficiency of decision making units with multiple-inputs and multiple outputs (Arjomandi et al., 2014; 2015; 2017). Many studies in the literature have traditionally used stochastic frontier analysis (SFA) and DEA to estimate banking efficiency in transition and emerging economies, indicating that bank ownership type is a major determinant (Phuong *et al.*, 2017; Thilakaweera *et al.*, 2016). These include both cross-country and single-country studies. In general, cross-country studies find that state-owned banks are the least efficient (see Jemric and Vujcic, 2002; Bonin *et al*., 2005a, 2005b; Fries and Taci, 2005; Grigorian and Manole, 2006). In contrast, single-country studies suggest that state-owned banks are at least as efficient as private-owned banks (Arjomandi, 2011; Arjomandi *et al.*, 2011; 2012; Karas *et*

al., 2010; Mamonov and Vernikov, 2017).[2] Most empirical studies of emerging economies conclude that foreign-owned banks are the most efficient (see, for example, Hasan and Marton, 2003; Weill, 2003; and Bonin *et al*., 2005a). Berger *et al*. (2000) argue that bank efficiency by ownership type can differ depending upon whether cost or profit efficiency is emphasised. Two separate hypotheses are referred to when addressing differences in efficiency scores; the global advantage hypothesis and the home field advantage hypothesis. The global advantage hypothesis postulates that foreign banks exhibit higher efficiency due to superior managerial skills, corporate policies and procedures, and better investment and risk management skills, resulting in lower costs, increased profitability and risk diversity. The home field advantage hypothesis, on the other hand, assumes that higher domestic bank efficiency is a result of the avoidance of certain implicit barriers, management and monitoring challenges, cultural and language differences, as well as reduced complexity in negotiating market, regulatory and supervisory aspects (Belousova *et al*., 2018). A third dimension is that state-owned and foreign banks in emerging or transition economies operate in an environment which provides them with a distinct competitive advantage in terms of government implicit guarantees and access to cheaper funding (Karas *et al*., 2010; Vernikov, 2012). In addition, state-owned banks may benefit from discriminatory policy measures aimed at maintaining their dominance in the market for political reasons.

Major cross-country studies on this issue include Bonin *et al.* (2005a) who used SFA to examine the effects of ownership on bank efficiency for eleven transition countries covering the period 1996 to 2000. Their findings suggest that foreign banks are the most cost-efficient bank ownership type and that bank size is negatively correlated with efficiency. Bonin *et al.* (2005b) analysed the largest banks in six European transition economies and found that

[2] Both studies focused on the cost efficiency of Russian banks, a measure of how well banks cut costs by offering a range of products and services. How efficiency is measured, cost or profit, can impact on the relative efficiency by ownership type.

majority foreign-owned banks were most efficient and government-owned banks the least efficient.[3] Fries and Taci (2005) consider 15 East European transition countries and a sample of 289 banks covering the period 1994 to 2001. They concluded that bank cost efficiency is higher in countries with lower nominal interest rates, a greater market share of majority foreign-owned banks, and a higher intermediation ratio. Banking systems with higher ratios of capital to total assets and banks with lower loan losses also tended to have lower costs. While private banks were more cost efficient than state-owned banks, major differences existed between them. Privatised banks with majority foreign ownership were the most cost efficient, followed by newly established private banks both domestic and foreign-owned. Privatised banks with majority domestic ownership were the least efficient private banks, but were more efficient than state-owned banks. The results are consistent with those in Grigorian and Manole (2006) and lend support to the global advantage hypothesis.

Koutsomanoli-Filippaki *et al.* (2009) also found that foreign banks were more efficient than domestic private and state-owned banks for Central and Eastern European transition countries covering the period 1998 to 2003, and that there was also a strong link between competition, concentration and bank efficiency. Similarly, Yildirim and Philippatos (2007), who analyse 12 transition countries over the period 1993 to 2000, conclude that foreign banks were the more cost-efficient but less profit-efficient relative to state-owned and private domestic banks. In a study of 19 European transition economies, Borovička (2007) observe that foreign investors performed better because they acquired the most cost-efficient banks in the first place. In addition, Brissimis *et al.* (2008) investigated 10 newly acceded EU countries, mostly from Central and Eastern Europe, and their results showed that banking sector reform and competition had a positive effect on efficiency. Fang *et al.* (2011) found that the cost and

[3] The transition economies considered in Bonin et al. (2005b) include Bulgaria, Czech Republic, Croatia, Hungary, Poland and Romania.

profit efficiency of foreign banks in 6 South-Eastern European transition countries over the period 1998 to 2008 was higher. Bank competitiveness and institutional development were also positively associated with cost and profit efficiency. Zajc (2006) estimated the cost efficiency of banks in 6 Central and Eastern European countries during the period 1995–2000 focusing on the role of foreign ownership. Zajc (2006) found that domestic banks were more cost-efficient than their foreign counterparts due to either higher start-up costs in a new market for foreign banks or from limited competition in the new market.

Many single-country bank efficiency studies suggest similar outcomes for transition economies. Tochkov and Nenovsky (2009) consider the case of Bulgaria and find that foreign banks were the most efficient. Bank capitalisation, liquidity, and enterprise restructuring were also found to have positive effects on efficiency, while banking reforms had an adverse effect. Havrylchyk (2006) examined the efficiency of Polish banks over the period 1997 to 2001 using DEA and argued that bank efficiency had not improved during this period, and that foreign banks acquiring domestic institutions had not succeeded in enhancing their efficiency. Nikiel and Opiela (2002) also consider the Polish context. Their findings suggest that foreign banks servicing foreign and business customers in Poland were more cost-efficient but less profit-efficient than domestic banks. Similar results were observed in a study of the Hungarian banking system (Hasan and Marton, 2000).

Country-specific results for transition countries adopting a more gradualist approach to bank reform produce more mixed outcomes. Empirical studies of Russian banks, for example, give contradictory results for the cost efficiency of foreign, domestic private and state-owned banks. The studies of Karas *et al.* (2010) and Styrin (2005) present evidence in support of the global advantage hypothesis. Specifically, Karas *et al.* (2010) showed that foreign banks were more cost efficient than domestic private banks due to advanced banking technology and superior risk-management, consistent with the global advantage hypothesis, but state-owned

banks were comparable with domestic banks in terms of cost efficiency. Belousova *et al.* (2018) showed that foreign-owned banks were the most profit efficient in Russia, followed by state-owned banks and private domestic banks. The profit efficiency of foreign-owned banks was higher than that of other banks during economically stable periods but state-owned banks were more profitable during periods of instability due to state support.

The findings in Vernikov (2012) indicate that state-owned Russian banks dominate the sector, but, contrary to expectations, were also more profitable and efficient relative to their private and foreign-owned equivalents. Their advantageous association with government, in terms of the acquiring and disposing of assets on their behalf, was a contributing factor in this result. Mamonov and Vernikov (2017) also find support for the home field advantage hypothesis for the case of Russian banks with core state banks, as distinct from other state-controlled banks, being nearly as efficient as private domestic banks. This was particularly the case both during and after the crisis of 2008-2009. Foreign-owned banks were the least cost efficient. Core state banks were most cost efficient when they engaged in less lending to the domestic economy, some of which involved investment in unprofitable projects as a result of political interference. Golovan *et al.* (2008) also found support for the home field advantage hypothesis for Russian banks. Foreign-owned banks often had to create infrastructure and branch networks, recruit staff, attract clients, and build long-term relations, all of which reduced foreign bank efficiency.

Berger *et al*., (2009) examined the dynamic effect of partial bank liberalisation in China for the period 1994 to 2003. Their findings revealed that the Big Four state-owned banks were the least efficient, foreign banks were the most efficient, and that minority foreign ownership was associated with significantly improved efficiency. Zhang and Wang (2014) also found evidence to support the notion that the Big Four banks were less efficient compared to other commercial banks, and that public banks are generally less efficient than private

banks. Foreign ownership was associated with high efficiency while state ownership was associated with lower productivity. Findings in Xu (2011) provide support for the positive effect of foreign banks on domestic bank competition and efficiency. Similarly, Leung and Chan (2006) observe that the efficiency of local banks improved with foreign bank entry.

Chen and Wang (2015) also present interesting findings on the efficiency of the Chinese banking system. Their study suggests that the average economic efficiency of joint-stock commercial banks was the highest, followed by the Big Four state-owned commercial banks and then the city commercial banks. They conclude that improved banking efficiency could be best achieved by improving regulatory reform with a focus on capital adequacy, encouraging more competition, establishing institutions that encourage the commercial operations of banks and ensuring healthy growth of the overall economy.

Unlike the gradual (partial) liberalisation of banking systems adopted in Russia and China, the effects of such an approach on bank efficiency based on ownership type has yet to be examined for the case of Vietnam. Banking reform in Vietnam is characterised by a sluggish approach towards bank privatisation and an unfriendly approach towards foreign investment in domestic banks. Hence, one might assume that the home field advantage hypothesis is still dominant in Vietnam. Nevertheless, the effects of this on bank efficiency by ownership type have until now not been adequately analysed. As a 'funds-starved' developing country, access to, and efficient allocation of, available funds through an efficient banking system is critical for its future economic development (Berger *et al.*, 2009). An important issue, and the focus of this paper, is whether Vietnam's approach to post-WTO bank reform has improved or exacerbated banking efficiency based on ownership type.

4. Methodology

This section outlines the methodology adopted in this paper to measure the technical efficiency of Vietnamese banks by ownership type covering the period 2005–2015. This period could not be extended due to data availability. The following two sub-sections describe the methods used in this study for estimating technical efficiency and exploring possible determinants of bank efficiency in Vietnam, respectively.

4.1 Measuring technical efficiency

Consider an industry consisting of *N* firms (here: banks) operating through T years. By pooling available data we can obtain *n* bank-year observations (*k=1,…,n*). Each bank employs *p* inputs to produce *q* outputs. Let $x \in \mathbb{R}_+^p$ denote a vector of *p* inputs and $y \in \mathbb{R}_+^q$ denote a vector of *q* outputs. Under a given technology the production set of the industry can be defined by:

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

We use the Farrell (1957) measure of output-oriented technical efficiency, defined by:

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

Under the assumption of free disposability of inputs and outputs and variable returns to scale, the DEA representation of the production set is: [4]

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

[4] The constant-returns-to-scale assumption is only appropriate when all firms are operating at their optimal scale (Charnes *et al*., 1978). In the banking sector banks are strongly impacted by regulations imposed by central banks, such as those on capital adequacy and loan-loss provisioning. In addition, in the case of Vietnam, private banks are discriminated against relative to state-owned banks, causing an imperfect business environment among different bank groups. Consequently, Vietnamese banks may not perform at their optimal scale. Hence, this research chooses the assumption of variable returns to scale when measuring the technical efficiency of Vietnamese banks.

Farrell's measure of technical efficiency (δ) is the reciprocal of the Shephard distance function (Shephard, 1970). The DEA output-oriented estimator of δ can be identified in the first stage by solving the following model:

$\hat{\delta} = Max\ \delta$

Subject to:

$$\sum_{k=1}^{n} z_k y_k^i \geq \delta y^i, i = 1, \dots, q;$$

$$\sum_{k=1}^{n} z_k x_k^j \leq x^j, j = 1, \dots, p;$$

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

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

To analyse the possible factors influencing technical efficiency we utilise the Simar and Wilson (2007) method as discussed in the following sub-section.

4.2 Double bootstrap DEA

Regressing the estimated DEA efficiency ($\hat{\delta}$) against a group of explanatory variables in the second stage can be conducted using several estimation techniques such as OLS or Tobit regression. There are, however, serious problems raised in the literature regarding the use of the OLS and Tobit methods (Simar and Wilson, 2007). One issue is that the DEA estimates which are based on a finite sample are downward-biased (Simar and Wilson, 1998; Kneip *et al.*, 1998; 2008). This is because the 'best practice' observations in the sample are employed to construct the production frontier rather than true efficient (but unobservable) observations. This means that coefficients derived from the second stage can be biased as well. It is also shown by Simar and Wilson (2007) that DEA efficiency scores are expected to be correlated with each other because the calculation of one firm's efficiency incorporates the observations of all other firms in the same data set. Hence, direct regression analysis can also be invalid due to the dependency of the efficiency scores. In order to avoid these problems the double bootstrap DEA model of Simar and Wilson (2007) is used in this study to regress inefficiency

scores against ownership indicators, policy-change indicators, bank characteristics and a time trend. In their proposed double bootstrap procedure, DEA bias corrected scores can then be used in a parametric bootstrap on the truncated maximum likelihood estimation. Confidence intervals can then be constructed for the regression parameters and the efficiency scores.

Formally, a model regressing true inefficiency scores on environmental variables is described as: $\delta_k = z_k\beta + \varepsilon_k \geq 1$ (5)

where z_k is a vector of explanatory variables for each bank-year observation ($k=1,\ldots,n$), including a constant term, that are expected to influence the efficiency of banks under consideration and β is a vector of parameters with some statistical noise ε_k. The true inefficiency scores (δ_k) are unobservable and are replaced by DEA estimates from the first stage.[5]

5. Data and specification of inputs and outputs

5.1 Data source

All four types of commercial banks in Vietnam are included in this study: state-owned commercial banks (SOCBs), joint-stock banks (JSBs), joint-venture banks (JVBs) and foreign-owned banks (FBs).[6] Although several SOCBs have been privatised and their equity sold to foreign and domestic private investors, most of these banks are still majority state-owned. JSBs are banks where the majority of ownership is held by private entities or SOEs, and where foreign ownership is capped at 30 per cent of total equity. JVBs are normally established by an SOCB with one or more foreign counterparts where the foreign investors own at least half of the bank capital. FBs are banks where total capital is contributed to by

[5] For a more detailed description of the double bootstrap approach used in this study, see Algorithm 2 of Simar and Wilson (2007, p.42) which is provided in Appendix A. This Algorithm was conducted using MATLAB codes provided by Associate Professor Valentine Zelenyuk, University of Queensland, Australia. The programming codes are not reported in this paper due to confidentiality requirements.
[6] See Table 1.

foreign investors. Because both FBs and JVBs contribute approximately 10 per cent of banking assets in Vietnam (see Table 1), and are mostly or totally owned by foreigners, we classify them together in a group called foreign and joint-venture banks (FJVBs). Consequently, there are three bank groups considered in this study: JSBs, SOCBs and FJVBs. Annual data on different bank ownership types for the period 2005 to 2015 has been collected and pooled from financial statements; generating an unbalanced panel consisting of 317 observations. Due to the small sample size the sample was pooled in order to overcome issues associated with a lack of statistical power (Salim *et al.*, 2017; Seufert *et al.*, 2017; Arjomandi *et al.*, 2018).

5.2 Inputs and outputs

The intermediation and operating approaches are employed in this study to define bank inputs and outputs. Both approaches are widely used in the banking literature (Jiang *et al.*, 2009; Arjomandi *et al.*, 2014; Rosman *et al.*, 2014; Belanès *et al.*, 2015; Chiu *et al.*, 2016; Salim *et al.*, 2016). Under the intermediation approach, banks are seen as financial institutions whose primary *modus operandi* is the intermediation of funds between savers and borrowers (Rosman *et al.*, 2014; Belanès *et al.*, 2015; Chiu *et al.*, 2016). The common inputs for this approach are labour expenditure, fixed assets and deposits while the outputs are loans and non-traditional assets, including trading securities and investments. These inputs and outputs are similarly employed in this study. Intermediation technical efficiency indicates the service-related performance of a bank in terms of providing loans and advances to their customers relative to other banks. It is the most commonly adopted approach used in existing studies to establish the technical efficiency of Vietnamese banks (see, for example, Nguyen, 2007; Nguyen *et al.*, 2012; 2014).

The operating approach (or profit-oriented approach) views banks as decision-making units that direct their efforts towards the maximisation of profit (Leightner and Lovell, 1998).

Berger and Mester (2003, p.80) state that the use of the operating approach "may help take into account unmeasured changes in the quality of banking services by including higher revenues paid for the improved quality, and may help capture the profit maximization goal by including both the costs and revenues". This approach considers interest and non-interest income as a bank's main outputs and defines interest and non-interest expenses as inputs. There is a consensus in the literature regarding the selection of these variables for analysing the operating (profit-oriented) efficiency of banks (Jiang *et al.*, 2009; Arjomandi *et al.*, 2014; Salim *et al.*, 2016). While used commonly in the literature this approach has not been considered in similar previous studies of Vietnamese banks. Both the intermediation and operating approaches are adopted in this study to help us better understand, and have a more complete picture, of the performance of Vietnamese banks from the perspective of both service-provision and profit-maximisation.

6. Empirical analysis and results

The empirical results are divided into a series of sub-sections. Section 6.1 presents an overview of the estimated original and bias-corrected efficiency scores. Sections 6.2 and 6.3 detail the specification of the primary regression model and results. The remainder of the section presents the results from a generalised difference-in-differences model of the relationship. Section 6.4 provides the justification for the use of this model and section 6.5 presents the results. Section 6.4 and 6.5 are included as means of addressing potential endogeneity concerns associated with self-selection and omitted variable bias when considering the influence of policy changes on bank efficiency.

6.1 Results for conventional and bootstrap DEA measures of bank efficiency

The estimated 95% confidence intervals for technical efficiencies under the intermediation and operating approaches are shown in Figures 1 and 2, respectively. The figures show the

pooled sample observations (for the sample period of 2005–2015) ordered by values of the bias-corrected efficiencies. The bias-corrected efficiency scores (shown as Bias cor.) and the intervals presented in the figures are estimated using the bootstrap procedure with 2000 replications. The confidence interval boundaries are shown by solid lines. As can be seen in the figures, the original efficiencies (Orig. eff.) are not included in the confidence intervals and lie just below the lower boundary; reflecting the theory behind the construction of these confidence intervals (Simar and Wilson, 1998; Arjomandi and Seufert, 2014). It is also apparent from the figures that bank efficiency ranking based on bias-corrected efficiencies is in many cases different from that derived from the original efficiencies. In particular, the most efficient banks (with Orig. eff. = 1) showed more dramatic deteriorations in the bias-corrected efficiencies in both figures. This issue is more noticeable under the intermediation approach. Overall, the results highlight the importance of using the bootstrapping method and bias-corrected estimates instead of the original scores. In the following sub-sections, regression variables used in this study are described followed by our empirical results.

<FIGURES 1 AND 2 ABOUT HERE>

6.2 Specification of the regression model

Intermediation technical efficiency (ITE) and operating technical efficiency (OTE) are used as bank performance measures in two different regressions. The independent variables are classified into three main types: ownership indicators, policy-change indicators and control variables. The control variables include bank-specific and time-trend variables. The model can be presented as: *Bank performance measure* = γ + ω_1 *Ownership Indicators* + ω_2 *Policy Change Indicators* + ω_3 *Bank-specific control variables* + ω_4 *Time Trend variable* + *Error term* (6)

The utilised variables are explained below and are summarised in Table 2.

Ownership indicators

There are three types of bank ownership considered in this study: state-owned commercial banks (SOCB), private banks (JSB) and foreign joint-venture banks (FJVB). Private banks are chosen as the base case and the other two ownership indicators (SOCB and FJVB) are included in the models. The indicator SOCB is set equal to one, indicating state-owned banks and zero for other bank types. A similar explanation is for the case of FJVB. Table 2 provides details on the definition of all environmental variables used in this study.

Policy change variables

We also investigate the major policy changes which could potentially have an impact on Vietnam's banking sector in the post-WTO era. Four reform measures are employed to capture the effect of these policies on banking efficiency.

(i) Business groups' participation in the banking sector (BG)

Several SOEs and private business groups were allowed by the government to participate in the banking sector and become holding companies of JSBs. Subsequently, a complex set of cross-ownership relationships between industrial and banking entities were established. To consider this issue, an indicator (BG) is included in the model to capture JSBs which have at least 20 per cent of their total equity owned by SOEs and/or private business groups. BG is set to one for periods after business group participation.

(ii) Privatisation of SOCBs (P)

In the post-WTO period SOCBs were targeted for privatisation, but this process had to ensure that the government retained a predominant fraction of the bank's capital. Following agency theory we would expect state ownership to negatively influence the performance of banks, and that state-owned banks would become more efficient after privatisation (La Porta *et al*., 2002). An indicator (P) is added to the model to capture privatised banks and is set equal to one for periods after privatisation.

(iii) Foreign strategic investment (FSI)

Foreign investors could become involved in domestic banks by purchasing the equity of either SOCBs or JSBs, with the proportion of equity sold to foreign investors not exceeding 30 per cent of total capital. FSI indicates banks with foreign involvement and is set equal to one for periods after foreign investment in these banks.

(iv) Transforming rural to urban JSBs (RU)

An indicator (RU) is utilised to identify thirteen rural JSBs that were permitted to transfer to urban banks and is set equal to one for periods after the bank has been transformed.

The reform changes included in this study are commonly regarded as the major changes in the literature regarding the Vietnamese banking sector (e.g., NAEC, 2012; IMF, 2012; World Bank, 2014). Several other non-trivial events, such as the global financial crisis, coincided with our study period, however it has been shown in previous studies that they were not as important in the context of the Vietnamese banking sector as the reforms considered in this study (see Nguyen *et al.*, 2014; Nguyen and Simioni, 2015; Nguyen *et al*., 2016).

Control variables

Several other variables were chosen to capture the impact of bank characteristics on efficiency, including the loan-to-asset ratio (LA) representing bank preference for traditional assets, the equity-to-asset ratio (EA) as a proxy for financial soundness and the log of total bank assets as a proxy for bank size (SIZE). To control for the effect of time, a time-trend variable (T) was also included, which takes the value 1 for 2005, 2 for 2006 and so on, to capture the evolving nature of efficiency. Tables 3–6 provide descriptive statistics on bank distribution, inputs, outputs and explanatory variables used in this study.

Table 3 shows the annual distribution of the banks by number for the whole sample as well as for each bank group. Table 3 indicates that joint-stock banks dominate the sample, making up

approximately two thirds of the banks in each year. Tables 4 and 5 provide statistical descriptions of the above-mentioned variables. State-owned banks have the largest inputs and outputs and their assets are more concentrated in loans when compared to private and foreign and joint-venture banks. The results of Kruskal-Wallis rank tests, which are provided in Table 5, confirm these differences between the three bank types. Specifically, we observe stark differences in efficiency under both intermediation and operating approaches. The state-owned banks are the most efficient group when having the lowest mean inefficiency values compared with JSBs and FJVBs counterparts under both approaches. Table 6 reveals the collinearity status between environmental variables. The results suggest that the privatisation indicator is highly correlated with the SOCB indicator, and that bank size is highly correlated with the SOCB indicator, the privatisation indicator, and the equity to asset and time trend variables.

<TABLES 2–6 ABOUT HERE>

6.3 Regression results

The output-oriented technical inefficiency estimates are regressed against the set of regressors identified previously. To test the stability of the models and provide robust conclusions, six different model specifications are presented under each approach in Table 7. Similar results were obtained from all six models under each approach and are discussed in detail below.[7]

<TABLE 7 ABOUT HERE>

[7] It is worth highlighting again that *inefficiency* values are used as the dependent variable; therefore a negative coefficient implies a positive (beneficial) impact on efficiency.

Ownership and efficiency

Using domestic private banks as the base case the SOCB indicator is employed to compare the efficiency of state-owned banks relative to these banks. The FJVB indicator plays a similar role in the regression models in Table 7.

Under both the intermediation and operating approaches the coefficients for the SOCB variable are negative across all five models that include this variable. The SOCB coefficients are also significant in models 3–5 indicating that publicly-owned banks are more efficient than domestic private-owned banks both in terms of services provided and profitability (see Table 7).[8] This result contradicts mainstream empirical research which suggests that privately-owned banks outperform state-owned banks under various input/output mixes (Bonin *et al*., 2005a; 2005b; Fries and Taci, 2005; Berger *et al*., 2009; Fang *et al*., 2011). Nevertheless, it is consistent with the findings of Kraft *et al*. (2006), Karas *et al*., (2010) and Denizer *et al*. (2007) who conduct similar analyses for various transition and newly emerging market economies. These studies concluded that an asymmetric business environment was the primary driver of their results. For instance, state-owned banks obtain guarantees of solvency from the government, and, therefore, are able to make loans and receive deposits more easily than their private counterparts. In addition, private banks struggle with a lack of access to capital, poor governance and risk management, and cross-ownership with industrial groups which increase the possibility of insider trading. All of these can contribute to a deterioration of private bank assets.

The case of Vietnamese banks is somewhat similar. State-owned banks are guaranteed against insolvency, whilst at the same time obtain substantial privileges from the state (for example, easier access to capital and at a lower cost). In addition, private banks may have

[8] The coefficients on the SOCB indicator lose significance in models 2 and 6 when the privatisation indicator is added. This could be due to the high correlation between these two indicators as can be seen in Table 6.

weaker governance relative to state-owned banks (Pincus, 2009; World Bank, 2014). There may be two reasons for this. Firstly, the government may have been insufficiently selective in the awarding of bank licenses to newly established JSBs or in the transformation of rural to urban private banks between 2005 and 2008. Both resulted in the rapid growth of credit; a consequence of poor monitoring by inexperienced management. Secondly, the Vietnamese government allowed industry groups in both the state and private sectors to participate in and open new domestic private banks. Similar mistakes were made in other countries such as Japan, Indonesia, and Chile when conglomerates employed banks as a source of funding their industrial and commercial projects. Subsequently, the allocation of credit became distorted when financial resources were not channelled to the most efficient projects.

The coefficients on the FJVB indicator are negative across the five models and significant in models 2 to 5 under the intermediation approach. This suggests a superior performance of foreign joint-venture banks in terms of providing loans and advances in comparison with their domestic private counterparts. None of the coefficients are significant under the operating approach. The better performance of FJVBs under the intermediation approach can be explained by their superior technology and expertise, which offset their lack of experience in the local market. Moreover, FDI enterprises, which contribute 18% of Vietnam's GDP, prefer to utilise the banking services provided by FJVBs rather than domestic banks due to their relationship with the parent banks of FJVBs in their home countries.

Business groups' participation in the banking sector (BG)

While the coefficients on the BG variable are insignificant under the intermediation approach, they are significant and positive under the operating approach, indicating underperformance of private banks with business group involvement compared with the other banks from a profit efficiency perspective. This finding suggests that business groups participate in the banking sector in Vietnam as a way to secure their funding sources.

However, this participation simultaneously undermines the operational (profitability) efficiency of these associate banks and the banking sector as a whole.

Privatisation of SOCBs (P)

The coefficients on the 'P' variable, indicating state-owned banks experiencing privatisation, are found to be negative and highly significant across the different models and approaches. This suggests that privatised banks outperformed other banks based on both the operating and intermediation approaches. That is, the privatisation of state-owned banks improved both their service and operating efficiency despite their ongoing predominant state ownership. These results are consistent with that of Berger *et al*. (2009) for the case of China arising from WTO entry, but contradict the findings of Bonin *et al*. (2005b). Bonin *et al*. (2005b) argue that the partial privatisation of SOCBs, for the cases of Vietnam and China, cannot generate any performance improvement. This is because, as the dominant shareholder, the state is continuously in a strong position to run the banks, thereby reducing the likelihood of changes to corporate governance practices. Kraft *et al*. (2006) also state that a comprehensive privatisation of public banks, without sufficient changes to management, can reduce the performance of the banking industry. Our findings do not lend support to this notion.

Foreign strategic investment (FSI)

The coefficients measuring the impact of foreign strategic investment on domestic private bank efficiency are found to be insignificant for both the intermediation and operating approaches, contrary to the findings of Berger *et al*. (2009) and for a number of studies highlighted previously. Berger *et al*. (2009) suggest that foreign involvement, even in terms of minority shareholding, is normally expected to have an unambiguously positive impact on banking performance. One may argue that the discriminatory measures in favour of state-owned banks in Vietnam are so significant that they offset traditional advantages arising from foreign investor strategic involvement in domestic private banks. Hence, unless such

discriminatory measures are addressed, the efficiency benefits derivable from foreign investment in the banking system will be limited, and the willingness of foreign investors to invest in domestic private banks will be limited. These results certainly go against the mainstream literature and suggest that the Vietnamese government needs to address this problem otherwise the benefits from foreign investment in domestic banks (expertise and capital) will be lost. The other factor is that minority foreign ownership will not be enough to bring about substantial changes in governance and management quality due to the reluctance of majority domestic owners who have control of these JSBs in Vietnam. Only banks with majority foreign ownership (FJVB) are found to be more efficient than domestic private banks under the intermediation approach. Hence, the 30 per cent limit on foreign ownership of domestic bank equity should be reviewed based on these results.

Transformed rural to urban JSBs (RU)

The RU coefficients indicate that transformed JSBs from rural to urban banks are negatively and significantly associated with bank efficiency in all the models under both approaches. This outcome indicates that transformed banks are less efficient in terms of both their ability to provide intermediation services and generate profit when compared to their counterparts. They contribute negatively to overall banking sector efficiency in Vietnam.

There are two possible reasons for this. Firstly, their governance capability may have been inadequate given the increased range of their operations after becoming urban banks. Transformed banks were required to cover a significantly larger range of operations than they had done before. Their customer base and assets had increased substantially within a period of two or three years and many branches had opened nationwide, but this did not improve efficiency. The second potential reason is that insufficiently selective decisions by the SBV on awarding licences to rural banks resulted in a rapid growth of credit under inexperienced bankers which led to increased risk taking and a failure to adequately diversify bank assets

and generate profits. In reality, many of the small transformed JSBs used the majority of their credit to purchase property and stocks. As a result, this risk-taking behaviour led to an accumulation of bad loans, substantially increased risk-related costs and contributed to a decline in private and overall banking sector efficiency.

Control variables

Loans-to-assets ratio (LA)

Under the intermediation approach we observe a positive relationship between the loans-to-assets ratio and bank efficiency. This outcome is in line with the findings of Chortareas *et al*. (2012), and supports the argument that banks engaging in more traditional activities (transforming deposits into loans) are more efficient. This can be explained by the fact that an expansionary monetary policy was implemented to stimulate economic growth during the pre- and post-WTO periods in Vietnam, and the fact that loans represent the bulk of bank assets. Domestic banks were in a race to expand branches nationwide and attract deposits from households and corporations. Under human capital and physical resource constraints, banks maximised their capability to provide intermediation services and expected that the loans would enhance their profitability.

Under the operating approach the regression results show a negative relationship between the LA ratio and efficiency, so the profit-oriented efficiency of private banks with a high LA ratio actually declined. The LA ratio is a proxy for liquidity risk, which considers the cost of attracting deposits and borrowing. Based on the results from this study it can be argued that Vietnamese banks can improve their (profit-oriented) efficiencies by decreasing traditional assets (loans and advances) and increasing non-traditional assets (investments and securities).

Equity-to-assets ratio (EA)

The equity-to-assets ratio acts as a proxy for the financial soundness of a bank (Gropp and Heider, 2010; Fiordelisi *et al.,* 2011). A bank with a higher EA ratio is safer in terms of

capital and is in a stronger position to deflect risks relating to equity losses. A positive relationship between capital and efficiency, consistent with agency theory, is commonly found in the literature (e.g., Fries and Taci, 2005; Fiordelisi *et al*., 2011). According to Jeitschko and Jeung (2005) the managers of banks with less capital have a greater incentive to engage in moral hazard because they face less shareholder scrutiny when compared with banks that have higher capital ratios. Berger and De Young (1997) also point out that those banks reaching higher risk levels in the medium term have to employ more inputs to administer these higher risks, which results in declining efficiency and profitability. Regulators can also force banks to increase their capital and adequately disclose their risk-related costs commensurate with the degree of risk assumed (Gropp and Heider, 2010).

All five models employed in this study using the intermediation approach produce insignificant results. This contrasts substantially with the operating approach, which produces significant results of a negative association between the EA ratio and the profit-oriented efficiency in all five models (see Table 7). This uncommonly negative relationship between capital and efficiency may be due to the weak regulatory and supervisory framework of the Vietnamese banking sector. Under this, risks, especially credit risks, are inadequately accounted for and as a result risk-related costs and equity are often underestimated. Subsequently, figures on bank profitability and equity are often not commensurate with the level of risk (Laeven, 1999). Moreover, outdated Vietnamese accounting standards cannot keep up with changes in the risk profile of banks (IMF, 2012). These factors implicitly stimulate banks to provide more intermediate services (especially loans) and obtain a higher rate of return. This cycle, repeated several times over, creates a negative relationship between capital and efficiency.

Bank size (SIZE)

The coefficient on bank size in model 1 of Table 7 is significant and negative under both the intermediation and the operating approach. These results suggest that larger banks exhibit greater intermediation (service-oriented) efficiency as well as operating (profit-oriented) efficiency. This aligns with other studies and supports the notion that economies of scale are beneficial in the banking sectors of transition and emerging economies (Bonin *et al*., 2005b; Berger *et al*., 2009).

Time trend (T)

The time trend coefficient indicates that banking efficiency increased between 2005 and 2015 under the intermediation approach but no significant result was found for this variable under the operating approach. This is consistent with a rapid increase in credit and lending intermediation undertaken by the banking sector during the period of this study and that this has been achieved along with increased efficiency.

6.4 Tests for bank-fixed effects and selection effects of policy changes

Although the above analysis provides substantial insights into the relationship between policy changes and Vietnamese bank efficiency, it is important to note that relying solely on the double bootstrap DEA results can be inadequate without considering potential endogeneity concerns. This arises because banking reforms which impacted some banks and not others might be due to self-selection or omitted variable(s). In other words, banks may have been selected into the various reforms based on particular *ex ante* characteristics which may lead to bias in the measurement of the effects of the reforms on efficiency levels. For example, foreign investors would select to invest in more promising JSBs based on pre-reform assessments of financial performance. Then the positive effects of foreign ownership on the efficiency of JSBs are not due to the participation of foreign investors but due to their selection based on *ex ante* characteristics. Therefore, in order to provide additional robustness

to the results provided in Table 7, a generalised difference-in-differences model with multiple treatments is included in this and the subsequent sections. Despite this latter model being limited in its capacity to address time-variant unobservable variable concerns, it does reduce bias in the estimation of policy effects by controlling for time-invariant confounders.

To justify the inclusion of a two-way fixed effects model, both the Breusch and Pagan (1980) Lagrange Multiplier (LM) and Hausman (1978) chi square statistics were calculated for the intermediation and operating efficiency models. Firstly, the Breusch and Pagan (1980) LM statistic identifies the existence of dynamic heterogeneity in the model. By using a set of OLS residuals it tests the null hypothesis that group effects do not exist (Greene, 2003). Secondly, the Hausman (1978) chi square statistic tests the appropriateness of employing a fixed effects or least squares dummy variable (LSDV) model relative to a generalised least squares (GLS) specification. The Hausman (1978) chi square statistic tests the null hypothesis that individual effects are appropriately modelled through the implementation of a random effects estimator (Judge *et al*. 1985; Green, 2003). With respect to both intermediation efficiency (column 1) and operating efficiency (column 2) regressions in Table 8, a two-way fixed effects regression is justified on the basis that both the Breusch and Pagan (1980) LM and Hausman (1978) chi square statistics are rejected at the 5 per cent level. Both the intermediation and operating efficiency regressions produce substantially large Breusch–Pagan LM statistics (Hausman statistics) of 129.14 (34.12) and 133.94 (30.18) respectively, with all results statistically significant at the 5 per cent level. Thus, the results from the two tests support the use of two-way fixed effects in accounting for heterogeneity in the dataset and facilitating the analysis of treatment effects with respect to the policy variables.

6.5 Two-way fixed effects regression: policy effects after controlling for time-invariant covariates

The generalised difference-in-differences (DID) (two-way fixed effects with multiple treatments) regression is a common method used in policy evaluation in the face of multiple treatments over a number of time periods (see Imbens and Wooldridge, 2002; Bertrand *et al*., 2004; Angrist and Pishke, 2009). This study incorporates the empirical framework established by Bertrand *et al*., (2004) and Hansen (2007) as a basis for conducting difference-in-differences with multiple treatments. At the individual level the equation employed in this study is established as:

$$\delta_{hgt} = \alpha + \beta d_{hgt} + \gamma z_{hgt} + \theta_g + \lambda_t + \varepsilon_{\mathrm{hgt}} \qquad (7)$$

Here, h is an index for individual banks ($h=1,\ldots,N$), g represents the bank groups (including privatised banks; banks with foreign strategic investment; banks with business participation and urban-rural transformed banks) and t is the index for time ($t=1,\ldots,T$). δ_{hgt} denotes the bank performance measure (either intermediation or operating efficiency). α is a constant, d_{hgt} is a policy change indicator that indicates bank h belonging to group g in year t, z_{hgt} is a vector of individual-specific control variables (which includes LA and EA ratios) and ε_{hgt} is the error term. Bank fixed effects are denoted as θ_g and a full set of year effects are captured in λ_t. In addition, robust standard errors are clustered at the bank-level.

The treatment effect of each policy is identified on their respective β coefficient, i.e. capturing the average treatment effect for each policy. The underlying intuition for this result is that the year effects (λ_t) provide a control for the post-regulation dummy, and bank fixed effects (θ_g) act as the control for the treatment dummy for each policy intervention. The use of year and bank fixed effects therefore create the conditions for the measurement of policy effects independent of time-invariant confounders.

The two-way fixed effects regressions in Table 8 supplement the main analysis in Table 7, and isolate 'within-bank' variation through the implementation of both bank and year fixed effects. For the purposes of consistency the directionality and interpretation of results provided in Table 8 are comparable to those in Table 7. This method is appropriate for testing the robustness of the main results provided in Table 7, given that we focus on the impact of several reform measures instituted by the Vietnamese government over a ten year period. By isolating the 'within' bank variation over time it reduces the likelihood of bias in the estimation of treatment effects brought about by features of the banking system which may have had a direct impact on efficiency. Given that this method controls for observed and unobserved time-invariant heterogeneity in regressions, variables representing bank ownership type are not included in the regression analysis in Table 8.

<TABLE 8 ABOUT HERE>

While the results from sub-section 6.3 point to no significant difference between banks with business participation and other banks (see Table 7) under the intermediation approach, the coefficients on the BG variable are significantly negative in model 1 of Table 8. Consequently, after controlling for time-invariant characteristics, the results in Table 8 indicate that the participation of business groups in private banks increases the intermediation efficiency of these banks over the long term. The reason for this is that these groups are contributors to bank equity, which in turn enables them to attract more deposits for lending. A substantial portion of these loans, however, are allocated to the subsidiaries of these groups, which raises concerns regarding the associated increase in credit risk. A high level of credit risk can lead to high loan-loss provisioning costs and lower profitability/operating efficiency but this issue is found to be insignificant in our regression models where time-invariant effects are not accounted for (see Table 8). The results in Table 8 support a positive and dynamic influence of privatisation on the operating efficiency of state-owned banks. The

policy of privatisation has forced privatised banks to increase their management quality, adhere to more rigorous banking standards, and increase their capital. In the long term, these banks are expected to operate more efficiently, consistent with their increased commercialisation. The results in Table 8 are also consistent with those in Table 7 in that privatised banks outperform the others under the operating approach.

Private banks that transformed from rural to urban have experienced a decline of intermediation efficiency between 2005 and 2015 (see Table 8). This result is consistent with the findings in Table 7 and indicates that transformed banks have a significant and negative effect on intermediation efficiency. Although the policy of transformation encouraged these banks to broaden their geographical reach and the scope of their intermediating services, the quality of their management has not improved in line with this growth. The end result is a decline in intermediation efficiency. Transforming rural into urban banks has contributed unambiguously to a negative impact on bank intermediation efficiency. Table 8 also supports the result in Table 7, which suggest that foreign strategic investment has not significantly impacted the intermediation and operating efficiency of domestic private banks.

7. Conclusion

The reform of banking sectors has diverged amongst transition economies and each transition can be categorised into either partial or full liberalisation. While the latter advocates a fair and competitive market for all banks, the former can reflect a desire by government to control and employ the sector as a tool to serve its political purposes and, in doing so, favour one type of bank over another. This study has examined the impact of reform measures on bank efficiency in the context of Vietnam's transition economy.

Using data for Vietnamese banks covering the pre- and post-WTO period (2005–2015) and applying the DEA double bootstrapping methodology to measure banking efficiency, under

the intermediation and operating approaches, it was found that the state-owned bank group was the most efficient. In contrast, and contrary to the mainstream view in the literature, joint-stock banks were found to be the least efficient.

In terms of the impact of reform measures on banking efficiency we find that transforming rural to urban banks contributed negatively to the intermediation efficiency performance of private banks and the overall banking sector under both the DEA and DID approaches. Negative results for bank operating efficiency were also observed under DEA. The privatisation of SOCBs was found to improve both their intermediation and operating efficiency using DEA, but was found to only improve their operating efficiency using DID. Foreign strategic investment exerted an insignificant impact on both private bank intermediation and operating efficiency using both DEA and DID. While the participation of business groups in the domestic banking sector improved intermediation efficiency but had no significant impact on operating efficiency using DID, using DEA indicated that they exerted a negative impact on operating efficiency and had no significant impact on intermediation efficiency. Under the DEA model, bank size positively impacts intermediation and operating efficiency and, paradoxically, a negative relationship between capital and operating efficiency is also found in this study.

Based on these findings, several key policies can be recommended to improve the efficiency of Vietnamese banks. First, the privatisation of SOCBs can result in a positive and dynamic effect on the operating efficiency of banks, and possibly also intermediation efficiency. Hence, one may argue that it can and should be applied more widely in the sector. Second, it is found that transformed JSBs from rural to urban banks are less efficient under the intermediation and operating approach using DEA, while this is only found to be the case for intermediation efficiency using DID. Since most of the transformed JSBs are small banks (their mean value of total assets is equivalent to approximately one third of the mean value

for the overall Vietnamese banking system)[9], one way of enhancing their efficiency may be to increase their size through either forced merger or acquisition. This is consistent with the results from DEA which suggest that there are benefits to be gained from economies of scale (SIZE) in the banking sector in terms of both intermediation and operating efficiency. Policymakers should, therefore, actively encourage consolidation of the banking sector through mergers and acquisitions, with transformed JSBs being an important priority. Other small and inefficient banks should be considered to take part in this process as well, regardless of their ownership types.

Third, foreign strategic investment (up to 30% of bank equity) has not significantly impacted the efficiency of domestic banks and the reasons for this need to be studied in more detail. This could arise due to the benefits of foreign investment being nullified by remaining discriminatory measures and barriers which need to be addressed. In addition, the limit of 30% foreign ownership of domestic bank equity should be increased. Fourth, the paradoxical negative relationship between the equity-to-asset ratio and operating efficiency found under DEA is indicative of a weak Vietnamese banking regulatory and supervisory framework. Hence policymakers need to improve the quality of the regulatory and supervisory framework of the banking system, and in doing so this may improve the management of risk in the sector and require banks to be more accountable for incurring risk-related costs.

[9] According to our calculations, the mean value of total assets for transformed JSBs is 18,388,534 million VND while this value is 63,257,994 million VND for all Vietnamese banks over the period 2005–2015.

Table 1: Structure of Vietnamese banking sector by ownership, 2007, 2011 and 2016

	December 2007			December 2011			December 2016		
	Total Assets (in VND trillions)	**Share of Total Assets**	**Share of GDP**	**Total Assets (in VND trillions)**	**Share of Total Assets**	**Share of GDP**	**Total Assets (in VND trillions)**	**Share of Total Assets**	**Share of GDP**
State-owned commercial banks	931.5	54	81	1912.3	40	69	3861.9	48	104
Joint-stock banks	597.7	34	52	2285.8	48	82	3422.8	42	92
Foreign and joint-venture banks	204	12	18	552.4	12	20	828.3	10	22
All banks	1733.2	100	152	4750.5	100	171	8113	100	218

Sources: World Bank (2014) and the SBV online resources.

Table 2: Summary of the employed regression variables

Variables	Abbreviations	Descriptions
Bank performance measures		
Intermediation technical efficiency	ITE	Obtained using DEA with three inputs (labour cost, fixed assets and deposits) and two outputs (loans and other assets).
Operating technical efficiency	OTE	Obtained using DEA with two inputs (interest expenses and non-interest expenses) and two outputs (interest income and non-interest income).
Ownership indicators		
State-owned banks	SOCB	Indicator indicating state-owned banks. Equal to one for all periods a bank is state-owned.
Foreign and joint-venture banks	FJVB	Indicator indicating foreign and joint-venture banks. Equal to one for all periods if a bank is a foreign or joint venture bank.
Policy change indicators		
SOCB privatisation	P	Indicator indicating SOCBs that experienced privatisation between 2005 and 2015. Equal to one for the periods after the privatisation of a bank.
Foreign capital participation	FSI	Indicator indicating a bank sold a minor proportion of its equity (not exceeding 30 per cent) to foreign investors. Equal to one for the periods after foreign capital investment in the bank. If an SOCB went through foreign capital participation and privatisation the variable will be set to zero due to the fact that foreign capital participation is one of many measures during the process of privatising state-owned banks.
Business group participation in JSBs	BG	Indicator indicating JSBs have experienced equity participation by SOEs and/or private business groups. Equal to one for the periods after business group participation in a bank.
Rural-urban transformation	RU	Indicator indicating JSBs that transformed from rural to urban banks. Equal to one for the periods after transformation of a bank.
Control variables		
Loans-to-assets ratio	LA	The ratio of loans to assets measures the preference for traditional banking activities.
Equity-to-assets ratio	EA	The ratio of equity to assets measures the financial soundness of a bank.
Size	SIZE	The log form of total bank assets is used as a proxy for bank size
Time trend	T	Time trend variable (2005 = 1, 2006 = 2, … , 2015 = 11).

Table 3: Annual distribution of the banks for the whole sample and each bank group

Year	No. of JSB	No. of SOCB	No. of FJVB	Total
2005	11	5	1	17
2006	14	5	1	20
2007	19	5	2	26
2008	24	5	2	31
2009	25	5	3	33
2010	25	5	4	34
2011	25	5	6	36
2012	24	5	6	35
2013	21	4	4	29
2014	21	4	5	30
2015	18	4	4	26
Total	227	52	38	317

Note: the last row presents the sums of bank-year observations when the sample is pooled.

Table 4: Statistical description of the variables for all banks

	Min	Max	Mean	S.D.
Dependent variables				
Intermediation technical efficiency	1	2.9343	1.3136	0.2877
Operating technical efficiency	1	2.8328	1.3096	0.2554
Ownership indicators				
State-owned Banks	0	1	0.1672	0.2374
Foreign and Joint-venture Banks	0	1	0.1199	0.3248
Policy change indicators				
SOCB privatisation	0	1	0.1041	0.3054
Foreign strategic investment	0	1	0.1640	0.3703
Business group participation in JSBs	0	1	0.3912	0.488
Rural-urban transformation	0	1	0.2114	0.4083
Bank characteristics				
Loans-to-assets ratio	0.1293	0.9496	0.5322	0.1423
Equity-to-assets ratio	0.0107	0.8006	0.1268	0.097
Total asset (in Million VND)	451,481	741,815,049	63,257,994	115,595,664
Time trend	1	11	6.3312	2.9012
Inputs (Is) and outputs (Os) of the intermediation approach in Million VND				
Labour expenses (I)	7,491	6,045,583	508,541	894,059
Fixed assets (I)	9,117	19,390,861	643,432	1,294,542
Deposits (I)	383,030	310,512,810	43,566,662	59,979,382
Loans (O)	260,542	250,177,717	32,203,788	52,539,522
Non-traditional assets (O)	1,892	59,277,701	8,603,438	10,985,510
Inputs (Is) and outputs (Os) of the operating approach in Million VND				
Interest expenses (I)	2,210	24,953,747	2,766,238	4,031,607
Non-interest expenses (I)	13,441	9,041,865	987,793	1,501,983
Interest income (O)	25,713	38,103,230	4,126,277	5,964,089
Non-interest income (O)	1,462	4,461,620	513,555	774,120

Notes: Number of observations is 317. The figures for total asset, inputs and outputs presented are discounted by the inflation rate for the benchmark year 2005.

Table 5: Statistical description of the variables for each bank group

	Private banks (227 observations)		State-owned banks (52 observations)		Foreign and Joint-venture banks (38 observations)		Kruskal Wallis rank test
	Mean	**Median**	**Mean**	**Median**	**Mean**	**Median**	**(Chi-Square)**
Dependent variables							
Intermediation technical efficiency	1.3742	1.3538	1.1479	1.0620	1.1882	1.0881	38.1051***
Operating technical efficiency	1.3475	1.3169	1.1666	1.0990	1.2804	1.2620	32.8920***
Bank characteristics							
Loans-to-assets ratio	0.5039	0.5015	0.6453	0.6575	0.5553	0.5385	46.5628***
Equity-to-assets ratio	0.1294	0.1021	0.0591	0.0599	0.2239	0.1848	115.9908***
Total asset (in Million VND)	33,304,604	17,163,207	230,109,366	167,926,627	11,502,526	5,977,193	98.3674***
Time trend	6.304	6	5.7692	6	7.2632	7.5	
Inputs (Is) and outputs (Os) of the intermediation approach in Million VND							
Labour expenses (I)	253,218	162,623	1,886,298	1,830,568	148,410	105,901	85.0420***
Fixed assets (I)	495,428	354,096	1,712,491	1,817,697	64,636	46,677	108.5739***
Deposits (I)	24,675,203	20,705,710	151,982,038	160,560,882	8,060,390	5,972,747	101.4054***
Loans (O)	14,825,513	12,003,522	127,633,721	138,217,241	5,427,787	5,477,247	97.0019***
Non-traditional assets (O)	5,835,428	3,416,682	25,858,500	25,416,975	1,526,464	492,980	88.8194***
Inputs (Is) and outputs (Os) of the operating approach in Million VND							
Interest expenses (I)	1,684,662	1,354,768	9,330,964	9,734,419	243,927	259,173	124.8364***
Non-interest expenses (I)	546,348	395,523	3,461,134	3,534,419	240,274	145,301	86.2677***
Interest income (O)	2,442,316	2,073,037	14,057,935	14,665,189	595,040	497,192	107.2766***
Non-interest income (O)	295,779	169,883	1,728,833	1,761,397	151,467	99,393	68.7230***

Notes: The figures for total assets, inputs and outputs presented are discounted by the inflation rate for the benchmark year 2005. *** indicates a statistically significant difference between groups at the 1 per cent level. Kruskal-Wallis tests show that intermediation efficiency, operating efficiency, explanatory variables (loan-to-equity ratio, equity-to-asset ratio and total asset), outputs (loans, non-traditional assets, interest income, non-interest income) and inputs (labour expenses, fixed assets, deposits, interest expenses, non-interest expenses) are different across the three bank categories.

Table 6: Correlation matrix of environmental variables

	SOCB	FJVB	P	FSI	BG	RU	LA	EA	SIZE	T
SOCB	1.0000									
FJVB	-0.1393	1.0000								
P	0.7608	-0.1258	1.0000							
FSI	-0.1985	-0.1635	-0.1510	1.0000						
BG	-0.3591	-0.2958	-0.2732	-0.3551	1.0000					
RU	-0.2320	-0.1911	-0.1765	-0.2293	0.3609	1.0000				
LA	0.3457	0.0598	0.2396	-0.1373	-0.2411	-0.0733	1.0000			
EA	-0.3092	0.3695	-0.2230	-0.1388	0.0402	0.2475	-0.0575	1.0000		
SIZE	0.5605	-0.3029	0.4979	0.1888	-0.2386	-0.2957	0.1787	-0.5505	1.0000	
T	-0.0774	0.1185	-0.0389	0.0816	0.0578	0.0874	-0.0679	0.0337	0.4239	1.0000

Notes: SOCB is state-owned banks; FJVB is foreign-joint venture bank: P is privatisation indicator; FSI is foreign strategic investment: BG: business group participation; RU is rural-urban transformation; LA is loan to asset ratio; EA is equity to asset ratio; SIZE is log of total assets; T is time trend variable.

Table 7: Regressing environmental variables on bank performance measures

	Intermediation technical efficiency (317 observations)						Operating technical efficiency (317 observations)					
	1	**2**	**3**	**4**	**5**	**6**	**1**	**2**	**3**	**4**	**5**	**6**
Constant term	4.3714***	2.2911***	2.2841***	2.2995***	2.2967***	2.2461***	3.5285***	0.9467***	0.9668***	0.8458***	0.958***	0.9412***
	(0.3197)	(0.1184)	(0.1233)	(0.1276)	(0.1210)	(0.1310)	(0.3554)	(0.1564)	(0.1598)	(0.1645)	(0.1500)	(0.1621)
Ownership												
State-owned banks, SOCB		-0.1847	-0.3791***	-0.3933***	-0.3401***	-0.0993		-0.1008	-0.5396***	-0.4307***	-0.4336***	-0.0229
		(0.1349)	(0.1059)	(0.1065)	(0.1000)	(0.1402)		(0.1328)	(0.1258)	(0.1246)	(0.1146)	(0.1354)
Foreign and Joint-venture banks, FJVB		-0.2066*	-0.1994*	-0.2156**	-0.1066*	-0.0531		-0.1131	-0.1426	-0.0356	0.0085	0.0436
		(0.0968)	(0.0938)	(0.0981)	(0.0936)	(0.1079)		(0.0945)	(0.0942)	(0.0997)	(0.0964)	(0.1088)
Policy Change Indicators												
Privatisation Indicator, P		-0.3938**				-0.3642**		-1.0137***				-0.9642***
		(0.1883)				(0.1783)		(0.2680)				(0.2513)
Foreign Strategic Investment Indicator, FSI			0.0393			0.1309			-0.177			-0.0349
			(0.0646)			(0.0867)			(0.0902)			(0.1070)
Business Participation Indicator, BG				-0.011		0.0104				0.1373**		0.0778*
				(0.0562)		(0.0681)				(0.0665)		(0.0369)
Rural-Urban transformation Indicator, RU					0.1931***	0.2329***					0.2454***	0.2160***
					(0.0607)	(0.0671)					(0.0715)	(0.0743)
Control Variables												
Loan to Asset ratio, LA	-1.3968***	-1.4135***	-1.4011***	-1.4042***	-1.4019***	-1.3864***	0.4260**	0.5676**	0.5942**	0.6502***	0.5741**	0.5494**
	(0.1806)	(0.1973)	(0.2101)	(0.2129)	(0.2091)	(0.1968)	(0.1842)	(0.2172)	(0.2203)	(0.2158)	(0.2117)	(0.2024)
Equity to Asset ratio, EA		0.1546	0.1546	0.1400	-0.1440	-0.1511		0.9006***	0.7703***	0.8257***	0.4904*	0.5423**
		(0.2744)	(0.2668)	(0.2619)	(0.2767)	(0.2802)		(0.2870)	(0.2968)	(0.2975)	(0.3027)	(0.2944)
SIZE	-0.1375***						-0.1507***					
	(0.0186)						(0.0229)					
Time Trend, T		-0.0298***	-0.0306***	-0.0300***	-0.0343***	-0.0354***		-0.0126	-0.0099	-0.0137	-0.0176	-0.0179
		(0.0093)	(0.0093)	(0.0090)	(0.0090)	(0.0092)		(0.0100)	(0.0102)	(0.0100)	(0.0099)	(0.0102)

Note: The coefficients with *, ** and *** are significant at 10, 5 and 1 per cent levels, respectively. Standard errors at the bank-level are provided in parentheses.

Table 8: Tests for bank-fixed effects and selection effects of policy changes

	(1)	(2)
	Intermediation Efficiency Scores	**Operating Efficiency Scores**
Constant term	1.8461***	1.2192***
	(0.1851)	(0.1749)
Policy Change Indicators		
Privatisation Indicator, P	0.0090	-0.1041**
	(0.0826)	(0.0498)
Foreign Strategic Investment Indicator, FSI	0.1349	-0.0688
	(0.1499)	(0.0670)
Business Participation Indicator, BG	-0.4996**	-0.0234
	(0.2339)	(0.0328)
Rural - Urban Transformation Indicator, RU	0.5633***	0.0287
	(0.1672)	(0.0513)
Control Variables		
Loan to Asset ratio, LA	-0.9100***	0.3999
	(0.2898)	(0.3183)
Equity to Asset ratio, EA	-0.3290	-0.2761
	(0.2576)	(0.3455)
Bank Fixed Effects	Yes	Yes
Year Effects	Yes	Yes
R-Squared (within)	0.3207	0.1563
Number of observations	317	317

Notes: The coefficients with **, or *** are significant at 5, and 1 per cent levels, respectively. Cluster-robust standard errors at the bank-level are provided in parentheses. All regressions include bank and year fixed effects. Intermediation efficiency is the dependent variable for model (1) and operation efficiency is the dependent variable for model (2). All 'policy change indicators' are set to one for the period after the introduction of the policy for banks in the treatment group, and zero otherwise. Control variables include the Loan to Assets ratio and the Equity to Assets ratio. Due to collinearity issues in the two-way fixed effects model the ownership variables on bank type JSB, SOCB and FJVB were not included in the analysis. The regressions provided in Table 7 were re-estimated with the use of Driscoll and Kraay (1998) standard errors. This additional analysis was completed to assess whether or not issues associated with cross-sectional dependence were present in the sample. Driscoll and Kraay (1998) standard errors account for potential herding behaviour amongst banks and spillover effects which otherwise would not be captured with the use of cluster-robust standard errors. We found no material difference between the two standard error estimations, and, therefore, the additional regressions are not disclosed in the tabulated result.

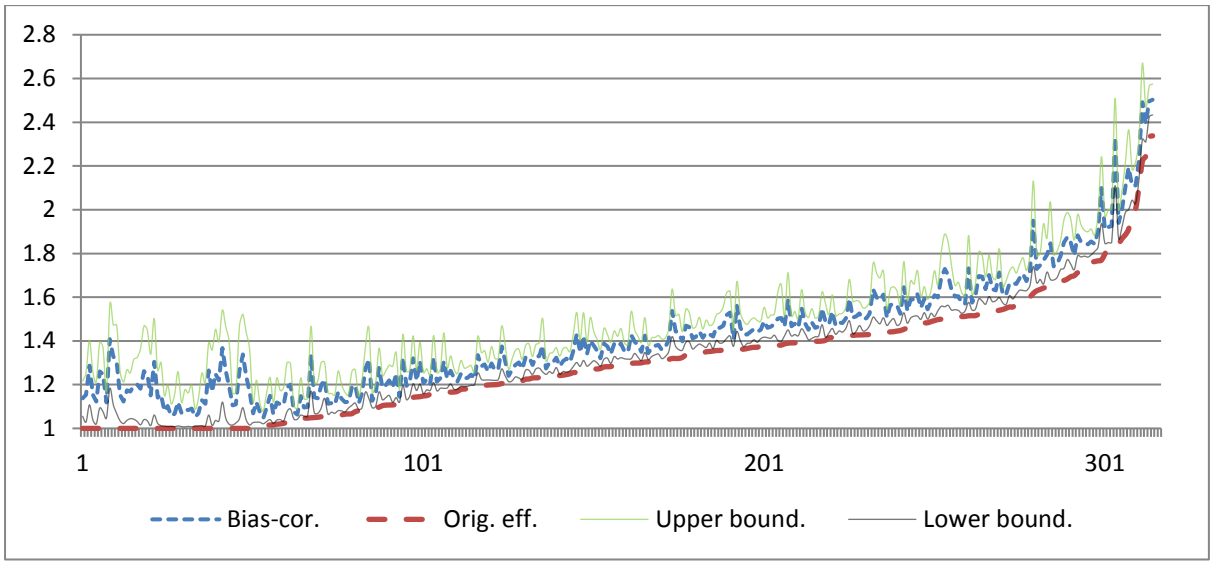

Figure 1: Confidence intervals and point estimates for technical efficiencies under the intermediation approach

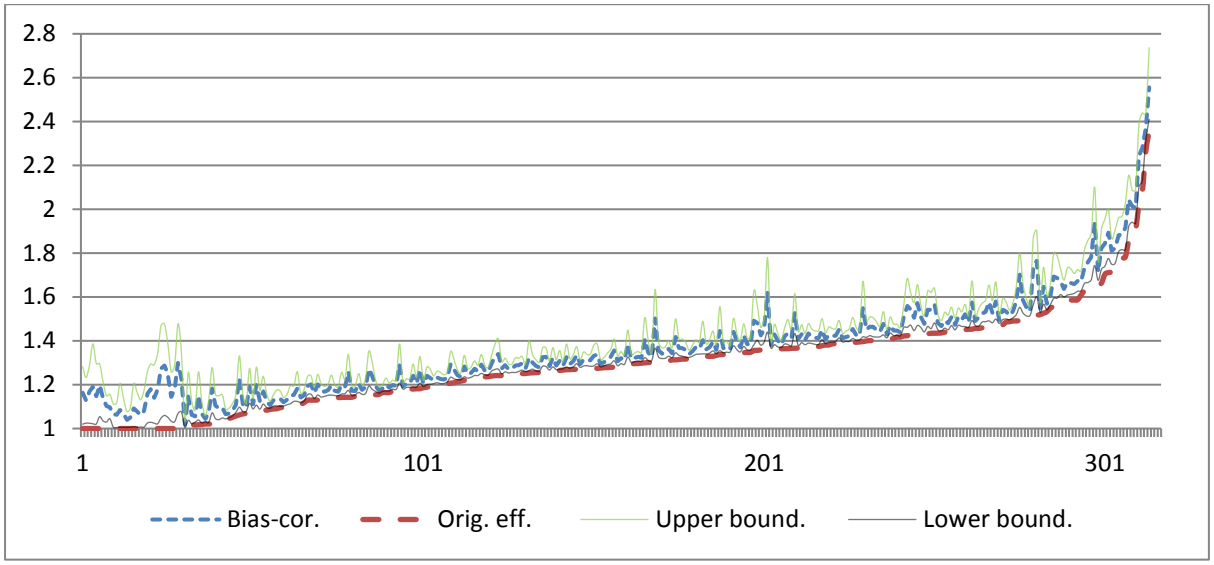

Figure 2: Confidence intervals and point estimates for technical efficiencies under the operating approach

Appendix A: Double-bootstrap two-stage DEA algorithm

1) Use the original data in $\mathcal{P}_n = \{x_k, y_k\}_{k=1}^n$ to compute $\hat{\delta}_k = \delta(x_k, y_k \backslash \widehat{\wp}) \forall k = 1, \dots, n$ by DEA, using equation (4)

2) Use the method of maximum likelihood to obtain an estimate $\hat{\beta}$ of β as well as an estimate $\hat{\sigma}_\varepsilon \; of \sigma_\varepsilon$ in the truncated regression of $\hat{\delta}_k$ on z_k using *m*<*n* observations when $\hat{\delta}_k > 1$

3) Loop over the next four steps (3.1-3.4) L_1 times to obtain *n* sets of bootstrap estimates $\mathcal{B}_k = \{\hat{\delta}_{kb}^*\}_{b=1}^{L_1}$:

3.1) For each $k = 1, \dots, n$ draw ε_k from the $N(0, \hat{\sigma}_\varepsilon^2)$ distribution with left-truncation at $(1 - z_k\hat{\beta})$

3.2) Again for each $k = 1, \dots, n$, compute $\delta_k^* = z_k\hat{\beta} + \varepsilon_k$

3.3) Set $x_k^* = x_k, y_k^* = y_k\hat{\delta}_k/\delta_k^*$ for all $k = 1, \dots, n$

3.4) Using equation (4) to compute $\hat{\delta}_k^* = \delta(x_k, y_k) \backslash \widehat{\wp}^* \forall k = 1, \dots, n$ where $\widehat{\wp}^*$ is obtained by replacing (x_k, y_k) in equation (3) with $(x_k^*, y_k^*)$from step (3.3)

4) For each $k = 1, \dots, n$ compute the bias-corrected estimator $\hat{\hat{\delta}}_k$ using the bootstrap estimates in $\mathcal{B}_k$ obtained in step (3.4) and the original estimate $\hat{\delta}_k$, where $\hat{\hat{\delta}}_k = 2\hat{\delta}_k - mean\hat{\delta}_{kb}^*$

5) Use the method of maximum likelihood to estimate the truncated regression of $\hat{\hat{\delta}}_k$ on z_k, yielding estimate $\hat{\hat{\beta}}, \hat{\hat{\sigma}}$

6) Loop over the next three steps (6.1-6.3) L_2 times to obtain a set of bootstrap estimates $\mathcal{C} = \{(\hat{\hat{\beta}}^*, \hat{\hat{\sigma}}_\varepsilon^*)_b\}_{b=1}^{L_2}$:

6.1) For each $k = 1, \dots, n$ draw ε_k from the $N(0, \hat{\hat{\sigma}})$ distribution with left-truncation at $(1 - z_k\hat{\hat{\beta}})$

6.2) Again for each $k = 1, \dots, n$, compute $\delta_k^{**} = z_k\hat{\hat{\beta}} + \varepsilon_k$

6.3) Use the method of maximum likelihood to estimate the truncated regression of δ_k^{**}on z_k, yielding estimate $(\hat{\hat{\beta}}^*, \hat{\hat{\sigma}}_\varepsilon^*)$

7) Use the bootstrap values in $\mathcal{C}$ and the original estimate $\hat{\hat{\beta}}, \hat{\hat{\sigma}}$ to construct estimated confidence intervals for each element of β and σ_ε.

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