Sectoral Impact of Barriers to Trade in Banking Services: A Cost and Profit-based Approach

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Abstract

This paper identifies the cost-escalating and price-creating effects of trade barriers in banking services. It also explores how prudential regulation reinforces or cancels out the impact of trade barriers on bank performance. Evidence on the determinants of cost and profit changes for 7,321 commercial banks in 28 countries over the period 1997-2006 highlights that trade barriers can affect both costs and prices. The impact of trade barriers is found to depend on the type of restriction. Restrictions on establishment and on-going operation of traditional banking services (TRI) are found to have both cost-escalating and price-raising effects but to be biased towards the former effect. This implies that liberalisation of this type of restriction would be more beneficial to society. However, no evidence is found for the impact of restrictions on banks' ability to do non-traditional banking services and to expand their business scale. The paper also finds that larger banks gain greater profits but the smaller firms experience higher costs because of trade barriers. The study also discovers some interesting results of how prudential regulation affects the impact of trade barriers. The total capital ratio is observed to mitigate the impact of trade barriers on bank cost but to reinforce its impact on profit. The liquidity ratio is shown to have no effect on the impact of trade barriers on bank cost but to enhance the impact of TRI on revenue. Although the ultimate target of prudential regulation is to preserve the stability and efficiency of the banking sector, this requirement can also be seen as a buffer for banks against trade barriers.

Key words:

Services barriers, banking, costs, profits, seemingly unrelated regression

1. Introduction

Because of the fragile nature of banking services, as well as the problem of information asymmetry, the banking sector is governed by prudential regulation to ensure the stability of the system, and to protect investors' rights, thereby avoiding an economic crisis. Capital adequacy and liquidity reserve requirements are among the most common prudential measures, which mainly serve to control risks assumed by banks and hence limit their failure to an acceptable level. Prudential regulation also consists of measures to protect investors and prevent financial failures, including deposit insurance schemes and the lender of last resort facility. Prudential regulation can be extended to protect consumer rights, through measures on information disclosure and business conduct.

Beside prudential regulation, a number of economic controls on bank establishment and operation are deliberately imposed to protect incumbent banks, especially domestic banks from competition. These regulations play as behind-the-border barriers to trade in banking services, which may escalate the real cost for banks. These controls may also induce banks to charge their customers at higher prices, likely creating more rents for banks.

The identification of these two effects – cost-escalating, price-raising, and rent-creating effects, is important to policy implications. Banks would be the first one to support for removing restrictions if these barriers are shown to raise cost but not to positively affect their price markup. Otherwise, banks would be reluctant to trade liberalization if impediments to trade in banking services help create extra rent for them. From the whole economy's perspective, the gain from liberalizing cost-escalating effects will always exceed the gain from lifting rent-creating restrictions (Dee 2005) as the former helps to mitigate dead-weight loss more than the latter. This means that cost-escalating restrictions should be a priority for liberalisation. In addition, in the context of preferential trade agreements, the danger of net welfare losses from net trade diversion happens only if the relevant barriers are rent-creating (Adams et al. 2003).

The answer to the question of whether trade barriers in banking services improve prices or escalate costs has not been well-defined in the literature although the question has been explored in a number of studies. Most research uses the net interest margin as a measure of bank performance, making it difficult to separate cost effects from price effects of trade barriers. In addition, using the reduced form prevents previous studies from tracing the vertical shifts in the supply side driven by trade barriers, thus preventing researchers from assessing the economy-wide effects of trade liberalisation in banking services. Although prudential regulation has been controlled for in measuring the impact of trade barriers, no studies have considered whether prudential regulation reinforces or cancels out the effect of barriers to trade in banking service.

There has been a theoretical and empirical debate on whether there are economies of scope and scale in banking services. Accordingly, it is not clear whether it is cost-ineffective to banks for being restricted from undertaking non-traditional financial services and expanding their networks. It is therefore necessary to separate the effects of restrictions on scope and scale of banking services from on traditional banking operation.

The purpose of the paper is therefore to contribute to the literature on establishing whether

trade barriers in banking services create rents or escalate costs. In particular, the study explores whether prudential regulation reinforces or cancels out the impact of trade barriers on bank performance. The study uses cost and profit as measures of economic performance for this impact assessment to avoid the problem of inconclusiveness in the literature in identifying whether trade barriers have rent-creating or cost-escalating effects. In addition, the cost and profit functions are structural and correct for quantities, enabling vertical shifts in supply to be traced, which deals with the problem of reduced forms applied in most previous studies.

In this study, the impact of trade barriers on cost is measured by the productivity equivalent, which is the percentage change in the cost with and without trade barriers. Similarly, the impact of trade barriers on revenue is measured by the tax equivalent, which is the percentage change in total revenue due to trade barriers, compared with unrestricted profit. The tax and productivity equivalents are examined across firm size, country, and time.

Data for this paper include panel accounting data on economic performance of 7,321 commercial banks in 28 countries from BankScope, which are used to set up measures of banking inputs and outputs. Trade restrictiveness indices from Dinh's (2008) study are also used as proxies for the barriers in banking services. These panel datasets allows the study to control the country and time-specific effects. This can correct for bias and inconsistency of estimations in previous studies. Moreover, this is likely to increase the accuracy of forecasting the sectoral impact of trade barriers for out-of-sample countries.

The remainder of the paper is constructed in seven sections. Section 2 provides a theoretical framework of the impact for barriers to trade in banking services on bank performance. Section 3 reviews the literature on sectoral impact assessment of barriers in banking services. Section 4 sets up the estimating specifications for this study after examining the limitations of models in the literature. Section 5 describes the accounting data on economic performance and the trade restrictiveness indices in banking services. Given the data, we construct relevant variables to put into models set up in the previous sections. Section 6 analyses the regression results, which play as the basis for calculating the cost and productivity equivalents. Section 7 discusses the cost and productivity equivalents for 36 countries. The last section summaries the findings and some limitations of the study.

2. Restrictions and bank performance

Because of the fragile nature of banking services, as well as the problem of information asymmetry, the banking sector is governed by prudential regulation to ensure the stability of the system, and to protect investors' rights, thereby avoiding an economic crisis. Capital adequacy and liquidity reserve requirements are among the most common prudential measures, which mainly serve to control risks assumed by banks and hence limit their failure to an acceptable level. Prudential regulation also consists of measures to protect investors and prevent financial failures, including deposit insurance schemes and the lender of last resort facility. Prudential regulation can be extended to protect consumer rights, through measures on information disclosure and business conduct.

Although the mandate of prudential regulation is to protect the stability of the whole financial system, its measures can also impose cost on banks, acting as a tax on these institutions (Kalirajan et al. 2000). The more capital and liquidity reserves a bank is required to hold, the

lower investible fund it can use, and thus facing the higher opportunity cost. However, banks may recoup the opportunity cost of holding capital and liquidity reserves by increasing lending rates. Consequently, the net association between prudential regulation and banks' net-interest margins may be positive. It is therefore essential to control for prudential regulation when measuring the impact of barriers to trade in banking services.

In addition to prudential measures, non-prudential regulations have been imposed on all banking services in order to protect incumbent banks from competition by limiting the entry of any new entrants and restricting the nature and scope of newcomers once they have entered, regardless of whether they are domestic or foreign (Nguyen Hong 2000). Non-prudential regulation may also be designed to protect domestic banks from foreign competition by explicitly discriminating against foreign entry, or the nature and scope of foreign operations.

Regulations may act as barriers to trade in banking services, affecting both bank cost and prices. Many studies share the same view that regulations by their nature are problematic and costly to banks (for example Llewellyn 1986, Gowland 1990) as regulations can be counter-productive and anti-competitive. Lack of competition due to restrictions discourages banks from operating at their lowest possible cost (Findlay & Warren 2000; Dee & Dinh 2008). On the other hand, restrictions may also cause an artificial scarcity of supply, inflating the service prices, although real resource cost remains unchanged. This means that banks can get economic rent – the price mark up due to these impediments. This rent is akin a tax on consumers, which makes the demand curve shift upward, but the revenue flows to the incumbent banks rather than to the government (Dee 2005).

Drawing on the analysis of Dee (2005), liberalization in banking services would have different effects, depending on whether barriers to trade in banking services were rent-creating or cost-escalating. On the one hand, liberalization of rent-creating barriers would yield a "triangle" efficiency gain for the whole economy since the removal of barriers to entry would increase the number of banks, reducing the market power of incumbent banks, and thus raising the market supply. In addition, such liberalization would obtain redistribution effects or allocation efficiency, where a part of economic rents flows from banks to their customers. On the other hand, lifting cost-escalating restrictions would yield a "trapezium" gain for the whole economy, associated with productivity improvement due to saving real resources. This could both enlarge returns for banks and reduce interest rates charged on borrowers.

As Dee (2005) points out, the distinction between cost-escalating and rent-creating effects is important to policy implications. In bilateral or multilateral liberalisation settings, the gain from liberalising cost-escalating restrictions will always exceed the gain from lifting rent-creating restrictions. This means that cost-escalating restrictions should be a priority for liberalisation. In addition, in the context of preferential trade agreements, the danger of net welfare losses from net trade diversion happens only if the relevant barriers are rent-creating (Adams et al. 2003).

3. Literature review

The impacts of barriers to trade in banking services have been explored in several studies: Saunders and Schumacher (2000), Kalirajan et al. (2000), Barth, Capiro and Levine (2006), Dihel and Shepherd (2007). Greater regulations are found to statistically raise NIMs of banks in most studies. Complementary research by Demirguc-Kunt, Laeven, and Levine (2004) finds that

restrictions on general freedom of bankers to conduct business raise net interest margins.

Many studies utilise the net-interest margin as a single measure of sectoral economic performance. However, restrictions may be both rent-creating and cost-escalating. As a result, these effects may be underestimated or even cancelled out when using only the price-cost margin (Nguyen Hong 2000). It is therefore necessary to use both cost and profit as measures of economic performance to capture the extent to which restrictions add to markups or real resource cost.

The impact of regulations in banking services on bank performance may depend on whether banks have economies of scale and scope. If there are economies of scale and scope in banking services, restrictions may prevent banks from attaining the lowest cost and enhancing revenue. However, if diseconomies of scale and scope prevail, restrictions may not damage bank performance. Restrictions on scope and scale should therefore be separated from other types of restrictions affecting trade in banking services.

Another issue in previous impact assessment studies in banking services is the inability to separate cost effects from revenue effects since the reduced form is used for estimation. Identification of the two effects requires the econometric models of sectoral impact assessment to be structural – that is, it is possible to separate and identify the causal effects of trade barriers on supply. This supports continuing efforts to build structural models that isolate supply-side influences (Dee 2005).

As prudential regulation may have an impact on bank performance, stringency of capital adequacy and liquidity has been controlled for in assessing the impact of trade barriers on bank performance. In most studies, the bank-specific total capital ratio and liquidity ratio have been used as proxies for prudential regulation. However, evidence on the impact of prudential regulation on bank performance is mixed. Barth, Capiro and Levine (2000) find no robust relationship between capital regulatory restrictiveness and bank performance, measured by net interest margin and overhead cost. Barth, Capiro and Levine (2006) also find no statistically significant and robust impact of the capital regulatory index[1] on bank efficiency. This may come from the fact that the capital regulatory index is a country-specific variable with little variation, statistically having no influence on bank performance

As in the case of trade barriers, most studies consider the impact of prudential regulation on NIMs rather than total cost. Using the bank-specific total capital ratio as a measure of stringency of capital requirements, Kalirajan et al. (2000) find the total capital ratio has statistically positive impacts on net-interest margins. Saunders and Schumacher (2000) find a positive relationship between capital requirements and the NIMs of banks for the case of European economies and the United States. However, Dihel and Shepherd (2007) find no evidence of an association between total capital and NIMs. In addition, no studies have considered whether prudential regulation reinforces or cancels out the effect of barriers to trade in banking service.

[1] The capital regulatory index incorporates the two measure of capital stringency: overall capital stringency and initial capital stringency. Overall capital stringency measure the extent of regulatory requirements regarding to the amount of capital that banks must have relative to specific guidelines. Initial capital stringency measures the extent to which the sources of funds can be counted as regulatory capital other than cash, or government securities, borrowed funds and whether the sources of capital are verified by the regulatory or supervisory authorities.

This calls for further research in the interaction impact between trade barriers and prudential regulation on bank performance.

Evidence on the impact of liquidity on bank performance is also ambiguous. Barth, Capiro, and Levine (2006) find that liquidity has statistically positive effects on overhead cost and negative effects on net interest margin. Saunders and Schumacher (2000) find a positive relationship between reserve requirements and the NIMs of banks for the case of European economies and the United States. In contrast, Kalirajan et al (2000) and Dihel and Shepherd (2007) also find no evidence of an association between the liquidity ratio and the NIMs of banks.

Most studies are carried out on a cross-country basis, making it difficult trace and analyze policy changes over time. Additionally, the inability to control for unobservable country-specific and time-fixed effects in a cross-sectional regression might cause the regression results to be biased and inconsistent, since country- and time-fixed effects are omitted and therefore captured in the error term of the regression. Moreover, the imputation of the impact for out-of-sample countries is based on the sample average, and the country's current policy settings. This assumes that the country follows the sample average responsiveness of performance to policy frameworks. Without considering the country- and time-fixed effect, this assumption may be unrealistic, reducing the accuracy of out-of-sample forecasting. As a result, panel analysis of the impact of barriers in services is preferable.

4. Modeling the effect of restrictions on bank performance

This study uses cost and profit as measures of bank performance to separate cost effects from revenue effects of trade barriers in banking services. Using cost and profit functions allows for the imperfect competition caused by trade barriers. The assumption of imperfect competition implies a wedge between cost minimization and profit maximization and ensures they are distinct concepts. The study also applies the structural functional forms of cost and profit to measure the direct effects of trade barriers on the supply side.

The Symmetric McFadden functional form is chosen to meet three criteria: flexibility[2]; parsimony[3]; and regularity conditions[4] (Lawrence 1988; Diewert and Wales 1995). The Symmetric McFadden is preferred to other flexible functional forms because it is not only flexible and rather parsimonious, but also relevant for multi-outputs, especially when some

[2] A functional form is flexible if it either provides a second-order approximation to an arbitrary twice continuously differential function (which satisfies the appropriate regularity conditions), or it can be formulated to represent a second order Taylor series approximation to an arbitrary function. In other words, a flexible functional form enables all of the effects in parameters to be portrayed, without imposing prior constraints across effects. As Chambers (1988) indicates, a flexible functional form with fewer restrictions increases the validity of any resulting inferences from the statistical tests, which are nested within the confines of the function forms.

[3] A functional form is parsimonious if it can provide a second order approximation using a minimum number of parameters. Using many parameters reduces the degrees of freedom.

[4] A functional form meets regularity conditions if it is consistent with the required properties of cost and profit functions (homogeneity, monotonicity, and curvature in input prices). A functional form is locally curvature correct if it satisfies the requirement of convexity or concavity at a single point; and globally curvature correct if it satisfies the correct curvature conditions at all data points in the statistical sample being used. Although the globally curvature correct form is preferred, it is rather difficult to impose this condition without violating the requirement of flexibility and parsimony (Lawrence 1988).

output is zero-quantity. In addition, the ability to keep negative profit data without converting them is another justification for using the Symmetric Mc Fadden.

In order to reflect the supply shift driven by trade barriers in banking services, output quantities must be kept constant. As such, an alternative profit function is used in this study rather than the normal one, where the alternative function is a function of input prices and output quantities. The alternative cost is like a short-run cost minimization where output cannot be adjusted but price can be varied. Given the same control variables, following the duality theory, the cost and alternative profit functions have the identical functional forms with the only difference being the dependent variables.

The functional forms for cost and profit used in this study are as:

The cost function

$$C(w,q,tk,t) = g_C(w)\left(\sum_{i=1}^{m}\beta_{Ci}q_i\right) + \sum_{i=1}^{n}a_{Ci}w_i + \left(\sum_{i=1}^{n}aa_{Ci}w_i\right)\left(\sum_{i=1}^{m}\beta_{Ci}q_i\right)$$
$$+ \sum_{i=1}^{n}\sum_{j=1}^{m}\sum_{t=1}^{m}aa_{Cijt}w_iq_jq_t + \left(\sum_{i=1}^{n}b_{Ci}w_i\right)\left(\sum_{i=1}^{m}\beta_{Ci}q_i\right)tk + \left(\sum_{i=1}^{n}bb_{Ci}w_i\right)tk + \left(\sum_{i=1}^{n}bb_{Cii}w_i\right)tk^2$$
$$+ \left(\sum_{i=1}^{n}c_{Ci}w_i\right)\left(\sum_{i=1}^{m}\beta_{Ci}q_i\right)t + \left(\sum_{i=1}^{n}cc_{Ci}w_i\right)t + \left(\sum_{i=1}^{n}cc_{Cii}w_i\right)t^2 + a_{Cf}FOR$$
$$+ a_{Cz1}TRI + a_{Cz2}TRI\_SCOPE + a_{Cz3}TRI\_SCALE + a_{Cp1}CAP$$
$$+ a_{Cp2}LIQ\sum_{i=2}^{5}a_{Czki}TRI \times TK\_pc_i + \sum_{i=2}^{5}a_{Czci}TRI \times CAP\_pc_i$$
$$+ \sum_{i=2}^{5}a_{Czli}TRI \times LIQ\_pc_i + \sum_{i=1}^{S-1}\varpi_{Ci}D_i$$

Where

$$TRI = \left[for * TRI_F + (1 - for) * TRI_D\right];$$
$$TRI\_SCOPE = \left[for * TRI\_SCOPE_F + (1 - for) * TRI\_SCOPE_D\right]$$
$$TRI\_SCALE = \left[for * TRI\_SCALE_F + (1 - for) * TRI\_SCALE_D\right]$$
$$g_C(w) = \frac{1}{2}\frac{w'S_Cw}{\theta_C'w};\ aa_{Cijt} = aa_{Citj};\ \text{for } i = 1,2,..,n;\ s_{Cij} = s_{Cji};\ \sum_{j=1}^{n}s_{Cij} = 0$$

The profit function

$$\Pi(w,q,tk,t) = g_{\Pi}(w)\left(\sum_{i=1}^{m}\beta_{\Pi i}q_i\right) + \sum_{i=1}^{n}a_{\Pi i}w_i + \left(\sum_{i=1}^{n}aa_{\Pi i}w_i\right)\left(\sum_{i=1}^{m}\beta_{\Pi i}q_i\right)$$
$$+ \sum_{i=1}^{n}\sum_{j=1}^{m}\sum_{t=1}^{m}aa_{\Pi ijt}w_i q_j q_t + \left(\sum_{i=1}^{n}b_{\Pi i}w_i\right)\left(\sum_{i=1}^{m}\beta_{\Pi i}q_i\right)tk + \left(\sum_{i=1}^{n}bb_{\Pi i}w_i\right)tk + \left(\sum_{i=1}^{n}bb_{\Pi ii}w_i\right)tk^2$$
$$+ \left(\sum_{i=1}^{n}c_{\Pi i}w_i\right)\left(\sum_{i=1}^{m}\beta_{\Pi i}q_i\right)t + \left(\sum_{i=1}^{n}cc_{\Pi i}w_i\right)t + \left(\sum_{i=1}^{n}cc_{\Pi ii}w_i\right)t^2$$
$$+ a_{\Pi f}FOR + a_{\Pi z1}TRI + a_{\Pi z2}TRI\_SCOPE + a_{\Pi z3}TRI\_SCALE + a_{\Pi p1}CAP + a_{\Pi p2}LIQ$$
$$\sum_{i=2}^{5}a_{\Pi zki}TRI \times TK\_pc_i + \sum_{i=2}^{5}a_{\Pi zci}TRI \times CAP\_pc_i + \sum_{i=2}^{5}a_{\Pi zli}TRI \times LIQ\_pc_i + \sum_{i=1}^{S-1}\varpi_{\Pi i}D_i$$

$$g(w) = \frac{1}{2}\frac{w'S_{\Pi}w}{\theta_{\Pi}'w};\ aa_{\Pi ijt} = aa_{\Pi itj};\ \text{for } i = 1,2,..,n;\ s_{\Pi ij} = s_{\Pi ji};\ \sum_{j=1}^{n}s_{\Pi ij} = 0$$

C : Total cost

Π : Total profit

q : Output quantities

w : Variable input prices

FOR : Foreign bank dummy variable

TRI_F : Trade restrictiveness index on foreign banks

TRI_D : Trade restrictiveness index on domestic banks

TRI_SCOPE_F : Trade restrictiveness index on other lines of business for foreign banks

TRI_SCOPE_D : Trade restrictiveness index on other lines of business for domestic banks

TRI_SCALE_F : Trade restrictiveness index on outlets expansion for foreign banks

TRI_SCALE_D : Trade restrictiveness index on outlets expansion for domestic banks

CAP : Total capital ratio

LIQ : Liquidity ratio

TK_pc_i : The i quintile of total fixed capital

CAP_pc_i : The i quintile of total capital ratio

LIQ_pc_i : The i quintile of liquidity ratio

tk : Total fixed assets

D : Country dummy variable

t : Time periods (1, 2, .., 10)

In these specifications, in addition to standard prices, quantities, total fixed capital, and time

variables used as control variables, the study focuses on the impact of three trade restrictiveness indices on bank economic performance: TRI including restrictions on establishment and on-going operation of traditional services; TRI_scope including restrictions banks' ability to undertake insurance, securities, and real estate business; and TRI_scale including restrictions banks' ability to expand their business scale through setting up additional branches and placing ATMs. By including three different TRIs, the study expects to see whether the impacts of trade barriers vary with the type of restrictions or not.

Apart from controlling for the difference in prudential regulation, the models also include the interaction terms between TRI and quintiles of total capital ratio, and of liquidity ratio. These interaction terms are taken to explore whether prudential regulation reinforces or cancels out the influence of barriers to trade on banking services.

In addition, the interaction terms between the trade restrictiveness index and quintiles of total fixed inputs are used to examine the impact of trade barriers on firms' economic performance at different levels of business scale. It is expected that the larger scale of business, the lower loss/damage caused by trade barriers.

Country dummy variables are used to capture the effect of country-specific characteristics such as the political system, geography, and history, which are time- and firm-invariant but country-variant. The study also takes into account the difference in cost/profit structure between domestic and foreign banks by including the foreign bank dummy variable.

5. Data sources

The main source of data on banks in this study is from Fitch IBCA's BankScope database. Other data sources are the International Monetary Fund's International Financial Statistics (IMF, 1996-2006) and Dinh's (2008) for the trade restrictiveness index in banking services.

The BankScope data provide standardized accounting data on 7321 banks in 28 countries from 1997 to 2006. The unique feature of this data is that they provide balance sheets and income statements of commercial banks on an unconsolidated basis. Thus, domestic banking services of a bank locally located can be separated from offshore-banking services of its branches or subsidiaries oversea. In addition, domestically-owned banks can also be separated from foreign-owned banks. In this study, a bank is classified as a foreign bank if its total foreign ownership is 51 per cent or more.

Another helpful feature is that BankScope provides data on bank-specific total capital ratio which is defined under the Basel Accords of the Bank for International Settlements at Basel. This ratio measures Tier 1 and Tier 2 capital (including subordinated debt, hybrid capital, loan loss reserves and the valuation reserves) as a percentage of risk-weighted assets and off-balance sheet risks. This variable of total capital ratio is thus a good proxy for prudential regulation. These unique features make it possible for measuring more accurately the impact of barriers to trade in domestic banking services across countries. The study also uses the bank-specific liquidity ratio, which is the ratio of liquidity assets to total assets, as another indicator of prudential regulation.

The BankScope is a rich dataset of commercial banks' economic performance. It allows for total assets to be divided into liquid assets, risk assets, and fixed assets. It also allows total

assets to be broken down in terms of loans and investment assets. In addition, the data provide different sources of liabilities: deposits and other borrowed funds such as certificates of deposits (CDs), commercial papers, debt securities, and securities loaned. In income statements, BankScope gives the total revenue as the sum of interest income, commission income, fee income, trading income, and other operating incomes. It gives the total expenses as the sum of interest expense, commission expense, fee expense, trading expense, personnel expense, and other operating expenses.

Following the intermediation approach where banks are considered as intermediaries between savers and investors (Sealey & Lindley 1977), the study defines three inputs (including two variable inputs and one fixed input), and two outputs. The inputs include total deposits and borrowed funds, labor, and fixed capital. The outputs consist of loans and investment. Given the high correlation between the two output quantities, an aggregate output quantity is used in the regressions.

The price of total deposits and borrowed funds is defined as the ratio of the sum of interest, commission, fee, and trading expenses to the deposits and borrowed funds. The price of labor is obtained by dividing personnel expense by number of employees. The fixed capital includes equity capital and fixed assets.

In general, firms use depreciation as the cost of fixed capital. However, depreciation does not reveal the actual cost of fixed capital because it does not reflect economic depreciation (or appreciation) in the market value of the firms' assets (Kalirajan et al. 2000). Therefore, the study uses the opportunity cost to measure the cost of fixed capital. The opportunity cost is the expected return on alternative investment rather than fixed capital. In this study, the opportunity cost of fixed capital is measured by the risk-free bond rate and the change in the market value of bank assets. The risk-free bond rate is measured by the government bond rate, and the change in market value of bank assets is measured by the relative change in bank equity capital. The price of investment is defined as the ratio of the sum of commission income, fee income, and trading income to the value of investment.

In this study, total cost is defined as the interest expenses paid on deposits and borrowed funds, plus costs of other purchased inputs including labor and fixed capital. Total revenue is defined as the sum of interest income, commission income, fee income, and trading income. Total profit is the gap between the imputed total cost and total revenue.

All prices and quantities of inputs and outputs are expressed in 1997 USD to remove the influence of inflation as well as to facilitate cross-country comparison. The annual consumer price index from the International Financial Statistics (IFS) of the International Monetary Fund is used to deflate nominal items into real ones. All data are converted into USD using the exchange rate from the IFS where the 1997 exchange rate is used for real-term data and the current exchange rate is used for nominal-term data.

Most sample countries require banks to keep a minimum ratio of 8 per cent capital to risk-weighted assets as recommended by the Bank for International Settlements in coping with credit risk. As such, there is a little sample variation in these prudential regulations, making it difficult to do econometric exercises. In addition, banks are likely to keep these prudent ratios higher than the requirement rates if they see that their assets are at high risk. On the contrary, they may

keep these ratios lower than the requirement if their assets are at low risk. These rates vary across banks in the same country. Therefore, the bank-specific total capital and liquidity ratios are used to represent prudential-regulation variable rather than country-specific regulations of capital adequacy and liquidity. Using the actual rates allows more variation in the data and therefore controls more accurately the impact of these prudential measures.

Data for the trade restrictiveness indexes for economies are drawn from Dinh's (2008) study. For the purpose of the study, only restrictions affecting domestic banking services are considered, including restrictions on mode 3 and mode 4, in order to keep with the structural approach which only includes measures directly affecting bank performance.

It would be ideal to see the impact of each individual indicator of restrictiveness on cost and profit. However, the high multicollinearity between these indicators prevents them from being simultaneously entered in the regression. The principal component analysis is therefore used to correct this problem by setting up summary indices of restrictiveness.

Table 1 Types and nature of restrictions

Type of restrictions	**Nature of restrictions**	**Components**
Barriers to establishment, and on-going operation (*TRI*)	Restrictions that prevent banks from establishing or setting up a commercial presence in the market, and undertaking traditional banking services.	Restrictions on: licensing, equity contribution, reciprocity requirement (F), screening and approval, movement of natural persons (F), lending, fund-raising, fund mobilization, foreign exchange business, settlement service, interest pricing
Barriers to scale *(TRI_scale)*	Restrictions that prevent banks from expanding their networks	Restrictions on: branching and placing ATMs
Barriers to scope (*TRI_scope*)	Restrictions that prevent banks from provision of non-traditional financial services once banks already set up their commercial presence	Restrictions on insurance, securities, real estate business, and ownership of non-financial firms

For the purpose of the study, only restrictions affecting domestic banking services are considered, including restrictions on mode 3 and mode 4, in order to keep with the structural approach which only includes measures that directly affect each bank. Three summary trade restrictiveness indexes are constructed separately for domestic and foreign banks: TRI including restrictions on establishment and on going operation of traditional services; TRI_scope including restrictions on banks' ability to undertake insurance, securities, real estate business

and ownership of non-financial firms and; TRI_scale including restrictions on setting up additional branches apart from headquarter, or placing ATMs. The detail components of each type of restrictions are shown in Table 1. The value of each index ranges from 0 to 100, where the higher the index, the more restrictive the banking sector.

Table A.1 provides the data summary used in the study. Using these variables, the regression variables are set up as shown in Table A.2 (Appendix A).

6. Estimation Results

Generic approach of estimation

In order to correct for the problem of heteroscedasticity which is common in cross-section and time series data, the study uses unit cost and unit profit as the dependent variables. These unit variables are the ratio of total cost and total profit to total fixed capital.

Given the dominance of US banks in the sample, the interaction terms between bank-specific variables and the dummy variable (1 if the bank is located in US, 0 otherwise) are used to control for the slope difference. The joint and individual parameter tests of the interactions terms show that they are statistically significant in both the estimated unit cost and unit profit functions.

In the literature, the cost/profit function is usually estimated along with the share/demand functions using Seemingly Unrelated Regression (SUR) to make parameter estimates more efficient. Given the cost and alternative functions have the identical functional form, the study estimates the Symmetric McFadden functional form of the unit cost and unit profit functions specified by using the Maximum Likelihood Seemingly Unrelated Regression to control for the serial correlation between the two error terms of the two functions. The standard errors are also corrected for heteroscadasticity under this maximum likelihood estimation. However, it may be more efficient if the cost and alternative profit functions are estimated associated with the share functions. This would be worth for further research.

Given the high correlation between interaction terms of prices and quantities, all these multiplicative interaction terms are transformed using their minimum and maximum values. Tables A.3, A.3.1, and A.3.2 in Appendix A summarizes the regression results of unit cost and unit profit functions.

Several formal tests including the MacKinnon and Davidson PE test, Sargan criterion ranking and Akaike criteria (AIC) are used to confirm the choice of the Symmetric McFadden functional form against the translog functional form[5]. Following the MacKinnon and Davidson PE test,

[5] The translog functional form for the cost function is

$$\ln\left(\frac{C}{p_2 q_2}\right) = \alpha_{C0} + \alpha_C \ln\left(\frac{p_1}{p_2}\right) + \beta_C \ln\left(\frac{q_1}{q_2}\right) + \delta_C \ln tk + \gamma_C t + \frac{1}{2}\left\{\alpha_{C11}\left[\ln\left(\frac{p_1}{p_2}\right)\right]^2 + \beta_{C11}\left[\ln\left(\frac{q_1}{q_2}\right)\right]^2 + \delta_{C11}(\ln tk)^2 + \gamma_{C11} t^2\right\}$$

$$+ \kappa_C \ln\left(\frac{p_1}{p_2}\right)\ln\left(\frac{q_1}{q_2}\right) + \sigma_C \ln\left(\frac{p_1}{p_2}\right)\ln tk + \omega_C \ln\left(\frac{p_1}{p_2}\right)t + + a_{Cf} FOR + a_{Cz1} TRI + a_{Cz2} TRI\_SCOPE + a_{Cz3} TRI\_SCALE$$

$$+ a_{Cp1} CAP + a_{Cp2} LIQ + \sum_{i=2}^{5} a_{Czki} TRI \times TK\_pc_i + \sum_{i=2}^{5} a_{Czci} TRI \times CAP\_pc_i + \sum_{i=2}^{5} a_{Czli} TRI \times LIQ\_pc_i + \sum_{i=1}^{S-1} \varpi_{Ci} D_i$$

The translog functional form for the alternative profit function is

each of the two models is tested against the remaining one by augmenting each model with the difference of the predictions of the dependent variables. The results in Table B.1 in Appendix B indicate that the McFadden functional form is preferred to the translog functional form because the z statistics measuring the contribution of the McFadden model to the predictive power of the translog models of cost and profit are 61.24 and 17.23, which are very large and decisive rejections. On the contrary, the respective contribution of the translog models to the McFadden predictions is small with z statistics of 0.45 and -4.47. Another simple criterion for choosing among these models is to choose the model with the highest maximized likelihood (this is referred to the Sargan criterion). The results in Table B.2 in Appendix B suggest that the McFadden is preferred. Based on the AIC values of the two models as shown in Table B.2 in Appendix B, the preferred model is the McFadden as its AIC is lower. The results of all these tests suggest that the McFadden offers a better fit of the data.

The concavity condition requires that the second derivative of the unit cost function with respect to banking wage be negative. The regression results from the estimated cost function show that the coefficient of the interaction term p1p2 are of the right sign and statistically significant but the joint significance test of p1p2 and US_p1p2 fails to reject the null hypothesis. The curvature condition also requires the second derivative of the profit function with respect to banking wage be positive. In the estimated unit profit function, the individual test for the coefficient p1p2 is statistically insignificant but the joint test of p1p2 and US_p1p2 is statistically positive. This means that non-US banks are cost-minimizers but not profit-maximisers. The opposite situation happens to US banks, and they are profit-maximisers but not cost-minimisers. Bikker and Bos (2008) explain that banks may not minimize their cost and maximize their profit. First, highly risk-averse banks are willing to forego high return but high risk opportunities for exchange of stable but moderate income. Given that studies on modeling banks' risk-return trade-off are still in their infancy and there is a lack of data on risk, this study excludes it from the general framework. Second, because of the information asymmetry between the principal and agent, managers may be induced to make discretionary decisions which are contrary to shareholder interests, resulting in un-maximized profit and/or un-minimized cost. Although the incentive structure can explain the suboptimal problem, it is tricky to test this argument empirically. Third, exogenous factors such as regulations or shocks can cause suboptimal performance. These factors may be the main culprit of inefficient uses of inputs and wrong setting output prices.

Estimation results

Basing upon the estimated unit cost and unit profit functions, the elasticity of total cost, total profit, total revenue with respect to total fixed capital, and trade restrictiveness index are derived, following formulas in Appendix C. Calculated at the world median value of prices and

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$$\ln\left(\frac{C}{p_2 q_2}\right)=\alpha_{\Pi 0}+\alpha_{\Pi}\ln\left(\frac{p_1}{p_2}\right)+\beta_{\Pi}\ln\left(\frac{q_1}{q_2}\right)+\delta_{\Pi}\ln tk+\gamma_{\Pi}t+\frac{1}{2}\left\{\alpha_{\Pi 11}\left[\ln\left(\frac{p_1}{p_2}\right)\right]^2+\beta_{\Pi 11}\left[\ln\left(\frac{q_1}{q_2}\right)\right]^2+\delta_{\Pi 11}(\ln tk)^2+\gamma_{\Pi 11}t^2\right\}$$

$$+\kappa_{\Pi}\ln\left(\frac{p_1}{p_2}\right)\ln\left(\frac{q_1}{q_2}\right)+\sigma_{\Pi}\ln\left(\frac{p_1}{p_2}\right)\ln tk+\omega_{\Pi}\ln\left(\frac{p_1}{p_2}\right)t++a_{\Pi f}FOR+a_{\Pi z1}TRI+a_{\Pi z2}TRI\_SCOPE+a_{\Pi z3}TRI\_SCALE$$

$$+a_{\Pi p1}CAP+a_{\Pi p2}LIQ+\sum_{i=2}^{5}a_{\Pi zki}TRI\times TK\_pc_i+\sum_{i=2}^{5}a_{\Pi zci}TRI\times CAP\_pc_i+\sum_{i=2}^{5}a_{\Pi zli}TRI\times LIQ\_pc_i+\sum_{i=1}^{S-1}\varpi_{\Pi i}D_i$$

quantities, a percentage increase in the total fixed capital is expected to generate nearly a percentage increase in total cost. The same impact also happens to total profit. The result shows there are slight economies of scale in commercial banks in the sample. This is consistent with some studies which find economies of scale when output is large.

The impact of trade barriers on cost/profit is determined by the coefficients of individual TRIs as well as the interaction term between TRI and the quintiles of total fixed capital, total capital ratio and liquidity ratio. The coefficient estimate of the interaction term between TRI and the quintiles of total fixed capital is important for assessing whether the impact of trade barriers is dependent on the scale of production, which is represented by the level of total fixed capital. Similarly, the coefficients of the interaction terms between TRI and the quintiles of total capital ratio and liquidity ratio can indicate whether prudential regulation reinforces or cancels out the impact of TRI on bank performance.

The regression result for the unit cost function indicates the coefficient of TRI has the expected sign and is statistically significant. The positive sign of this coefficient implies a cost escalating effect of trade barriers. In the unit profit function, the estimated coefficient of TRI is statistically negative. The impact of TRI on revenue[6] can be indirectly evaluated by the summation of the impact of TRI on cost and profit. Given the coefficient of TRI in the estimated unit cost function is positive and high enough to cancel out the negative value of the coefficient of TRI in the unit profit function, the impact of TRI in revenue is thus positive. In other words, TRI also has a rent-creating effect; however, this effect is dominated by the cost-escalating effect. Without considering the impact of prudential regulation measures and total fixed capital on bank performance, a percentage point increase in TRI is found to increase total cost by 0.75 per cent and to reduce total profit by 3.47 per cent, or increase total revenue by 1.1 per cent.

Restrictions on other lines of business including securities, insurance, real estate, and other non-financial activities as well as restriction on outlets expansion are shown not to be determinants of bank performance.

Along with non-prudential restrictions, prudential regulation is found to be a determinant of bank performance. The estimated coefficients indicate that a percentage point increase in the total capital ratio cuts the total cost by 1.6 per cent and total profit by 1.1 per cent, holding other variables constant. Higher capital adequacy means banks use fewer funding inputs for producing the same outputs, leading to lower total cost. However, higher capital adequacy may induce banks to behave recklessly, and invest in more risky assets or easily provide loans, leading to lower profit.

The liquidity ratio also significantly affects bank cost but profit. A percentage point increase in the liquidity ratio is estimated to increase total cost by 0.26 per cent. The higher liquidity ratio may lead to a reduction in funds used for lending and investment services. In order to keep the output quantity unchanged under an increase in the liquidity ratio, banks need to use more inputs, which increase their total cost.

The impacts of trade barriers affecting banking services on bank economic performance vary

[6] The interaction of TRIs on total cost, total profit, and total revenue can be imputed from the estimated unit cost and unit profit functions. For more detail, please refer to Appendix 2.

with the business scale, as expected. In the unit cost regression, all coefficients on the interaction terms between TRI and the quintiles of total fixed capital are statistically negative and increase in absolute values. Although trade barriers escalate cost, this effect is constrained by the level of total fixed capital. For example, the impact of TRI on total cost at the third quintile of total capital is 27 per cent lower than that at the first quintile. This suggests that trade barriers are more cost-escalating for small banks than large ones. However, in terms of profit, the opposite occurs: trade barriers are more rent-creating for larger banks, as seen by the positive coefficients of the interaction terms in the estimated profit function. This evidence is similar to Dee and Dinh's (2008) findings for insurance.

While the total capital ratio is observed to cancel out the impact of TRI on bank cost, it reinforces its impact on profit. For example, the impact of TRI on total cost at the third quintile of the total capital ratio is 46 per cent lower than that at the first quintile of the total capital ratio. In contrast, the impact of TRI on total profit at the third quintile of the total capital ratio is 12 per cent higher than that at the first quintile. Although the ultimate target of capital adequacy stringency is to keep the stability and efficiency of the banking sector, this requirement can be seen a buffer for banks against trade barriers.

The liquidity ratio is shown to have no effect on the impact of TRI on bank performance but to reduce the profit-reducing impact of TRI. At the third quintile of liquidity ratio the impact of TRI on total profit is 12 per cent lower than that at the first quintile. Banks with the higher liquidity ratio are less damaged by trade barriers.

The coefficients for the foreign bank dummy variable show that foreign banks have lower cost and higher profit than domestic banks. Evaluated at the world median value of prices and quantities, foreign banks have total cost 17 per cent lower than domestic banks. The former groups are shown to have total profit of 0.8 per cent higher but to have revenue of 12 per cent lower. This suggests that foreign banks use inputs more efficient and charge lower prices to their services than domestic banks.

7. Impact Analysis

The previous section provides a preliminarily useful look at the impact of trade barriers on bank performance. In order to facilitate for the economy-wide impact assessment of trade liberalization in banking services, three measures of impact are constructed, including cost impact, price impact, and rent impact. Cost impact or productivity equivalent is defined as the percentage change in variable cost due to impediments to trade in banking service. Price impact is defined as the percentage change in the price driven by restrictions on banking services. The two measures - productivity and tax equivalents, can be then modeled as shocks on supply and demand sides and put in a computable general equilibrium model to trace on the economy-wide effect.

Here are the formulas for evaluating cost and price effects of trade barriers in banking services:

$$\cos t\_impact = productivity\_equivalent = \frac{v_1 - v_0}{v_0} \times 100\% = \frac{v_1 q_1 - v_0 q_0}{v_0 q_0} \times 100$$

$$= \frac{TC_1 - TC_0}{TC_0} \times 100\%$$

$$price\_impact = tax\_equivalent\_threshold = \frac{p_1 - p_0}{p_0} \times 100$$

$$= \frac{p_1 \times q_1 - p_0 \times q_0}{p_0 \times q_0} \times 100 = \frac{TR_1 - TR_0}{TR_0} \times 100$$

where: $q_1 = q_0$

$v_0, p_0, q_0, TC_0, TR_0$: are the unit variable cost, unit price, output quantity, total cost, and total revenue when there are no trade barriers in banking services, respectively.

$v_1, p_1, q_1, TC_1, TR_1$: are the unit variable cost, unit price, output quantity, total cost, and total revenue when there are trade barriers in banking services, respectively.

The cost, profit, and revenue can be predicted from the estimated unit cost and profit functions (see Appendix D for more detail).

By construction, the productivity equivalent presents the vertical shift in the supply curve driven by TRI, while holding output quantities and other explanatory variables constant. The tax equivalent shows the price markup due to TRI, also with output quantities kept unchanged. A positive productivity equivalent means banks loss in terms of productivity from restrictions. In other words, banks would gain in terms of productivity if these restrictions are removed. Similarly, a positive tax equivalent reflexes a gain in terms of prices due to trade barriers acting as a tax on consumers. This also implies a gain in bank prices or revenue if these barriers are released.

Productivity and tax equivalents versus TRI

The unit cost and unit profit are modeled to be determined by both TRIs and the interaction terms between TRI and business scale and prudential regulation. In order to examine the pattern of productivity and tax equivalents purely driven by TRI, these measures are evaluated at the world median value of quantities and prices without considering the effects of business scale and prudential regulation measures.

Figure 1 scatters the productivity equivalent against TRI in the range of TRI. The figure shows that there exists a monotonically increasing relationship between the productivity and tax equivalents and TRI, implying a positive association between total cost and total revenue and barriers to trade in banking services. The world median value of TRI is projected to raise the total cost by 26 per cent and the total revenue by 24 per cent. Figure 1 also shows that the productivity equivalent is always higher than the tax equivalent. The result suggests that TRI in

banking services are both cost-escalating and rent-creating. The evidence here is richer than Kaliragan et al.'s (2000) study where they find only evidence of rent-creating. In addition, the result also indicates that TRI in banking services are biased towards cost-escalating.

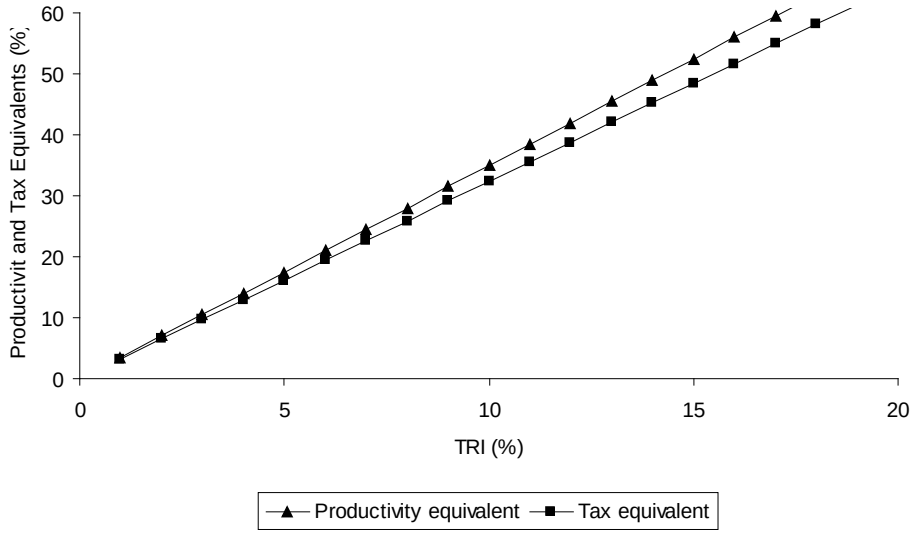

Figure 1: Productivity and Tax Equivalents versus TRI

Source: Author's calculation

Interaction between TRI and prudential regulation

Table 2 shows how the productivity and tax equivalents change across the level of total capital ratio. At the first quintile of total capital ratio, the total cost is projected to increase by 30.3 per cent and the total revenue is estimated to increase by 9.3 per cent compared with the case of without TRI. At the median of total capital ratio, the total cost is still higher than the case of without TRI but its increase declines to 17.3 per cent. Especially, at this level of total capital ratio, the total revenue starts to fall. This comes from the fact that the higher capital ratio has a negative impact on total cost and total revenue. The results suggest that banks with the higher capital ratio are less affected by TRI in terms of cost increase but less benefited from TRI in terms of rent-creating.

Table 2: Productivity and Tax Equivalent over Total Capital Ratio

Quintile	Productivity equivalent	Tax equivalent
1	30.30	9.33
2	22.82	4.53
3	17.31	-0.90
4	11.37	-6.71
5	7.09	-11.06

Source: Author's calculation

Table 3 shows how the impact of trade restrictiveness on total cost and profit varies across the level of liquidity ratio. It shows that the impact of TRI on total cost changes very little by level of liquidity ratio. All the change in the productivity equivalent comes from the change in the total cost driven by the change in the liquidity ratio rather than the change in the impact of TRI due to the change in the liquidity ratio. This is confirmed by the fact that all the interaction terms between TRI and level of liquidity ratio are statistically significant. In contrast to the case of total capital ratio, the impact of TRI on total revenue increases by level of liquidity ratio. At the first quintile of liquidity ratio, the total revenue is projected to increase by 8.4 per cent. This impact figure rises to 8.8 per cent when evaluated at the world median value of the liquidity ratio. At the highest level of the liquidity ratio, the total revenue is found to increase by 11.2 per cent. The results suggest that banks with the higher liquidity ratio can get more benefits from restrictions.

Table 3: Productivity and Tax Equivalent versus Liquidity Ratio

Quintile	Productivity equivalent	Tax equivalent
1	26.50	8.35
2	26.36	8.40
3	26.25	8.79
4	26.12	9.47
5	25.87	11.22

Source: Author's calculation

Productivity and tax equivalent over business scale

Table 4: Productivity and Tax Equivalent over Business Scale

Quintile	Productivity equivalent	Tax equivalent
1	26.60	8.38
2	19.66	3.74
3	17.92	3.45
4	17.48	5.20
5	12.77	6.16

Source: Author's calculation

Table 4 presents the productivity and tax equivalents across the quintile of total fixed capital. At the first quintile of total fixed capital, the total cost is projected to soar by 26.6 per cent and the total revenue is estimated to rise by 8.4 per cent compared with the case of without TRI. At the median of total fixed capital, the figures are reduced to 17.9 per cent for the productivity

equivalent and 3.5 per cent for the tax equivalent. At the highest level of business scale, the total cost is found to increase by 12.8 per cent and the total revenue to rise by 6.2 per cent, higher than the median level of business scale. The results show that the productivity equivalent reduces by the level of total fixed capital. This suggests that bigger banks are less affected by restrictions affecting banking services on cost escalation. However, there is a non-linear association between the tax equivalent and TRI. The tax equivalent tends to fall until the total fixed capital reaches a certain threshold. Over this threshold, the tax equivalent begins to rise. This suggests that small banks are getting fewer benefits from TRI when they expand their scale. However, large banks can get more benefits by expanding their scale. We also observe that at any level of total fixed capital, the cost-escalating impact always dominates the rent-creating impact. To summarise, big banks are less affected by TRI than small banks. This finding is consistent with the evidence Dee and Dinh's (2008) find for the case of insurance.

Cross-country productivity and tax equivalents

In order to examine the cross-country pattern of productivity and tax equivalents, it would be ideal for these measures to be evaluated for a typical firm of each country. However, country data are unbalanced so not all country sub-samples are fully representative of that particular country. To ameliorate the data skewness and to enable the out-of-sample forcasting, this study uses the world median value of prices, quantities and country effects. However, the evaluation uses the country-specific values of TRI.

Figure 2 features the productivity and tax equivalents of trade barriers of 36 countries in OECD, Africa and Middle East, Latin America, and Asia. The tax equivalent ranges from 0.11 to 51 per cent. That is, the cost of banks is 0.11 to 51.41 per cent higher than it would be in the absence of trade barriers in banking services. It is also estimated that the productivity equivalent fluctuates from 0.03 to 15.68 per cent. In other words, banks gain from 0.03 to 15.68 per cent higher in their revenue due to non-prudential regulations.

Asian countries are shown to have the highest productivity and tax equivalents. In particular, eight Asian countries — Vietnam, India, China, Korea, Malaysia, Taiwan, Thailand, and Pakistan are in the top-ten countries in the sample. These countries are highlighted by the high government ownership in banking system and tight controls on other lines of banking business. In contrast, seven of the ten least-affected countries are in Europe, including the United Kingdom, Austria, Spain and the Netherlands.

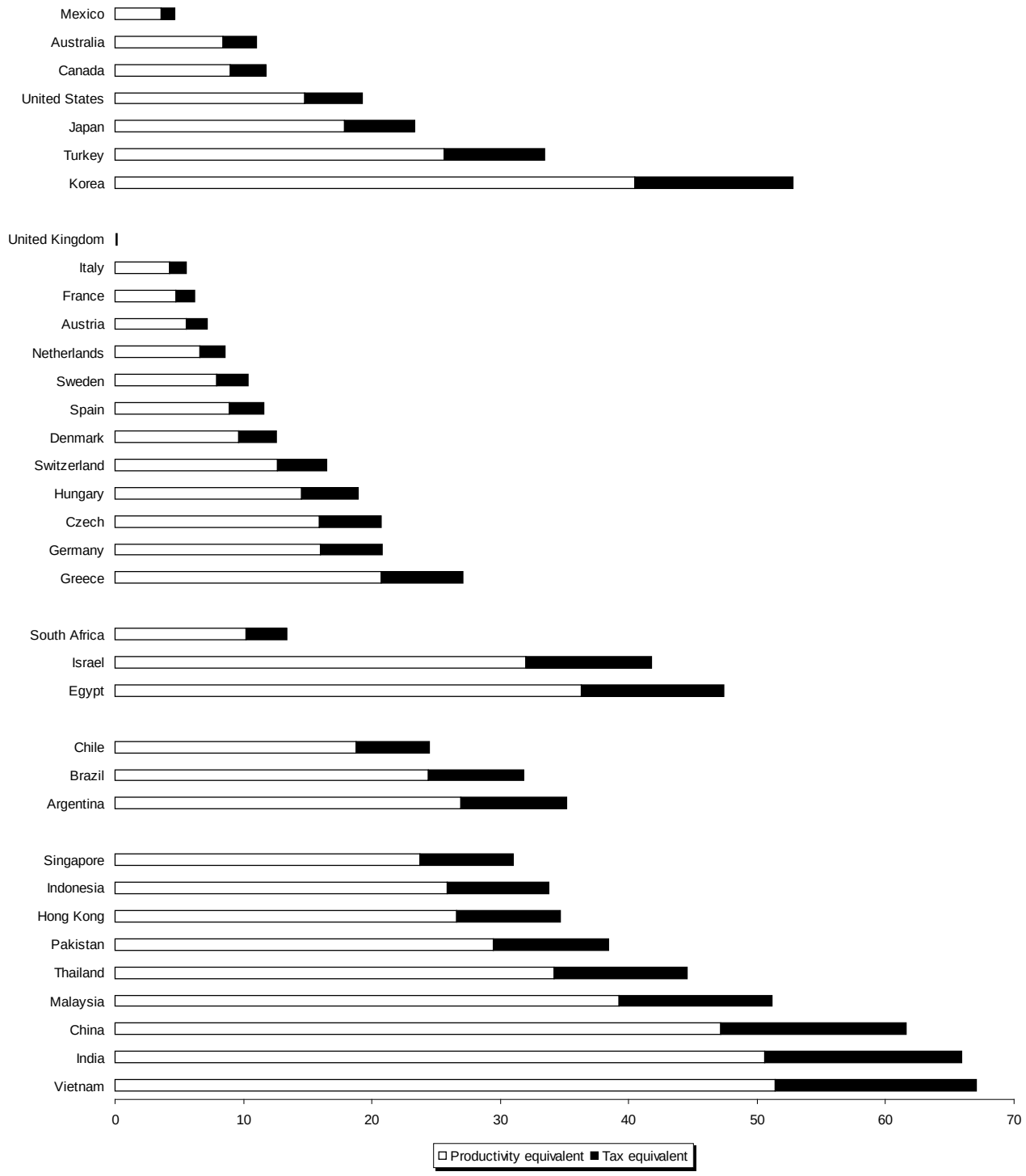

Figure 2: Cross-country Productivity and Tax Equivalent, average 1997-2006

Source: Author's calculation

8. Conclusion

Using cost and profit as measures of bank performance, the study has identified and separated the cost effects from the price effects of trade barriers in banking services. The impact of trade barriers is found to depend on different type of restrictions. Restrictions on establishment and on-going operation of traditional banking services are found to have both cost-escalating and price-improving effects but to be biased towards the former effects. This implies that liberalization on this type of restrictions would be more beneficial to the society. Restrictions banks' ability to undertake securities, insurance, real estate business and ownership of non-financial firms as well as restrictions on business scale expansion are found to have no impact on both cost and profit.

The results also illustrate how prudential regulation affects the impact of trade barriers. The total capital ratio is observed to reduce the impact of trade barriers on bank cost but to reinforce their impact on profit. Although the ultimate target of capital adequacy stringency is to keep the stability and efficiency of the banking sector, this requirement can be seen as a buffer for banks against trade barriers. The liquidity ratio is shown to have no effect on the impact of TRI on cost but to enhance the impact of TRI on revenue.

The impacts of trade barriers affecting banking services on bank economic performance vary with the business scale, as expected. Although trade barriers escalate cost, this effect is constrained by the level of total fixed capital. This suggests that costs are more affected for small banks than large ones. However, in terms of profit, the opposite occurs: trade barriers are more rent-creating for larger banks, as seen by the positive coefficients of the interaction terms in the estimated profit function.

Using the regression results, the study has projected the productivity and tax equivalents of 36 countries, which would be used as inputs in measuring economy-wide impact of trade liberalization in banking services. The projection suggests that removing restrictions affecting banking services in Asian countries could be expected to significantly reduce cost of their commercial banks. Although this process also means the reduction in bank revenue, banks would be more benefited due to the gain from cost-reducing effects in excess of the lost from revenue-reducing effects.

Using Maximum Likelihood Seemingly Unrelated Regression to jointly estimate the cost and alternative profit functions is a contribution of the study to the literature. This approach helps to correct the correlation between errors in the two equations, making parameter estimate more efficient. However, it may be worth to further research to improve the estimation by including the share functions along with the cost and profit functions in SUR.

Appendix A

Table A.1: Summary of data

Country	NOBs[1]	NOOs[2]	unit_ cost	unit_ profit	Borrowing rate	Wage	Loans	Investment	Total fixed capital (th USD)	Total capital ratio (%)	Liquidity ratio (%)	TRI	TRI_s cope	TRI_s cale
Argentina	9	10	0.79	0.21	5.24	28.47	2343862	826368.6	575616.6	11.74	45.37	5.63	0.57	0.00
Australia	2	2	0.84	0.16	5.55	185.27	4348622	914213.3	280068.4	5.54	10.20	4.54	2.05	0.00
Austria	18	73	0.82	0.18	4.11	81.65	3265584	1296268	391555.2	8.88	33.74	1.66	0.92	0.00
Brazil	13	20	0.84	0.16	15.73	49.20	5609674	5771867	1978730	16.03	60.36	8.90	2.52	0.80
Chile	1	2	0.98	0.02	8.32	51.55	1367384	220095.3	389719.3	12.11	15.11	4.17	3.84	0.00
China	8	18	0.64	0.36	1.86	23.85	55400000	32700000	194357.4	10.02	24.97	9.67	4.99	0.18
Czech Republic	13	27	0.78	0.22	3.20	20.68	1369469	537993.6	7217563	14.26	50.57	3.24	3.22	0.00
Denmark	10	31	0.82	0.18	2.95	73.83	18700000	12600000	308674.6	12.32	23.34	2.14	2.33	0.00
France	132	716	0.78	0.22	4.68	77.56	8929088	6316311	2082974	8.32	37.84	1.45	1.43	0.00
Germany	72	330	0.82	0.18	3.93	89.16	26300000	15400000	2719901	5.27	33.04	3.91	1.35	0.00
Greece	8	14	0.88	0.12	4.20	46.32	11400000	4096181	426857.7	8.82	35.32	4.15	1.79	0.00
Hungary	3	6	0.89	0.11	7.08	19.45	1230078	507390.8	954478.1	10.49	28.54	4.51	2.96	2.44
India	50	153	0.90	0.10	7.36	5.32	1865941	1571081	1511772	13.03	54.56	12.46	1.81	2.14
Indonesia	11	15	0.75	0.25	6.64	21.86	586779.4	82747.14	235310.8	38.50	59.75	8.04	4.81	0.62
Israel	3	5	0.93	0.07	5.63	76.60	10000000	1535998	78401.13	13.34	29.11	9.83	3.54	0.00
Italy	126	252	0.74	0.26	3.17	65.71	6493582	2071596	1216617	16.55	41.38	1.01	2.97	1.22
Japan	113	322	0.81	0.19	1.09	79.28	45200000	24900000	305757.1	10.34	20.63	4.21	3.18	0.08
Korea	3	3	0.82	0.18	6.67	41.79	3924937	2360932	995356.1	10.47	20.40	12.11	3.01	0.00
Netherlands	3	6	0.93	0.07	6.79	87.74	555619.2	415431.8	4023583	21.67	54.42	3.08	1.01	0.00

Table A.1: Summary of data (cont.)

Country	NOBs[1]	NOOs[2]	unit_ cost	unit_ profit	Borrowing rate	Wage	Loans	Investment	Total fixed capital (th USD)	Total capital ratio (%)	Liquidity ratio (%)	TRI	TRI_s cope	TRI_s cale
Singapore	4	7	0.67	0.33	2.99	56.26	11500000	5767697	696534	12.44	59.96	5.46	3.33	1.33
South Africa	2	6	0.87	0.13	10.14	91.25	225601.5	178768.7	180118.8	26.54	42.55	2.36	1.32	0.00
Spain	5	5	0.72	0.28	2.20	52.31	4012225	66469.68	2702433	9.47	5.40	2.05	1.52	0.00
Sweden	4	21	0.81	0.19	3.98	88.18	27200000	32600000	2913271	22.26	65.10	3.59	1.74	0.00
Switzerland	92	457	0.70	0.30	2.58	96.85	3090504	2313997	1658593	10.32	24.33	3.91	1.43	0.00
Taiwan	27	43	0.74	0.26	1.83	43.32	16000000	4896894	2377485	12.32	17.55	8.56	3.58	2.02
Thailand	13	24	0.81	0.19	3.47	17.97	9987830	1946742	112759.9	13.74	21.93	11.77	3.47	1.89
United States	6576	34717	0.73	0.27	2.66	43.44	655887.9	310324	37587.48	15.35	8.46	3.17	2.94	0.01
Vietnam	2	5	0.91	0.09	3.71	6.20	215378.5	13353.17	104224.9	11.38	33.32	11.46	1.71	2.13
The whole sample	7323	37290	0.81	0.19	4.92	57.89	10063502	5793526	1309654	13.62	34.19	5.61	2.48	0.53

Notes:

[1] Number of banks; [2] Number of observations

Table A.2: List of regression variables

Variable name	Description	Formula
US	US dummy variable (1 if country is US, 0 otherwise)	
q1	Total loan (USD th)	
q2	Total investment (USD th)	
q	The total output quantities	$q = q_1 + q_2$
tk	Total fixed capital (USD th)	
t	Time period (1, 2, .., 10)	
p1p2	The interaction term between squared input price gap and output quantities	$\frac{(p_1 - p_2)^2 q}{\theta_{c1} p_1 + \theta_{c2} p_2}$
US_p1p2_1	The interaction term between p1p2 and US	$p1p2 \times US$
p1	Borrowing rate (%)	
US_p1_1	The interaction term between p1 and US	$p_1 \times US$
p2	Wage (USD th)	
US_p2_1	The interaction term between p2 and US	$p_2 \times US$
p1out	The interaction term between p1 and total output quantity	$p_1 \times q$
US_p1out_1	The interaction term between p1out and US	$p_1 \times q \times US$
p2out	The interaction term between p1 and total output quantity	$p_2 \times q$
US_p2out_1	The interaction term between p1out and US	$p_2 \times q \times US$
p1out2	The interaction term between p1 and square of total output quantity	$p_1 \times q^2$
US_p1outa1	The interaction term between p1out2 and US	$p_1 \times q^2 \times US$
p2out2	The interaction term between p2 and square of total output quantity	$p_2 \times q^2$
US_p2outa1	The interaction term between p2out2 and US	$p_2 \times q^2 \times US$
p1tkout	The interaction term between p1out and tk	$p_1 \times tk \times q$
US_p1tko_1	The interaction term between p1tkout and US	$p_1 \times tk \times q \times US$
p2tkout	The interaction term between p2out and tk	$p_2 \times tk \times q$
US_p2tko_1	The interaction term between p2tkout and US	$p_2 \times tk \times q \times US$
p1tk	The interaction term between p1 and tk	$p_1 \times tk$
US_p1tk_1	The interaction term between p1tk and US	$p_1 \times tk \times US$
p2tk	The interaction term between p2 and tk	$p_2 \times tk$
US_p2tk_1	The interaction term between p2tk and US	$p_2 \times tk \times US$
p1tk2	The interaction term between p1 and square of tk	$p_1 \times tk^2$
US_p1tk2_1	The interaction term between p1tk and US	$p_1 \times tk^2 \times US$
p2tk2	The interaction term between p2 and square of tk	$p_2 \times tk^2$
US_p2tk2_1	The interaction term between p2tk and US	$p_2 \times tk^2 \times US$
p1tout	The interaction term between p1t and out	$p_1 \times t \times q$
US_p1tou_1	The interaction term between p1tout and t	$p_2 \times t \times q$
p2tout	The interaction term between p2t and out	$p_1 \times t \times q \times US$
US_p2tou_1	The interaction term between p2tout and t	$p_2 \times t \times q$
p1t	The interaction term between p1 and t	$p_2 \times t \times q \times US$
US_p1t_1	The interaction term between p1t and US	$p_2 \times t \times q$
p2t	The interaction term between p2 and t	$p_2 \times t$
US_p2t_1	The interaction term between p2t and US	$p_2 \times t \times US$

Table A.2: List of regression variables (cont.)

Variable name	Description	Formula
p1t2	The interaction term between p1 and square of t	$p_1 \times t^2$
US_p1t2_1	The interaction term between p1t2 and US	$p_1 \times t^2 \times US$
p2t2	The interaction term between p2 and square of t	$p_2 \times t^2$
US_p2t2_1	The interaction term between p2t2 and US	$p_2 \times t^2 \times US$
for	Foreign bank dummy variable (1 if yes, 0 otherwise)	
TRI	Trade restrictiveness index	
TRI_scope	Trade restrictiveness index in other lines of business	
TRI_scale	Trade restrictiveness index in outlets expansion	
cap	Total capital ratio	
liq	Liquidity ratio	
_Itk_XTRI_2	The interaction term between TRI and the second quintile of total fixed capital	
_Itk_XTRI_3	The interaction term between TRI and the third quintile of total fixed capital	
_Itk_XTRI_4	The interaction term between TRI and the fourth quintile of total fixed capital	
_Itk_XTRI_5	The interaction term between TRI and the fifth quintile of total fixed capital	
_IcapXTRI_2	The interaction term between TRI and the second quintile of total capital ratio	
_IcapXTRI_3	The interaction term between TRI and the third quintile of total capital ratio	
_IcapXTRI_4	The interaction term between TRI and the fourth quintile of total capital ratio	
_IcapXTRI_5	The interaction term between TRI and the fifth quintile of total capital ratio	
_IliqXTRI_2	The interaction term between TRI and the second quintile of liquidity ratio	
_IliqXTRI_3	The interaction term between TRI and the third quintile of liquidity ratio	
_IliqXTRI_4	The interaction term between TRI and the fourth quintile of liquidity ratio	
_IliqXTRI_5	The interaction term between TRI and the fifth quintile of liquidity ratio	

Table A.3: Regression summary

Obs	ll(null)	ll(model)	df	AIC	BIC
37290	.	55243.42	123	-110241	-109192

Table A.3.1: Regression summary for unit cost function

unit_cost	**Coef.**	**Robust Std. Err.**	**z**	**P>|z**
p1p2	-8.149423	2.835385	-2.87	0.004
US_p1p2_1	24.46253	2.931397	8.35	0.000
p1	4.853071	0.4078476	11.90	0.000
US_p1_1	-0.1949078	0.4981694	-0.39	0.696
p2	-0.3314073	0.2611095	-1.27	0.204
US_p2_1	0.6493516	0.3015489	2.15	0.031
p1out	15.83574	4.151428	3.81	0.000
US_p1out_1	0.9023613	4.372011	0.21	0.836
p2out	2.36E-09	9.14E-09	0.26	0.796
US_p2out_1	-3.92E-08	9.78E-09	-4.01	0.000
p1out2	-14.68251	15.33875	-0.96	0.338
US_p1outa1	43.10478	15.29067	2.82	0.005
p2out2	9.573277	21.50607	0.45	0.656
US_p2outa1	-49.85335	20.55275	-2.43	0.015
p1tkout	-35.56238	24.19367	-1.47	0.142
US_p1tko_1	-43.14893	23.35348	-1.85	0.065
p2tkout	10.98594	16.69517	0.66	0.511
US_p2tko_1	32.49185	15.8209	2.05	0.040
p1tk	-16.41503	7.454061	-2.20	0.028
US_p1tk_1	4.377992	7.571931	0.58	0.563
p2tk	-1.122045	5.296196	-0.21	0.832
US_p2tk_1	4.816133	5.379044	0.90	0.371
p1tk2	54.36086	12.07565	4.50	0.000
US_p1tk2_1	-0.3697598	11.58817	-0.03	0.975
p2tk2	-6.639873	12.58042	-0.53	0.598
US_p2tk2_1	-16.53758	12.23626	-1.35	0.177
p1tout	0.8652629	2.870765	0.30	0.763
US_p1tou_1	2.386446	2.848249	0.84	0.402
p2tout	0.7713326	4.921061	0.16	0.875
US_p2tou_1	-3.593992	4.933802	-0.73	0.466
p1t	-1.615815	1.183204	-1.37	0.172
US_p1t_1	-0.3609934	1.470964	-0.25	0.806
p2t	1.07065	0.654615	1.64	0.102
US_p2t_1	-0.8596292	0.60773	-1.41	0.157
p1t2	0.0244579	0.816789	0.03	0.976
US_p1t2_1	0.6585268	0.9139465	0.72	0.471
p2t2	-0.8126347	0.5139392	-1.58	0.114
US_p2t2_1	0.5733569	0.4924008	1.16	0.244
for	-0.1005862	0.0369207	-2.72	0.006

Table A.3.1: Regression summary for unit cost function (cont.)

unit_cost	Coef.	Robust Std. Err.	z	P>|z
TRI	0.0247918	0.0122941	2.02	0.044
TRI_scope	-0.0164641	0.014237	-1.16	0.248
TRI_scale	0.0232601	0.0386298	0.60	0.547
cap	-0.0093204	0.0035126	-2.65	0.008
liq	0.0015395	0.0003766	4.09	0.000
_Itk_XTRI_2	-0.006464	0.0001769	-36.53	0.000
_Itk_XTRI_3	-0.0080902	0.0004527	-17.87	0.000
_Itk_XTRI_4	-0.0084985	0.0009673	-8.79	0.000
_Itk_XTRI_5	-0.0128898	0.0012568	-10.26	0.000
_IcapXTRI_2	-0.0066853	0.0011337	-5.90	0.000
_IcapXTRI_3	-0.0113514	0.0013803	-8.22	0.000
_IcapXTRI_4	-0.016245	0.0036618	-4.44	0.000
_IcapXTRI_5	-0.0197837	0.010712	-1.85	0.065
_cons	0.381733	0.120733	3.16	0.002

Table A.3.2: Regression summary for unit profit function

unit_profit	Coef.	Robust Std. Err.	z	P>|z
p1p2	0.2644956	0.2952546	0.90	0.370
US_p1p2_1	20.69963	0.4105376	50.42	0.000
p1	0.136805	0.3435338	0.40	0.690
US_p1_1	-0.1922349	0.4025501	-0.48	0.633
p2	0.052104	0.1492562	0.35	0.727
US_p2_1	1.286214	0.163282	7.88	0.000
p1out	0.4244706	0.3253066	1.30	0.192
US_p1out_1	-5.292717	0.3669941	-14.42	0.000
p2out	-2.02E-09	1.05E-09	-1.92	0.054
US_p2out_1	2.77E-09	1.09E-09	2.53	0.011
p1out2	2.230549	0.7319479	3.05	0.002
US_p1outa1	6.365906	0.9976582	6.38	0.000
p2out2	-3.07981	1.139332	-2.70	0.007
US_p2outa1	30.36398	2.641516	11.49	0.000
p1tkout	-3.703523	1.697724	-2.18	0.029
US_p1tko_1	36.19009	1.763697	20.52	0.000
p2tkout	2.288251	1.178976	1.94	0.052
US_p2tko_1	-62.70284	1.338444	-46.85	0.000
p1tk	-1.153822	0.45553	-2.53	0.011
US_p1tk_1	8.890296	0.4657055	19.09	0.000
p2tk	0.7794666	0.4624824	1.69	0.092
US_p2tk_1	-8.547102	0.444712	-19.22	0.000
p1tk2	4.247192	1.726718	2.46	0.014
US_p1tk2_1	-47.26763	1.852335	-25.52	0.000
p2tk2	-2.280145	1.385329	-1.65	0.100
US_p2tk2_1	47.00412	1.351994	34.77	0.000
p1tout	-0.8660636	0.2514975	-3.44	0.001

Table A.3.2: Regression summary for unit profit function (cont.)

unit_profit	Coef.	Robust Std. Err.	z	P>|z
US_p1tou_1	3.39754	0.3425855	9.92	0.000
p2tout	2.099192	0.6188835	3.39	0.001
US_p2tou_1	2.872072	0.6440112	4.46	0.000
p1t	-0.5462823	0.778359	-0.70	0.483
US_p1t_1	-0.5933531	0.761021	-0.78	0.436
p2t	-0.0351799	0.47175	-0.07	0.941
US_p2t_1	-3.083046	0.4897438	-6.30	0.000
p1t2	0.1502552	0.4648142	0.32	0.746
US_p1t2_1	-0.0585198	0.4356476	-0.13	0.893
p2t2	-0.1990738	0.4111137	-0.48	0.628
US_p2t2_1	1.983416	0.4278517	4.64	0.000
for	0.0018474	0.0176549	0.10	0.917
TRI	-0.0129435	0.0046504	-2.78	0.005
TRI_scale	-0.0053887	0.0139844	-0.39	0.700
TRI_scope	0.0098098	0.0144927	0.68	0.498
cap	-0.0024415	0.0004524	-5.40	0.000
liq	0.0002586	0.0002619	0.99	0.323
_Itk_XTRI_2	-0.0000883	0.000087	-1.02	0.310
_Itk_XTRI_3	0.0011217	0.0000988	11.35	0.000
_Itk_XTRI_4	0.0040046	0.0002934	13.65	0.000
_Itk_XTRI_5	0.0097637	0.0013921	7.01	0.000
_IcapXTRI_2	0.0004508	0.0002509	1.80	0.072
_IcapXTRI_3	-0.0015943	0.0004916	-3.24	0.001
_IcapXTRI_4	-0.003569	0.000836	-4.27	0.000
_IcapXTRI_5	-0.0045595	0.0022112	-2.06	0.039
_IliqXTRI_2	0.0001089	0.0001617	0.67	0.501
_IliqXTRI_3	0.0007037	0.0002282	3.08	0.002
_IliqXTRI_4	0.0017397	0.0005364	3.24	0.001
_IliqXTRI_5	0.0043688	0.0016385	2.67	0.008
_cons	0.2347398	0.0457522	5.13	0.000
/sigma1_1	0.0199167	0.0130756	1.52	0.128
/sigma1_2	0.0019353	0.0008169	2.37	0.018
/sigma2_2	0.0090813	0.0009713	9.35	0.000

Appendix B Specification tests

Table B.1

H1: Alternative Model		**H0: Maintained Model**		
		The McFadden Model	The Translog Model	
			Cost function	Profit function
The McFadden Model		……..	Z = 61.54 (0.017) Reject H0	Z = 17.23 (0.736) Reject H0
The Translog Model	Cost function	z = 0.45 (0.001) Accept H0	……..	……
	Profit function	z = -4.47 (0.001) Reject H0	……..	……

Table B.2

	Maximized Log-Likelihood	AIC	BIC
The McFadden Model	55244.6	-110161	-108763
The Translog Model	-36573.6	73419.11	74578.71

Appendix C

The imputation of elasticity and semi-elasticity

The elasticity of total cost, total profit, and total revenue with respect to total fixed capital, respectively, can be imputed through the estimated marginal cost and marginal profit as follows:

$$\frac{d\ln C}{d\ln tk}=\frac{dC}{dtk}\times\frac{tk}{C}=\frac{dC}{dtk}\times\frac{1}{UC}=\frac{d\left(UC\times tk\right)}{dtk}\times\frac{1}{UC}$$
$$=\left(tk\times\frac{dUC}{dtk}+UC\right)\times\frac{1}{UC}=\frac{dUC}{dtk}\times\frac{tk}{UC}+1$$

$$\frac{d\ln \Pi}{d\ln tk}=\frac{d\Pi}{dtk}\times\frac{tk}{\Pi}=\frac{d\Pi}{dtk}\times\frac{1}{U\Pi}=\frac{d\left(U\Pi\times tk\right)}{dtk}\times\frac{1}{U\Pi}$$
$$=\left(tk\times\frac{dU\Pi}{dtk}+U\Pi\right)\times\frac{1}{U\Pi}=\frac{dU\Pi}{dtk}\times\frac{tk}{U\Pi}+1$$

$$\frac{d\ln TR}{d\ln tk}=\frac{dTR}{dtk}\times\frac{tk}{TR}=\frac{d\Pi}{dtk}\times\frac{1}{U\Pi}=\frac{d\left[\left(UC+U\Pi\right)\times tk\right]}{dtk}\times\frac{1}{UC+U\Pi}$$
$$=\left[tk\times\left(\frac{dUC}{dtk}+\frac{dU\Pi}{dtk}\right)+\left(UC+U\Pi\right)\right]\times\frac{1}{UC+U\Pi}$$ Th
$$=\left(\frac{dU\Pi}{dtk}+\frac{dU\Pi}{dtk}\right)\times\frac{tk}{UC+U\Pi}+1$$

e semi-elasticity of total cost, total profit, and total revenue with respect to total capital ratio, respectively, can be imputed through the estimated marginal cost and marginal profit as follows:

$$\frac{d\ln C}{dcap}=\frac{dC}{dcap}\times\frac{1}{C}=\frac{d\left(UC\times tk\right)}{dcap}\times\frac{1}{C}=\frac{dUC}{dcap}\times\frac{tk}{C}=\frac{dUC}{dcap}\times\frac{1}{UC}$$

$$\frac{d\ln \Pi}{dcap}=\frac{d\Pi}{dcap}\times\frac{1}{\Pi}=\frac{d\left(U\Pi\times tk\right)}{dcap}\times\frac{1}{\Pi}=\frac{dU\Pi}{dcap}\times\frac{tk}{\Pi}=\frac{dU\Pi}{dcap}\times\frac{1}{U\Pi}$$

$$\frac{d\ln TR}{dcap}=\frac{d(C+\Pi)}{dcap}\times\frac{1}{C}=\frac{d[(UC+U\Pi)\times tk]}{dcap}\times\frac{1}{C}$$
$$=\left[\frac{dUC}{dcap}+\frac{dU\Pi}{dcap}\right]\times\frac{tk}{C}=\left[\frac{dUC}{dcap}+\frac{dU\Pi}{dcap}\right]\times\frac{1}{UC}$$

The semi-elasticity of total cost, total profit, and total revenue with respect to liquidity ratio, respectively, can be imputed through the estimated marginal cost and marginal profit as follows:

$$\frac{d\ln C}{dliq}=\frac{dC}{dliq}\times\frac{1}{C}=\frac{d(UC\times tk)}{dliq}\times\frac{1}{C}=\frac{dUC}{dliq}\times\frac{tk}{C}=\frac{dUC}{dliq}\times\frac{1}{UC}$$

$$\frac{d\ln \Pi}{dliq}=\frac{d\Pi}{dliq}\times\frac{1}{\Pi}=\frac{d(U\Pi\times tk)}{dliq}\times\frac{1}{\Pi}=\frac{dU\Pi}{dliq}\times\frac{tk}{\Pi}=\frac{dU\Pi}{dliq}\times\frac{1}{U\Pi}$$

$$\frac{d\ln TR}{dliq}=\frac{d(C+\Pi)}{dliq}\times\frac{1}{C}=\frac{d[(UC+U\Pi)\times tk]}{dliq}\times\frac{1}{C}=\left[\frac{dUC}{dliq}+\frac{dU\Pi}{dliq}\right]\times\frac{tk}{C}$$
$$=\left[\frac{dUC}{dliq}+\frac{dU\Pi}{dliq}\right]\times\frac{1}{UC}$$

Notations:

C, Π, TR : Total cost, total profit, and total revenue, respectively

UC, $U\Pi$: Unit cost and unit profit, respectively

tk : Total fixed capital

cap : Total capital ratio

liq : Liquidity ratio

$\frac{d\ln C}{d\ln tk}, \frac{d\ln \Pi}{d\ln tk}, \frac{d\ln TR}{d\ln tk}$: The elasticities of total cots, total profit, and total revenue with respect to total fixed capital, respectively

$\frac{d\ln C}{dcap}, \frac{d\ln \Pi}{dcap}, \frac{d\ln TR}{dcap}$: The semi-elasticities of total cots, total profit, and total revenue with respect to total capital ratio, respectively

$\frac{d\ln C}{dliq}, \frac{d\ln \Pi}{dliq}, \frac{d\ln TR}{dliq}$: The semi-elasticities of total cots, total profit, and total revenue with respect to total capital ratio, respectively

$\frac{dUC}{dtk}, \frac{dU\Pi}{dtk}$: The estimated marginal unit cost and unit profit of total fixed capital

$\frac{dUC}{dcap}, \frac{dU\Pi}{dcap}$: The estimated marginal unit cost and unit profit of total capital ratio

$\frac{dUC}{dliq}, \frac{dU\Pi}{dliq}$: The estimated marginal unit cost and unit profit of liquidity ratio

Appendix D

The imputation of tax and profit function

$$\frac{C - C_0}{C_0} \times 100\% = \frac{UC \times tk - UC_0 \times tk_0}{UC_0 \times tk_0} \times 100\%$$

$$\frac{TR - TR_0}{TR_0} \times 100\% = \frac{(UC + U\Pi) \times tk - (UC_0 + U\Pi_0) \times tk_0}{(UC_0 + U\Pi_0) \times tk_0} \times 100\%$$

C, C_0: The total cost with and without trade barriers in banking services, respectively

Π, Π_0: The total profit with and without trade barriers in banking services, respectively

TR, TR_0: The total revenue with and without trade barriers in banking services, respectively

UC, UC_0: The unit cost with and without trade barriers in banking services, respectively

$U\Pi$, $U\Pi_0$: The unit profit with and without trade barriers in banking services, respectively

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