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MACRO-FINANCIAL LINKAGES IN EGYPT: A PANEL ANALYSIS OF ECONOMIC SHOCKS AND LOAN PORTFOLIO QUALITY

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Working Paper No. 798

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Abstract

This paper investigates macro-financial linkages in Egypt using two complementary methods, assessing the interaction between different macroeconomic aggregates and loan portfolio quality in a multivariate framework as well as through a panel vector autoregressive method that controls for bank-level characteristics. Using a panel of banks over 1993-2010, the authors find that a positive shock to capital inflows and growth in gross domestic product improves banks' loan portfolio quality, and that the effect is fairly similar in magnitude using the multivariate and panel vector autoregressive frameworks. In contrast, higher lending rates may lead to adverse selection problems and hence to a drop in portfolio quality. The paper also reports that a larger market share of foreign banks in the industry improves loan quality.

JEL Classification: C63; E44; G21; G28

Keywords: Macroeconomic Shocks; Banks; Loan Quality; Panel Vector Autoregression

ملخص

تبحث هذه الورقة الروابط المالية الكلية في مصر باستخدام طريقتين تكميليتين، وتقييم التفاعل بين المجاميع الاقتصادية الكلية المختلفة وجودة محفظة القروض في إطار متعدد المتغيرات، وكذلك من خلال مسح متجه الانحدار الذاتي الذي يتحكم في خصائص على مستوى البنك. باستخدام مسح من البنوك خلال 1993-2010، نجد أن هناك صدمة إيجابية لتدفقات رأس المال والنمو في الناتج المحلي الإجمالي والذى بدوره يحسن جودة قرض محفظة البنوك، وأن هناك تأثير مشابه إلى حد ما في الحجم باستخدام أطر الانحدار الذاتي متعدد المتغيرات. في المقابل، قد يؤدي ارتفاع أسعار الفائدة على القروض إلى مشاكل سوء الاختيار، وبالتالي إلى انخفاض في جودة المحفظة. تشير الورقة أيضا الى أن الحصة السوقية الأكبر من البنوك الأجنبية تؤدى الى تحسين نوعية القرض.

1. Introduction

The regular monitoring of loan quality is crucial to alert regulatory authorities on potential bank weaknesses and ensure financial system soundness in the context of macro-prudential regulation. Macroeconomic shocks can feed into banks' balance sheets through the credit risk transmission channel following deterioration in the credit quality of loan portfolios that can cause significant losses for banks and may even mark the onset of a banking crisis (Reinhart and Rogoff, 2010).

The determinants of bank loan portfolio quality are well documented in the literature using multivariate frameworks. A large body of research finds that bank loan portfolio quality can be explained by both macroeconomic conditions and other idiosyncratic features. Recent studies show that factors like borrower type (Bofondi and Ropele, 2011), loan category (Louzis, Vouldis and Metaxas, 2011), quality of institutions (Breuer, 2006), and form of banking organization (Salas and Saurina, 2002) are major determinants of credit risk. Further, the presence of second-round effects of the deterioration of banks' loans quality on the macro economy has also been investigated using the vector autoregressive (VAR) method (Hoggarth, Sorensen, and Zicchino, 2005; Dovern, Meier, and Vilsmeier, 2008; Marcucci and Quagliariello, 2008). Recently, the panel vector autoregression (PVAR) system was employed to account for specificities at the banking sector level in a cross-country framework and assess macro-financial linkages between credit markets and macroeconomic performance (Espinoza and Prasad, 2010; Nkusu, 2011).

In this paper, we build on the extant literature and analyze the transmission of macroeconomic shocks to the credit portfolios of banks as well as the presence of second-round feedback effects from loan portfolio quality to macroeconomic performance. We first examine the determinants of loan portfolio quality in a multivariate panel context using both static and dynamic models while controlling for bank-specific effects. We then assess macro-financial linkages using the PVAR model developed by Love and Zicchino (2006) that allows for endogeneity in our variables of interest and more importantly introduces fixed effects at the bank level to account for differences in bank activities or business models. Whereas prior studies using the PVAR method consider loan quality data that is aggregated at the industry level and do not control for individual bank characteristics, we include in the PVAR system both macroeconomic and bank-level variables, a procedure that, to our knowledge, has not been implemented in the literature yet.

To assess macro-financial vulnerabilities and the transmission of macroeconomic shocks to the banking sector, we use Egypt as an empirical fieldwork for different reasons. The banking sector in Egypt has historically been dominated by state banks, notwithstanding an on-going process of financial liberalization that began in the early 1990s and which led to a rising presence of foreign banks. Unlike state banks that generally direct lending to designated priority sectors in the economy as well as to politically connected or influential entities and individuals, foreign banks seek a more efficient allocation of funds and use more sophisticated credit risk management techniques compared to state-owned banks. They may also have greater incentives to monitor the performance of their credit portfolios compared to state banks that benefit from the explicit protection of the government. In addition to these unique structures, Egypt presents itself as an interesting case study for two other reasons. First, similar to other developing economies, the banking sector in Egypt is the main provider of credit and it thus plays a crucial role in funding the economy, given that its financial markets lack depth and breadth. Second, the advent of the Arab spring in January 25, 2011 has recently subjected the country to aggregate economic shocks that are likely to be persistent in the future, with possible negative repercussions on the main providers of credit in the economy. To better understand the effect of macroeconomic shocks on the banking sector and whether they are likely to further destabilize the economy, we investigate the strength of macro-financial linkages using a panel of banks over the eighteen-year period of 1993-2010 prior to the uprising.

Multivariate analyses suggest that macro-financial vulnerabilities in Egypt work their way to the banking sector through the credit channel and that larger shares in foreign bank assets have a favorable impact on bank loan portfolio quality. Also, capital inflows and GDP growth improve loan quality while lending rate shocks may lead to adverse selection problems and hence to a drop in portfolio quality. The results from the PVAR framework additionally indicate that shocks to the capital account and to GDP growth have the greatest impact on loan portfolio quality and they also have a larger explanatory power for loan reserves compared to other bank-level variables.

The rest of the paper is organized as follows. Section 2 reviews the theoretical and empirical literature on macro-financial linkages, focusing on the determinants of loan portfolio quality and on second-round effects between banks' balance sheets and business cycles. Section 3 presents the data and methodology. Section 4 discusses the empirical results of the multivariate regressions and Section5 analyzes the PVAR findings. Section 6 concludes.

2. Literature Review

The interaction between macroeconomic performance and the banking sector is well documented in the theoretical literature on financial stability. Banks are vulnerable to external shocks because they finance illiquid assets with liquid liabilities (Diamond and Rajan, 2001) and such fundamental shocks are the main driver of financial crises as in Allen and Gale's (2004) general equilibrium framework. Allen and Gale (1998) also support the business cycle view of bank instability and propose that economic agents observe a leading economic indicator that correlates with future asset returns. With the unfolding of economic recessions, the value of bank assets is reduced and the value of the collateral that is pledged by borrowers may also be impaired, thereby increasing the likelihood of a banking crisis (Gorton, 1988).

The empirical literature similarly provides evidence on the linkages between business cycles and performance in banking. In a booming economy, revenues of households and businesses improve and increase the ability to service debt payments. In their quest to increase market share during a boom, banks extend their lending activities often reaching out for lower credit quality borrowers. However, the extension of credit to subprime borrowers inevitably increases nonperforming loans (NPLs) when a recession subsides and asset prices fall (Carey, 1998). Thus, macroeconomic shocks are inevitably transmitted to banks' balance sheets through a worsening of their credit portfolio.

To examine the macroeconomic determinants of credit risk, studies generally use different proxies of loan quality, including loan loss provisions, NPLs, and loan write-offs. Among the earlier research, Keeton and Morris (1987) find that loan losses in the U.S. reflect adverse local economic conditions and poor performance of certain industries.[1] Pesola's (2001, 2007) results indicate that loan losses from the banking crises in Nordic and other European countries stem from the high exposure of banks to strong adverse aggregate shocks, and Berge and Boye (2007)

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[1] Research by Berger and DeYoung (1997) and Podpiera and Weill (2008) attributes problem loans to bank-specific factors in that a worsening in banks' cost efficiency increases nonperforming loans.

report that problem loans for these countries are highly sensitive to real interest rates and unemployment. Rinaldi and Sanchis-Arellano (2006) argue that household NPLs in Indonesia depend on a set of macro fundamentals, among which are current income, the unemployment rate, and monetary conditions. Nkusu (2011) also confirms that adverse macroeconomic shocks associate with rising NPLs across a sample of 26 industrialized economies.

Instead of considering only macroeconomic factors, Clair (1992) and González-Hermosillo, Pazarbasioglu, and Billings (1997) use both macroeconomic and bank-specific variables to explain NPLs. More recently, Quagliariello (2007) finds that the quality of loans at Italian banks follows a cyclical pattern related to the evolution of business cycles and that it also depends on bank-specific factors. Similarly, Espinoza and Prasad (2010) report that NPLs deteriorate across banks in the Gulf Cooperation Council (GCC) countries as economic growth slows and interest rates increase, but also in conjunction with other firm-specific factors related to risk-taking.

Additionally, a growing trend in the literature attributes loan quality not only to macroeconomic and bank-specific factors, but also to other idiosyncratic aspects such as the type of borrower, loan category, institutions' quality, and form of banking organization. Bofondi and Ropele (2011) analyze the quality of loans to households and businesses separately, under the assumption that these two classes of borrowers may respond differently to macroeconomic variables. They find that the ratio of new bad loans to the outstanding amount of loans in the previous period at Italian banks can be explained by the general state of the economy, the cost of borrowing, and the burden of debt, albeit with a lag that differs for households and firms. Louzis, Vouldis, and Metaxas (2011) investigate the determinants of NPLs separately for different loan categories (consumer loans, business loans and mortgages) in the Greek banking sector and document that both macroeconomic fundamentals and management quality matter for loan quality, with mortgage NPLs being the least responsive to macroeconomic shocks. Breuer (2006) considers that a variety of institutions may determine NPLs on the grounds that legal, political, sociological, economic, and banking institutions may affect bank activities and thus the quality of loans. Salas and Saurina (2002) confirm the relevance of the institutional form of financial intermediation in the management of credit risk in Spanish banking. They document the presence of significant differences in the determinants of NPLs between commercial and savings banks and that, among others, variables like GDP growth, leverage, past credit growth, portfolio composition, and size explain credit risk. In this paper, when investigating the determinants of loan portfolio quality, we additionally account for a structure that is unique to a country like Egypt which is state ownership or control of bank assets. We examine its effect on the quality of bank loans by including the market share in assets of foreign and state banks as additional determinants of loan portfolio quality,

In parallel, another strand in the literature assumes that there are second-round effects between banks' balance sheets and business cycles. Using the vector autoregressive (VAR) methodology to account for feedback effects of the deterioration of banks' loan quality on the macro economy, a body of literature relaxes the strict assumption of exogenous macro fundamentals in relation to problem loans. In a VAR system, all variables are endogenously determined, and the method allows for the implementation of multiple shock scenarios that capture the interactions between bank and macro variables. Hoggarth, Sorensen, and Zicchino (2005) use the VAR methodology to conduct a stress test for UK banks, evaluating the dynamics between the ratio of write-offs to loans and other key macroeconomic variables. The authors find a significant and negative relationship between changes in the output gap and the financial stress indicator, and that write-offs rise following increases in inflation and nominal interest rates. Similarly, Gambera (2000) reports that state and nationwide macroeconomic variables affect different types of loans in the U.S., and Bacouček and Jančar (2005) find evidence of positive correlation between nonperforming loans and the rates of unemployment and inflation in the Czech banking sector. Marcucci and Quagliariello (2008) implement a VAR system at Italian banks and confirm the presence of cyclicality in borrowers' default rates, which drop in good macroeconomic times and rise in bad times. The authors also document that bank capital serves as a feedback channel from the banking sector to the macro economy. Filosa (2007) similarly estimates different VAR specifications for Italian banks but finds weaker evidence on the cyclicality between macroeconomic developments and bank soundness indicators. Dovern, Meier, and Vilsmeier (2008) use the same method to account for cyclicality between the German banking system and macroeconomic developments over a 36-year time period, reporting that monetary policy shocks strongly feed into the banking sector.

In this paper, we implement a PVAR instead of a traditional VAR. Two other studies have investigated macro-financial linkages using a PVAR system. Espinoza and Prasad (2010) examine the feedback effects of increasing industry NPLs on the economy using a PVAR on a panel of countries in the GCC region and find a strong but short-lived feedback effect from losses in banking sector balance sheets to non-oil growth. Nkusu (2011) similarly uses a PVAR method on a large panel of advanced economies and document long-lived linkages between credit market frictions and macroeconomic performance. Both of these papers, however, consider the aggregate volume of NPLs in the PVAR system and do not account for bank-specific effects when assessing macro-financial vulnerabilities. We propose to include in the PVAR framework bank-level indicators of loan portfolio quality among other firm-level variables, estimating the model with bank fixed effects and thereby accounting for differences in bank activities or business models.

3. Data and Methodology

3.1 Data

We retrieve firm-level annual financial data on all banks operating in Egypt for an 18-year period extending between 1993 and 2010 from the Bankscope database provided by Bureau Van Dijk. We compare bank names from Bankscope with the official list of banks provided by the Central Bank of Egypt and classify financial institutions based on their ownership status: state, domestic private (non-state), and foreign.[2] We also collect macroeconomic data on Egypt for the same period from a variety of sources, including the International Financial Statistics database, the World Bank Indicators, and the Central Bank of Egypt.

Our main variable of interest, loan portfolio quality, is usually proxied in the literature by the ratio of impaired or nonperforming loans to total loans; however, this variable is missing for most banks in Egypt. We use instead the ratio of reserves for impaired loans to total loans, which banks disclose more frequently across all years. After deleting records for which data on our key

[2] There are three state commercial banks in Egypt (Banque du Caire SAE, Banque Misr SAE, and National Bank of Egypt) and three specialized state banks (Egyptian Arab Land Bank, Industrial Development & Workers Bank of Egypt, and Principal Bank for Development and Agricultural Credit). An additional commercial bank used to be state-owned (Bank of Alexandria), but it was privatized in 2006 through a sale to a foreign bank.

variable of loan quality are missing, the original sample of 46 banks (a total of 828 bank-year observations) is reduced to 41 banks (a total of 586 bank-year observations).[3]

We briefly present some stylized facts about the dataset. Figure 1 depicts the size of the total banking sector between 1993 and 2010; Table 1 shows the market share in assets of commercial, Islamic, and specialized banks; and Table 2 shows the evolution of the market share of each category of bank ownership (state, domestic private, and foreign) over the 18-year study period.

Between 1993 and 2010, the total assets (loans) of the banking sector rose from $44.4 billion ($17.8 billion) to $188 billion ($73.5 billion), registering an annual increase of 8.35% (8.20%). Table 2 indicates that commercial banks have historically dominated banking activity in Egypt, whereas Islamic and specialized banks account for close to 5% of the market each. However, the ownership structure of the banking sector in Egypt witnessed considerable changes between 1993 and 2010. The market share of state banks decreased from 66.88% in 1993 to 51.30% in 2010, or an average of close to 1.5% per year. In contrast, foreign banks' penetration increased substantially from 5.08% in 1993 to 23.88% in 2010, or an average annual rate of close to 9%. The increase in foreign banks' market share over the past couple of decades reflects the results of financial sector liberalization efforts in line with the government's Economic Reform and Structural Adjustment Program. Over this period, the government's ownership in joint venture banks was privatized and a major state bank was also sold to foreign investors while strengthening the regulatory framework and introducing new prudential regulation. Nonetheless, the banking sector is still dominated by state banks in 2010, whereas foreign and domestic private banks have almost equal market shares.

Figures 2 and 3 show the increased role of foreign banks compared to state banks both in financing the domestic economy (share in market loans) and the government (share in Treasury bills), respectively.

Figure 4 graphs the portfolio composition of state and foreign banks and indicates that the latter allocate a larger share of their assets to loans compared to their peers.

Figures 5 and 6 illustrate the pattern of return on average equity and assets, respectively, over the study period for all banks, state banks, and foreign banks. Both indicators of profitability suggest that foreign banks are generally more profitable than their competitors.

Finally, Figure 7 presents the trend in the ratio of reserves for impaired loans to total loans (our loan quality variable) over the period 1993-2010 for all banks, state banks, and foreign banks. Prior to 2005, foreign banks provisioned more reserves in proportion to loans compared to state banks but as financial sector reform and bank privatization accelerated in Egypt, foreign banks' operations seem to have become more efficient. The trend in their ratio of reserves to loans is not only downward since 2005, but its level is also considerably lower than that of state banks, suggesting a better loan portfolio quality at foreign banks.

3.2 Methodology

Following the literature, we implement two complementary methods to assess macro-financial linkages in Egypt (Espinoza and Prasad, 2010; Nkusu, 2011). First, we check for persistence in the deterioration of loan quality following an aggregate shock using both static and dynamic multivariate specifications that investigate the determinants of loan quality. Then we implement

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[3] The current official list of banks includes 39 banks. The greater number of banks in the sample considers entry and exit into banking over the study period.

a PVAR to assess the extent to which macroeconomic shocks affect the banking sector, capturing feedback effects that may not be identified from the first-stage analysis.

3.2.1 Determinants of Loan Portfolio Quality

We use the following baseline multivariate panel data specification to investigate the determinants of loan portfolio quality for bank i in year t:

$$Reserves_{it} = \alpha Reserves_{it-1} + \sum_n \beta_n Mkt\_Share_{nt}$$
$$+ \sum_j \gamma_j MacroVar_{jt-1} + \sum_k \delta_k BankVar_{it-1} + \theta_i + \varepsilon_{it}, \qquad (1)$$

where $Reserves_{it}$ is the logarithmic transformation of the ratio of reserves for impaired loans to total loans and the regressor $Reserves_{it-1}$ captures persistence in loan quality over time.[4] When banks expect to incur more losses on their loan portfolio, their provisions for loan losses increase, thereby adding to the amount of reserves against which impaired loans can be charged off when these losses materialize. Thus, higher values of $Reserves_{it}$ indicate a worsening of the credit quality of the loan portfolio.[5]

Mkt_Share_{nt} comprises $n = 2$ variables, the market share in total assets of state ($MktShare\_State_t$) and foreign ($MktShare\_For_t$) banks in a given year t. We expect a larger foreign share in the banking sector to associate with lower reserves or a better loan portfolio quality, whereas a larger market share for state banks may lead to more loan portfolio manipulation, so that the sign on $MktShare\_State$ can be either positive or negative. $MacroVar_{jt-1}$ is a vector of j macroeconomic variables including the GDP growth rate ($GDPGr$), domestic credit to the private sector to GDP ($DomCred$), the aggregate lending rate ($LendRate$), the nominal effective exchange rate ($NEER$), and capital inflows ($CapInfl$). All of the $MacroVar_{jt-1}$ enter equation (1) with a lag to account for plausible delay with which macroeconomic shocks affect banks' credit portfolio.[6] Following the literature, we expect the sign on $GDPGr$ to be negative, on $DomCred$ to be positive, on $LendRate$ to be positive, and on $CapInfl$ to be negative, whereas the sign on $NEER$ may be either positive or negative.

We include k bank-level variables ($BankVar_{it-1}$) in equation (1), all of which are also lagged for one period. The choice of the bank-level variables follows the literature; it accounts for loan portfolio composition, the rate of credit growth, and incentives to take riskier loans (e.g., Salas and Saurina, 2002; and Quagliariello, 2007). Loan portfolio composition as given by the ratio of loans to assets (LTA) reflects the choices by bank managers for riskier investments compared to holding government securities, and which may affect loan quality. A higher proportion of assets allocated to loans increases credit risk exposure at banks and may result in more problem loans. We therefore expect the sign on LTA to be positive.[7] Also, a bank in favor of rapid loan growth

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[4] The ratio of reserves for impaired loans to total loans is bound by zero and one; we use its logarithmic transformation so that it spans a wider interval over $]-\infty; +\infty[$ (see Salas and Saurina, 2002; Quagliariello, 2007; and Espinoza and Prasad, 2010).

[5] We acknowledge that reserves are a measure of banks' perceived quality of their loan portfolio and not losses per se and that they might even be used by the bank's manager to smooth income. However, we use it as a proxy of loan portfolio quality because banks in Egypt do not report nonperforming loans or other measures of loan losses.

[6] Since the time span of the dataset is relatively short and mindful of the limited degrees of freedom, a one-lag is used. We check the validity of the lag selection using the Akaike and Schwartz information criteria.

[7] Ideally, a decomposition of the loan portfolio into consumer, business, and real estate loans (as well as the presence of collateral) would have provided a more accurate representation of the risk taking of managers.

$(LoanGR)$ is likely to be negatively affected by adverse selection, which might reduce its asset quality. We expect the sign on LGR to be positive, since higher growth rates may increase credit risk and consequently more reserves would be provisioned. Another factor that may affect the quality of credit policies is the incentive to take on riskier loans. Since the charter value of banks increases with more profitability, higher return on average equity $(ROAE)$ is likely to curb bank risk-taking and improve the incentives to monitor the performance of the credit portfolio. Therefore, we expect that better profitability will improve loan quality, implying that $ROAE$ will negatively associate with $Reserves$. α, β_n, γ_j, and δ_k are parameters to be estimated, θ_i captures unobserved bank-specific effects, and ε_{it} is the random error term.

We address concerns about the presence of unit roots in the series by conducting panel unit root tests that do not require a balanced sample to avoid reducing the time span of our sample. Table 3 presents the results of the Fisher Augmented Dickey-Fuller (ADF) and Fisher Phillips-Perron (PP) tests of unit roots, where the null hypothesis is that all series are non-stationary and the alternative hypothesis is that at least one of the series in the panel is stationary.

The Fisher ADF tests reject the presence of unit roots for most variables in levels, while the Fisher PP tests fail to reject the null hypothesis for four variables. We consider all variables as stationary based on the ADF test results and include them in levels in equation (1), except for the lending rate $(LendRate)$ and capital inflows $(CapInfl)$ that we include in differences.

We estimate equation (1) using both static and dynamic specifications. We first fit a bank-specific random effects model and we also account for the persistence in $Reserves$ or deterioration in loan quality using a dynamic panel approach (e.g., Salas and Saurina, 2002; Espinoza and Prasad, 2010; Louzis, Vouldis, and Metaxas, 2011; and Nkusu, 2011). We implement the Arellano and Bond (1991) one-step Generalized Method of Moments (GMM) estimator as well as the system estimator developed by Blundell and Bond (1988) that builds on the work of Arellano and Bover (1995).[8] In dynamic GMM estimation, equation (1) is first-differenced to eliminate individual effects and avoid estimation bias from an inconsistency in the estimates.[9] This procedure requires no second-order correlation in the differenced equation, notwithstanding first-order correlation in the error terms. The advantage of dynamic models is that they allow releasing the assumption of exogeneity of the regressors, which are instrumented with themselves, whereas the predetermined/endogenous variables as well as the dependent variable are instrumented using their lags.

3.2.2 Panel Vector Autoregression

To complement the multivariate analysis above and identify the transmission of macroeconomic shocks, we use a panel vector autoregression (PVAR) model developed by Love and Zicchino (2006). The advantage of the PVAR is that it accounts for individual bank specificity in the level of the variables by introducing fixed effects (μ_i), isolating the response of the bank credit channel to macroeconomic shocks while allowing for unobserved bank heterogeneity. It is written as:

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[8] The one-step GMM estimator generally tends to be less biased than the two-step estimator in small samples (Arellano and Bond, 1991).

[9] In the Arellano/Bond estimation, the model is only fitted in first differences, whereas the Blundell-Bond/Arellano-Bover is a system estimator that fits one equation in levels and another one in first differences. Time invariant regressors are omitted for the equation in first differences but they are still present in the equation in levels.

$$y_{it} = \mu_i + \Theta(L)y_{it} + \varepsilon_{it}, \quad (2)$$

where $\Theta(L)$ is the lag operator and y_{it} is a vector of macroeconomic and bank-level variables. To avoid obtaining biased coefficients that result from correlation between the fixed effects and the regressors, the Helmert procedure is used following Love and Zicchino (2006) to remove only the forward mean, i.e. the mean of all the future observations available for each bank-year. This procedure preserves the orthogonality between the transformed variables and the lagged regressors, making it possible to use lagged regressors as instruments and estimate equation (2) by system GMM (Arellano and Bover, 1995).

We use the Cholesky decomposition to identify orthogonal shocks in our variables of interest and examine their effect on the remaining variables in the system holding other shocks constant. To analyze the response of one variable to an orthogonal shock in another variable, we focus on impulse-response functions (IRFs) – i.e. the response of one variable to a shock in another variable. We generate confidence intervals for the orthogonolized IRFs with Monte Carlo simulations and identify the response to one shock at a time while holding other shocks constant.

Variables that enter first in equation (2) are assumed to be the most exogenous and hence affect subsequent variables both contemporaneously and with a lag, whereas variables that are ordered later are less exogenous and affect previous variables only with a lag. As a baseline specification, we consider a model that includes three macro variables and three bank-level variables. On the macro side we use the capital account $(CapInfl)$, GDP growth rate $(GDPGr)$ and the aggregate lending rate $(LendRate)$. The ordering of the variables in the PVAR is used in the estimation of impulse-responses. Thus, we assume in our baseline ordering that the original shock comes from the change in $CapInfl$. This shock has a contemporaneous impact on $GDPGr$, $LendRate$, and all bank-level variables. However, all other variables only impact the capital account with a lag. The shock to $GDPGr$ is assumed to have a contemporaneous impact on $LendRate$ and all bank variables, while it is affected by others with a lag.

For the bank-level variables and similar to the multivariate analysis, we use $LoanGr$, $Reserves$ (our proxy for loan quality), and $ROAE$. This ordering assumes that, on the bank level, the shock comes from loan growth, which affects loan reserves and profitability contemporaneously, while reserves and profitability affect loan growth only with a lag. However, because all macroeconomic variables are entered first in the system, they have an immediate impact on bank variables, while the feedback from bank-level variables on macroeconomic variables occurs only with a lag. This assumption is in line with the intuition that macro shocks are more likely to be transmitted to individual banking firms rather than for individual bank problems to be reflected in the macro aggregates.

4. Determinants of Loan Quality

4.1 Multivariate Results

In this section, we present the multivariate estimation results of equation (1) using random effects static models and GMM dynamic models. Since macroeconomic variables included in equation (1) are likely to be highly correlated with each other, we first compute the pairwise correlation among them and present the results in Table 4. Among all macro variables, $DomCred$ and $LendRate$ are strongly positively correlated with each other and we do not include them together in the same regressions.

Table 5 presents the estimation results of different random effects specifications of equation (1). The dependent variable in all specifications is the logistic transformation of the ratio of reserves for impaired loans to total loans. It is assumed that banks set aside more reserves when they expect more bad loans, so that higher values on $Reserves$ imply a worsening in the credit portfolio. Different models are estimated in each table as we gradually incorporate the considered $MacroVar_{jt-1}$, running each specification with and without $BankVar_{it-1}$. As expected, there is a strong persistence in the ratio of reserves to total loans across all models.

From the tables above, the sign of $MktShare\_For$ is negative and significant across all models, whereas the coefficient of $MktShare\_State$ is consistently insignificant. It seems that a larger market share of foreign banks in the industry associates with less reserves in proportion to total loans, improving the banks' loan portfolio quality. This effect is maintained when incorporating $BankVar_{t-1}$.

The results also suggest that most macroeconomic aggregates are significant determinants of loan portfolio quality for banks in Egypt. First, the coefficient on the growth rate in GDP is negative and significant across most models. A negative shock to GDP growth feeds into the credit channel through higher reserves and a worsening of the loan portfolio.

Second, the ratio of domestic credit to private sector to GDP positively associates with an increase in reserves in the following period, eventually feeding into a deterioration of loan quality. The significant positive effect of $DomCred_{t-1}$ on $Reserves$ is maintained across all specifications. It could be that banks loosen their lending policies as credit becomes more available, seeking a larger market share to increase future profits.

Third, a rise in the lending rate increases loan reserves in the following period, notwithstanding non-significant positive coefficients when bank-level variables are considered. A positive relationship between the lending rate and the amount of reserves at banks supports the moral hazard incentives of borrowers to take on more risk and try to meet higher interest payments, thereby increasing the risk of default. This effect, however, becomes subdued when adding $BankVar_{t-1}$.

Fourth, the different estimations do not capture the effect of a currency appreciation/ depreciation on loan quality, probably because the Egyptian pound was managed in the early part of the study period and it was allowed to freely float at a later stage.

Fifth, an increase in capital inflows reduces loan reserves significantly, thereby signaling an improvement in loan portfolio quality, and this effect does not disappear once we account for bank-level characteristics.

We also analyze the economic effect of an aggregate macroeconomic shock of a one-standard deviation in magnitude on loan portfolio quality using the median (11.3%) and the 90th percentile (22.2%) of the ratio of reserves for impaired loans to total loans. We choose different initial values of this ratio because of its non-linearity, which suggests that banks with worse loan credit quality will be affected differently by a macroeconomic shock than banks with better loan portfolio quality (Espinoza and Prasad, 2010).

To illustrate, given a one standard deviation reduction in $GDPGr$ (or 1.33%) and using the largest impact of this macroeconomic variable on $Reserves$ in absolute value (given by the coefficient 0.048 in Model 1 of Table 5), the ratio of reserves for impaired loans to total loans would increase between 0.66% and 1.12% depending on the initial level of the loan quality variable.[10] Using the highest coefficient on $DomCred$ (or 0.01 in Model 5), a similar analysis shows that when the ratio of domestic credit to GDP is shocked by a one standard deviation unit of 10.6%, the ratio of reserves for impaired loans to total loans rises between 1.11% and 1.88% depending on its initial value (i.e. the median or 90th percentile of this ratio). Also, a 167 basis points increase in the lending rate (a one standard deviation change in the lending rate) results in an increase in the ratio of reserves for impaired loans to total loans between 1.35% and 2.30%; the effect of a one standard deviation unit increase in $NEER$ (a currency appreciation) results in 0.89% to 1.52% increase in reserves, albeit the effect is generally statistically insignificant; and capital outflows $2.49 billion (a one-standard deviation unit in the capital account series) lead to a rise in the ratio of reserves for impaired loans to total loans between 0.59% and 1%. Thus, it seems from the interpretation of the economic significance of the coefficients that, among all macroeconomic shocks, an increase in the lending rate may have the greatest effect on the worsening of the loan portfolio quality in Egypt.

At the bank-level, bank profitability (and to a lesser degree loan portfolio composition) is a significant determinant of credit quality with the expected sign, whereas the growth rate of loans is generally insignificant. A higher return on average equity reduces reserves in the next period, leading to an improvement in loan portfolio quality. As a bank becomes more profitable, its charter value increases, implying that it would have a lot to lose in case of bankruptcy. In this case, managers have greater incentives to monitor loan portfolios and reduce adverse selection problems. Alternatively, a decrease in profitability may bring about a change in credit policies that become riskier because banks have less at stake if things turn bad, thereby resulting in a loan portfolio that has a higher future default probability.

4.2 Robustness

We estimate equation (1) using the one-step dynamic GMM system estimator of Arellano-Bover/ Blondell-Bond and report the results in Table 6.[11,12]

The figures shown in Table 6 indicate that all the previous results are maintained, notwithstanding a higher significance for the ratio of loans to assets. As portfolio composition gears towards more loans, the credit risk exposure rises and the bank consequently needs to set aside more reserves in anticipation of greater future loan losses.

We also replace Mkt_Share_{nt} or the market share in assets of state and foreign banks in a given year in equation (1) with a vector $BankOwn_{in}$ of two dummy variables, $State$ and $Foreign$, that designate state and foreign banks, respectively, and run both the random effects and dynamic models. The results (not reported) are qualitatively unchanged.

Finally, we address the issue of parameter stability as the exchange rate regime in Egypt changed in 2003 when the monetary authorities adopted a more flexible exchange rate, moving from a

[10] The logistic transformation of an initial value of the ratio of reserves for impaired loans to total loans that is equal to the median (90th percentile) or 11.3% (22.2%) is -2.06 (-1.25). If these values are augmented by -0.048*1.33%, then the new level for the ratio of reserves for impaired loans to total loans will be 11.96% (23.32%), registering an increase in this ratio or alternatively a worsening in loan quality of 0.66% (1.12%).

[11] Additional estimations are conducted using the one-step dynamic GMM Arellano and Bond (1991) estimator. The results (not reported) are qualitatively unchanged.

[12] The results of the diagnostic tests AR(1) and AR(2) appearing in Table 6 meet the requirements of rejecting no first order serial correlation and failing to reject no second order serial correlation in first-differenced errors.

pegged system to a managed float.[13] It is expected that the monetary regime will gain a greater margin of flexibility under a managed float compared to a pegged system, responding more efficiently to the mounting pressures of an exchange rate appreciation and improving the transmission of changes in monetary aggregates to banks' balance sheets. We divide our sample into two sub-periods and run the random effects and dynamic regressions separately for each sub-sample, pre and post 2003. While our previous findings (not reported) are generally maintained, we still do not report a significant effect of an exchange rate appreciation on banks' credit portfolio quality. However, we acknowledge that we are not able to capture the effect of an exchange rate appreciation due to the reduced sample size in each sub-period and we try instead to capture the effect of an exchange rate appreciation by including in our full sample a dummy variable for the period post the managed float. Table 7 shows the results.

Similar to previous robustness tests, our results are maintained, but we are now able to capture the effect of a currency appreciation on banks' loan portfolio quality whereas it was previously pervasively insignificant. When the currency moved into a managed float, a positive association ensued between a currency appreciation and loan reserves, indicating a worsening the credit portfolio of banks. As predicted, the monetary aggregates are reflected in banks' balance sheet in a more flexible manner post 2003 compared to the previously pegged regime, thereby putting less pressure on the country's foreign exchange reserves.

5. PVAR Framework

5.1 Discussion of Results

In this section, we build a model that combines macroeconomic variables and bank-level variables in a PVAR framework. The key focus is to explore how various macroeconomic shocks affect bank-level variables. The VAR framework allows for all variables in the system to affect each other. In other words, it simultaneously takes into account all possible interactions between the variables in the model.

The ordering of variables in the baseline PVAR specification considers three macroeconomic aggregates ($CapInfl$, $GDPGr$, and $LendRate$), and three bank-level variables ($LoanGr$, $Reserves$ – our proxy for loan quality, and $ROAE$).[14] Table 8 displays descriptive statistics on the key variables entering the PVAR model; Table 9 presents the estimation results of the system GMM coefficients of the baseline PVAR – most of which are significant; Table 10 shows the details of the impulse-response magnitudes; and Figure 8 graphs the corresponding impulse-response functions.

We focus our discussion on the impulse-response functions results of macroeconomic shocks that are reported in Figure 8, and which take into account contemporaneous as well as lagged responses.

Among the macroeconomic variables (the top left 3x3 graphs of Figure 8), GDP growth responds positively to a capital account shock (the response lasts 1-3 years), while lending rates decline significantly for most periods in response to a capital account shock. Both of these results are

[13] We thank an anonymous referee for pointing our attention to the issue of parameter stability in light of the large size of our sample.

[14] We explore the robustness of our results to other orderings of the variables, always ordering macroeconomic variables first, because they are assumed to have a more direct (i.e. contemporaneous) impact on bank-level variables. The results (not reported but available from the authors upon request) appear to be fairly robust to changes in the ordering of variables.

expected and show a positive influence of capital inflows on the Egyptian economy. The lending rate declines in response to a positive GDP growth shock, while GDP growth responds negatively to a positive lending rate shock. Also, an increase in the lending rate results in a decline in capital inflows. These results are expected and show that contractionary macroeconomic policies (i.e. increased interest rates) negatively affect growth and discourage capital inflows.[15]

Several interesting patterns emerge from the interactions among the bank variables (the bottom right 3x3 graphs). We observe that reserves decline (i.e. loan quality improves) in response to a positive shock to profitability or loan growth, that loan growth increases in response to a positive shock to profitability, and that profitability increases in response to a positive shock in loan growth. As might be expected, we observe a slight decline in loan growth in response to an increase in reserves, albeit not significant. The results indicate a changing response of profitability to reserves over time. The immediate response is negative, meaning that an increase in reserves (i.e. a poorer loan quality) has an immediate negative response on profitability. However, the response turns to positive over time, suggesting that increased reserves have a positive long-term impact on profitability. This could be explained by the fact that a shock to reserves may lead to more prudent lending policies in the future years, which will eventually result in improved profitability. Alternatively, over provisioning for bad loans (which may turn out not as bad as expected) would also result in improved performance in the future. Finally, taking a "hit" today in terms of the higher reserves implies that there likely to be less need for write-offs (and hence higher profitability) in the future.

The bottom left 3x3 graphs of Figure 8 show impulse-response functions for bank level variables in response to shocks in macro variables. First, a positive shock to capital account results in higher loan growth, a drop in reserves (i.e. improvement in loan quality) and an increase in profitability, suggesting that capital inflows improve bank performance on all three dimensions (loan growth, loan quality and profitability). Second, a positive shock to GDP growth triggers a positive loan growth response, a negative response in reserves (i.e. improvement in portfolio quality), and a positive improvement in bank profitability that is only significant in period zero or at the time of the shock. Third, a lending rate increase has an immediate negative impact on profitability and results in higher reserves (i.e. lower portfolio quality) over time.

Additionally, we quantify the effect of a one standard deviation shock in each of the three macroeconomic fundamentals on bank reserves. The estimated magnitudes suggest that a one standard deviation shock to the capital account (which is equal to an increase of $2.490 billion USD in capital inflows from Table 8) translates to about 1.34% decline in reserve for impaired loans to total loans with maximum impact achieved in period one.[16] Also, a one standard deviation shock to GDP growth (which equals to 1.33% from Table 8) translates into about 1.06% decrease in reserves for impaired loans to total loans. Similarly, a one standard deviation

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[15] Among the macro-level responses, the only surprising result is the negative response of the capital account to a GDP growth shock.

[16] Note that *Reserves* in the model are used as a logistic transformation of the reserves ratio, which results in a more normal distribution. The untransformed variable has a mean of about 12% (as percent of total loans) and a standard deviation of 7.46%. We obtain the impact using the impulse response estimates in Table 10, observing that the maximum impact is -0.10 (in time 1), which translates to about 18% of one standard deviation in the transformed variable (mean-differenced standard deviation is equal to 0.56). Then we apply this percentage to the value of one standard deviation of the untransformed variable, which results in 1.34% (i.e. 18% of 7.46%).

shock to the lending rate (which equals to 1.67%) results in an increase in the reserves ratio of about 0.4%. Thus, changes to growth or capital flows result in over one percent increase in reserve provision, which is a significant change. Also, the magnitudes of the response to a one-standard deviation unit shock to GDP and to the capital account concur with the estimated impact in the previous section. The effect of a lending rate shock, however, is estimated to be higher using the multivariate framework as compared to the PVAR analysis.

The results also allow for assessing the effect of a macroeconomic shock on bank profitability. A one-standard deviation unit shock to the capital account results in 1.12% increase in ROE, a one standard deviation shock to GDP growth results in about 0.66% increase in ROE, and a one standard deviation shock to interest rate results in 0.88% decline in ROE.

Finally, we analyze the variance decomposition results that we report in Table 11 for the baseline PVAR model.

We observe that the capital account and GDP growth explain about 7.4% and 8.6% of the total variance in reserves, respectively, while the lending rate explains only about 2% of the total variance in credit quality. Loan growth has the largest explanatory power for reserves, explaining about 16% of total variance in reserves, while ROE explains about 7%.[17] Loan growth and reserves each explain about 8% of profitability variance, while macro variables have relatively small impacts on profitability (less than 2%). Macroeconomic variables have low explanatory power for loan growth as well, with capital account and GDP growth explaining about 3% each of loan growth, whereas the lending rate accounts for less than 1% of the variance. These calculations demonstrate that macro variables have a fairly large explanatory power for reserves, but a much smaller explanatory power for loan growth and profitability. Among the macroeconomic variables, capital account and lending rate explain about 3.5% of GDP growth each, while GDP growth has a larger influence on the lending rate (explaining about 9% of its variance).

5.2 Robustness

In this section we explore the robustness of our results to different ordering of the variables. Because we assume that macroeconomic shocks have more direct (i.e. contemporaneous) impact on bank-level variables, we always order macroeconomic variables first, before bank-level variables. Therefore, we only explore the changes in relative ordering among the macroeconomic and bank variables. We consider four changes to ordering, described below, the first two of them change the ordering of the macroeconomic variables and the last two change the ordering of the bank-level variables for the baseline and alternative macroeconomic ordering. The following discussion is based on the impulse response functions, since the coefficient estimates are unchanged with a change in ordering. The figures with impulse response functions are not reported to save space (they are available on request).

The first ordering considers GDP Growth, Capital Account, Lending Rate, Loan Growth, Reserves, and ROE. This model assumes that the initial shock comes from GDP growth, rather than capital inflows (since GDP growth is the first variable in the ordering). There are no material differences in the results of this model compared to the baseline model.

[17] The total variance is calculated over the 10-year period.

The second ordering accounts for the Lending Rate, GDP Growth, Capital Account, Loan Growth, Reserves, and ROE. This model assumes that the initial shock comes from the lending rate, presumably as a result of changes in the macro policy, which leads to changes in GDP growth and then to the capital account. Most of the results discussed above are the same, except for the following changes: the response of lending rate to GDP growth is not significant (it was significant before), and the response of lending rate to a shock to capital account is positive (it was marginally negative before). The bank-level variables exhibit mostly the same responses to macroeconomic level shocks, except that the response of reserves to lending rate is stronger (it was marginally significant before).

The third ordering considers Capital Account, GDP Growth, Lending Rate, ROE, Loan Growth, and Reserves. This model preserves the original ordering of the macroeconomic variables (as in the baseline model) but changes the ordering of the bank-level variables, putting the shock to profitability first in the ordering, followed by loan growth and finally reserves as the most endogenous variable. This ordering is plausible if the shock originates due to new technology, such as credit scoring, or better availability of credit information or improved efficiency. Because the macro variable ordering is unchanged, there are no changes in the results for macro variables, relative to baseline. In addition, there are no material changes in the responses of bank-level variables to any of the macroeconomic shocks.

The fourth ordering includes GDP Growth, Capital Account, Lending Rate, ROE, Loan Growth, and Reserves.

Finally, we consider the alternative macroeconomic variable ordering with GDP shock in the first place and the alternative bank-level ordering with ROE in the first place among the bank-level variables. We do not find any change in the response of either macroeconomic or bank-level variables relative to the baseline model.

To summarize, the responses of the macroeconomic-level variables to macroeconomic shocks and bank-level variables to macroeconomic shocks appear to be fairly robust to changes in the ordering of variables.

6. Conclusions

This paper investigates macro-financial linkages in Egypt, assessing the transmission of macroeconomic shocks on bank loan portfolio using two complementary methods, multivariate analyses as well as panel vector autoregressive framework.

The multivariate investigation indicates that a greater presence of foreign banks in the industry lowers reserves on loan portfolios, leading to lower overall credit risk. In this light, it is important to maintain the privatization efforts of the banking sector in Egypt while ensuring that an adequate macro-prudential regulatory framework is in place.

The results also reveal that a positive shock to capital inflows and to GDP growth results in favorable changes in all bank-level variables, whereas higher lending rates may lead to adverse selection problems and hence to a drop in portfolio quality. When quantifying the effects of macroeconomic shocks on reserves, we find that the magnitude of the change in loan portfolio quality in response to a surge in capital inflows and GDP growth is fairly similar using the multivariate and PVAR frameworks. Analyses of variance decomposition further suggest that macroeconomic variables have a fairly large explanatory power for reserves compared to other bank-level variables such as loan growth and profitability, with the capital account and GDP growth explaining more of the total variance in reserves compared to the lending rate.

To sum, our findings from both the multivariate and PVAR frameworks confirm that macroeconomic shocks in Egypt are transmitted to the banking sector through the credit channel. Capital inflows, which have significantly dropped in Egypt following the advent of the Arab uprising, are likely to have the most detrimental effect on loan portfolio quality among other macroeconomic aggregates. The results thus suggest that persistent negative shocks in the future to the capital account (as well as to GDP growth) are likely to adversely affect the soundness of the banking sector in the country and further destabilize the economy.

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Figure 1: Size of the Banking Sector, 1993-2010 (Figures in Million USD).

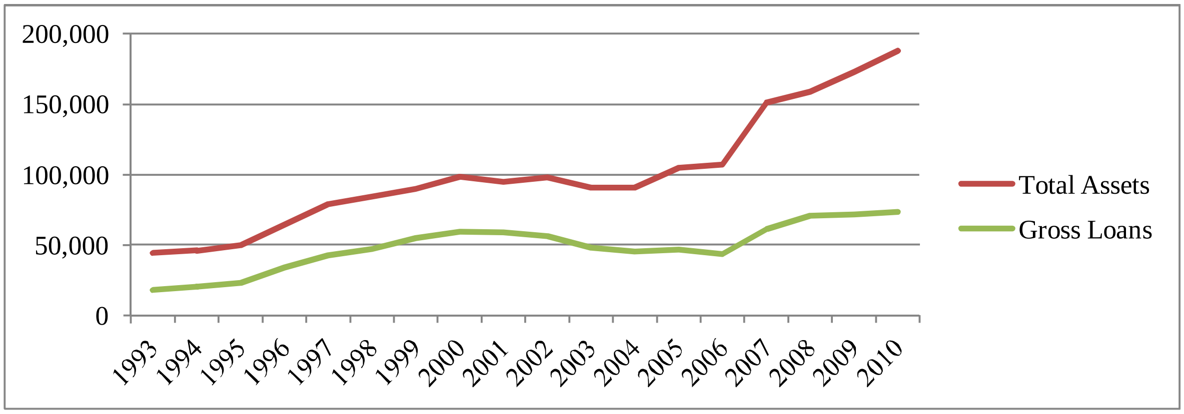


Figure 2: Market Share in Loans, State vs. Foreign Banks, 1993-2010

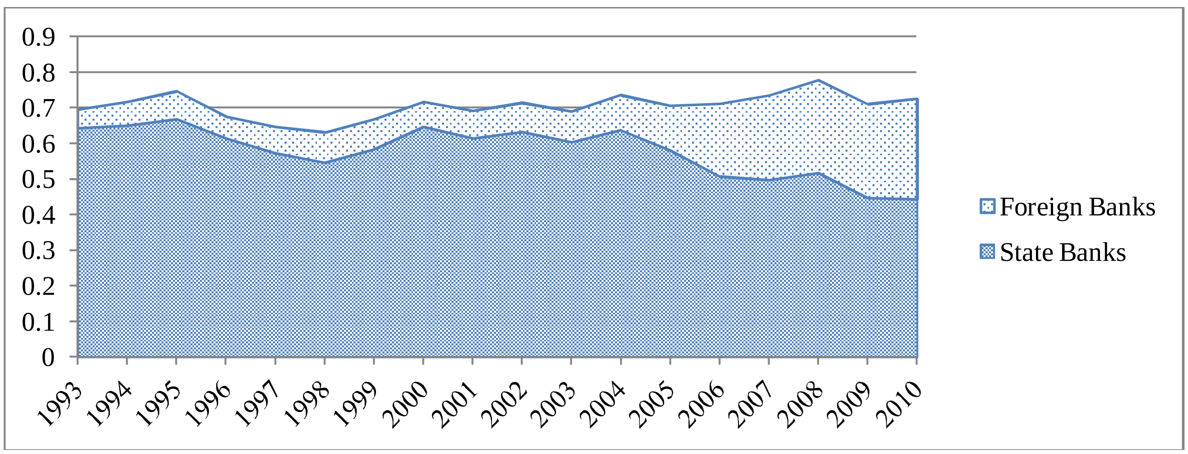


Figure 3: Market Share in Treasury Bills, State vs. Foreign Banks, 1993-2010

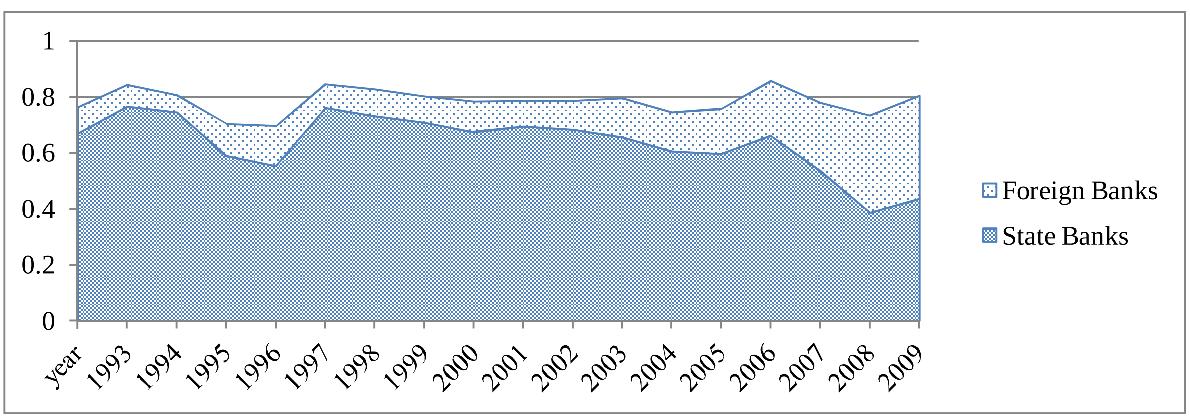
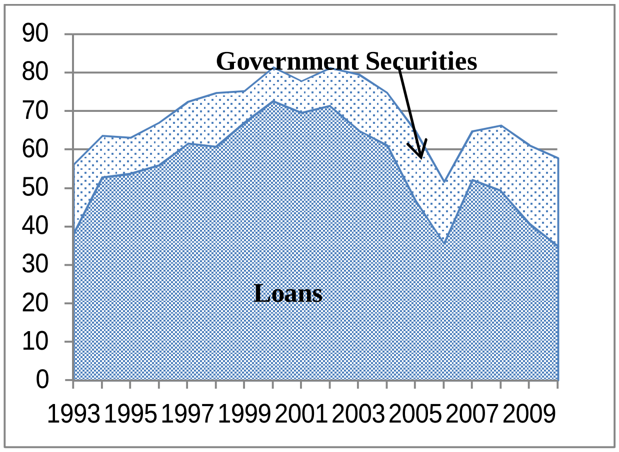


Figure 4: Portfolio Composition, State vs. Foreign Banks, 1993-2010

Panel A: State Banks



Panel B: Foreign Banks

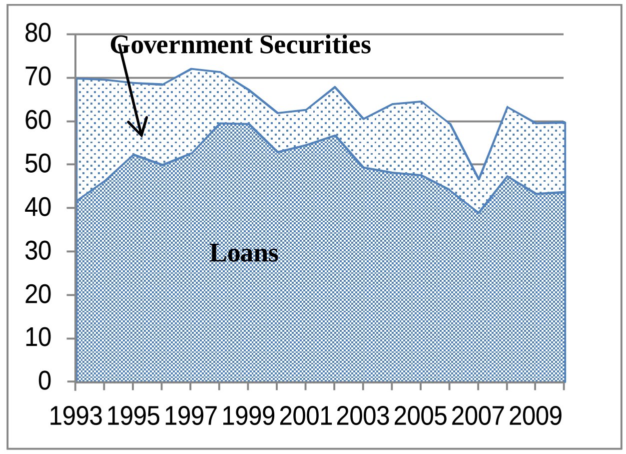


Figure 5: Return on Average Equity, State vs. Foreign Banks, 1993-2010

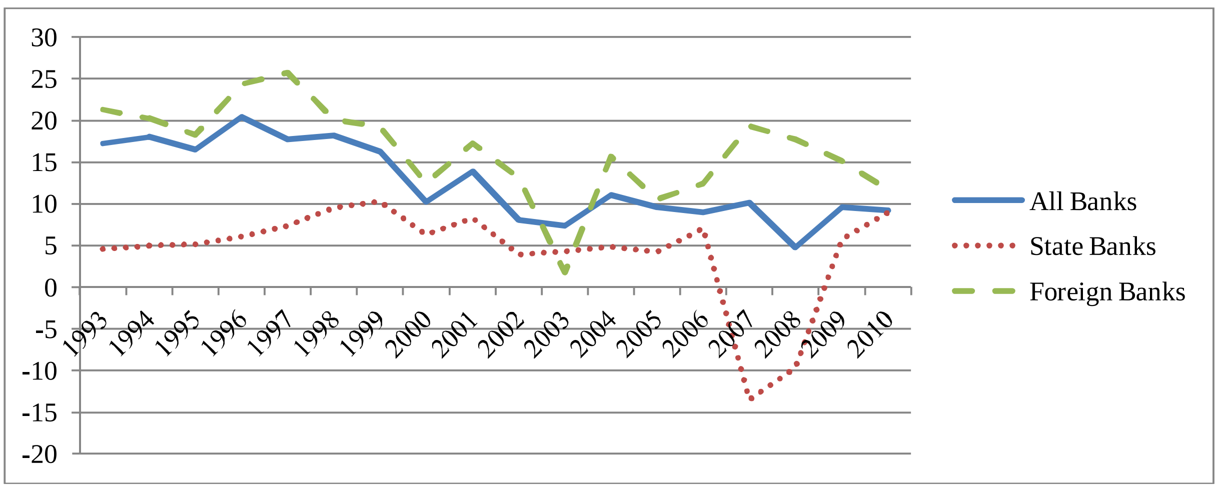


Figure 6: Return on Average Assets, State vs. Foreign Banks, 1993-2010

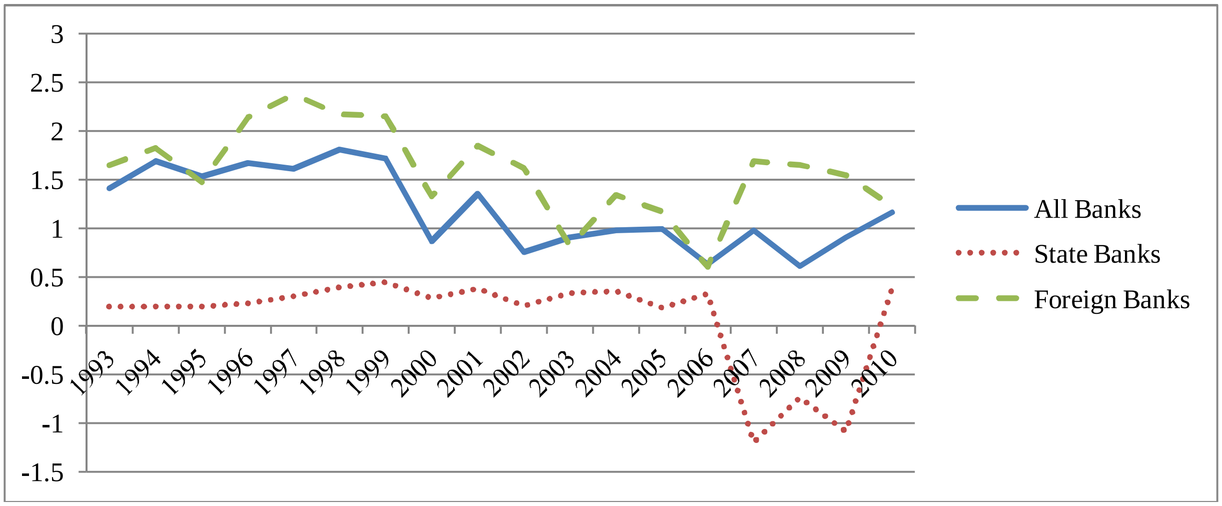


Figure 7: Reserves for Impaired Loans / Total Loans, State vs. Foreign Banks, 1993-2010

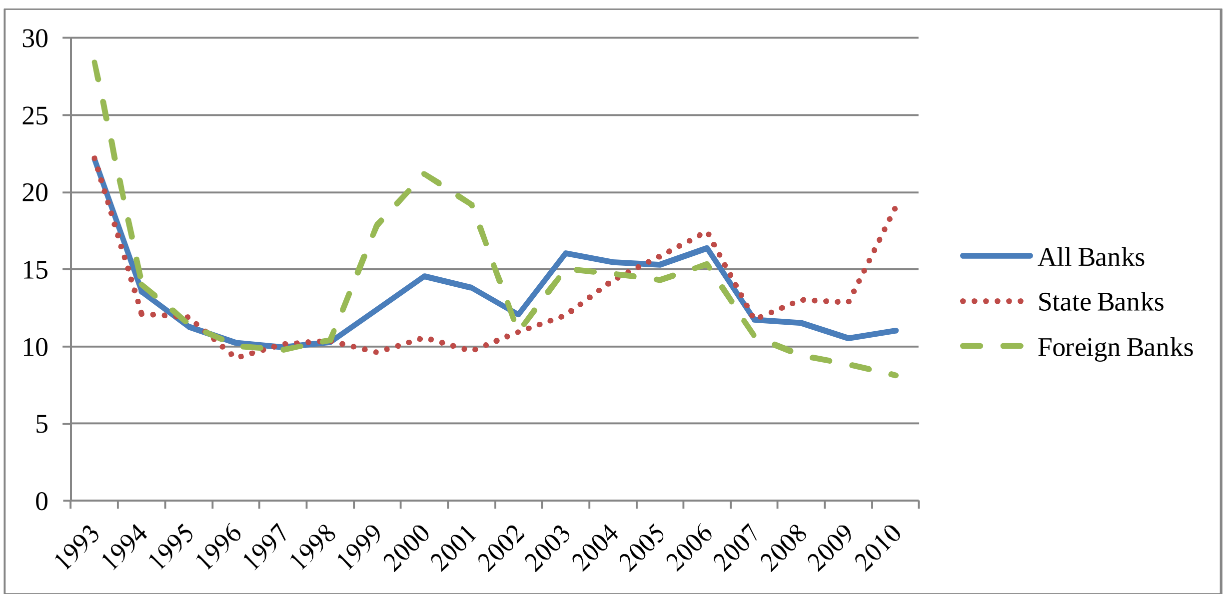


Figure 8: Impulse Response Functions to Shocks, PVAR Baseline Model

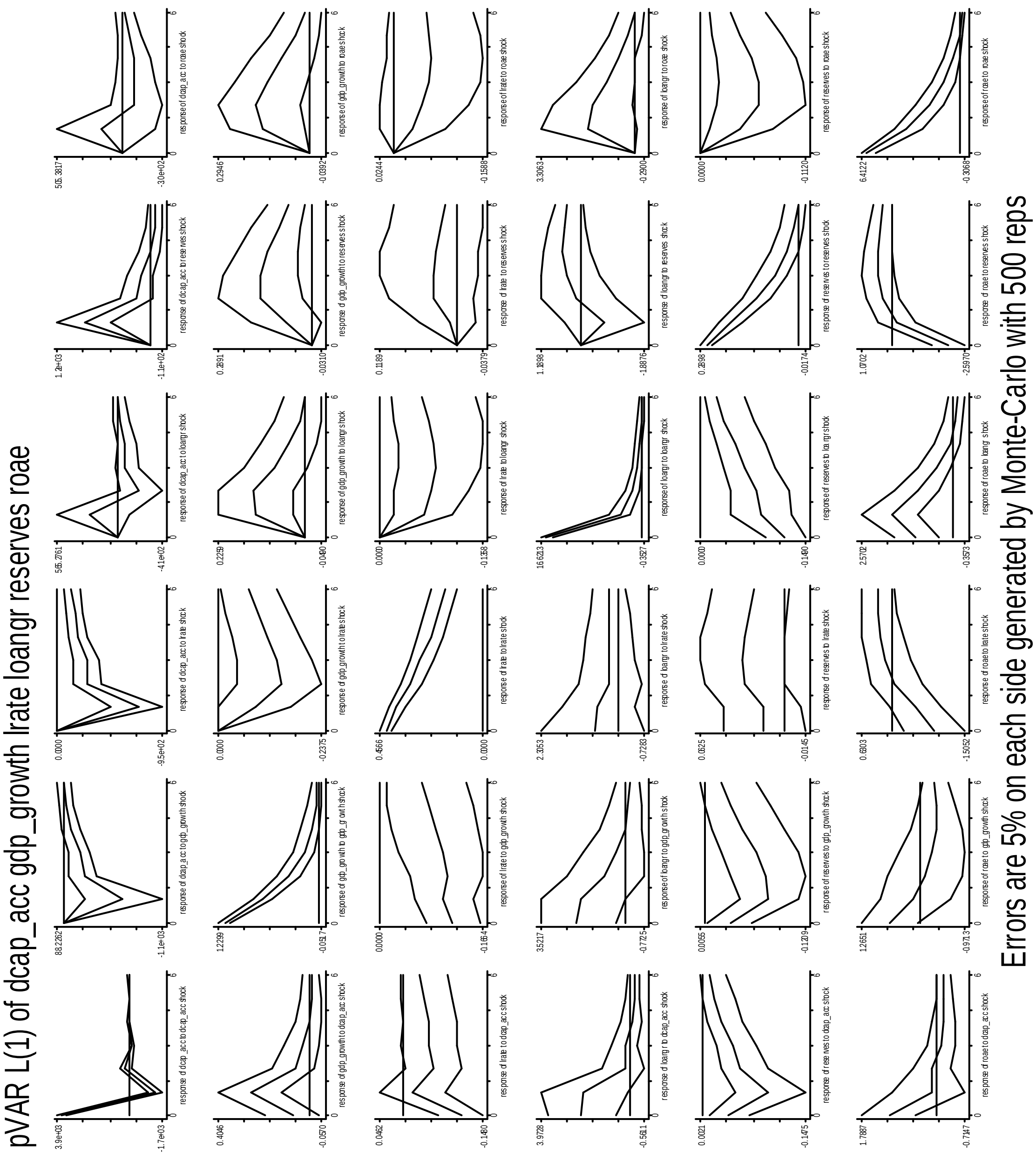


Table 1: Market Share in Assets of Commercial, Islamic, and Specialized Banks, 1993-2010

Year	Commercial Banks	Islamic Banks	Specialized Banks
1993	95.53	3.67	0.80
1994	93.52	4.50	1.98
1995	95.78	1.20	3.02
1996	90.41	4.35	5.24
1997	90.87	3.73	5.40
1998	90.05	3.90	6.05
1999	88.99	3.05	7.97
2000	85.98	2.75	11.26
2001	88.32	3.42	8.25
2002	85.51	3.48	11.01
2003	84.34	3.14	12.52
2004	86.15	3.56	10.29
2005	92.57	3.72	3.71
2006	93.39	4.39	2.22
2007	91.45	3.71	4.84
2008	90.06	1.19	8.74
2009	90.62	4.17	5.21
2010	90.70	4.20	5.10

Table 2: Market Share in Assets of State, Domestic, and Foreign Banks, 1993-2010

Year	State Banks			Domestic Private Banks				Foreign Banks		
	Commercial Banks	Specialized Banks	Total	Commercial Banks	Specialized Banks	Islamic Banks	Total	Commercial Banks	Islamic Banks	Total
1993	66.88	-	66.88	23.57	0.80	3.67	28.04	5.08	-	5.08
1994	66.00	1.03	67.02	20.92	0.96	4.50	26.37	6.60	-	6.60
1995	67.50	1.17	68.67	21.04	1.86	1.20	24.10	7.24	-	7.24
1996	61.72	1.21	62.92	22.94	4.03	3.88	30.85	5.75	0.47	6.22
1997	57.42	2.09	59.51	26.35	3.31	3.15	32.82	7.09	0.58	7.68
1998	56.98	2.48	59.46	25.81	3.57	3.30	32.69	7.26	0.59	7.86
1999	55.42	4.04	59.47	25.72	3.92	2.45	32.10	7.84	0.59	8.43
2000	55.49	7.49	62.98	23.23	3.78	2.24	29.24	7.26	0.52	7.78
2001	55.81	4.35	60.16	24.59	3.90	2.84	31.33	7.93	0.59	8.51
2002	55.42	7.22	62.64	22.30	3.79	2.85	28.94	7.79	0.63	8.42
2003	51.56	6.76	58.32	24.24	5.76	2.53	32.53	8.54	0.60	9.15
2004	54.33	6.50	60.83	22.26	3.79	2.76	28.80	9.56	0.81	10.37
2005	57.67	-	57.67	23.62	3.71	2.76	30.09	11.28	0.95	12.24
2006	52.75	-	52.75	21.77	2.22	3.17	27.17	18.86	1.21	20.08
2007	46.32	2.88	49.19	20.84	1.96	2.65	25.45	24.30	1.06	25.36
2008	49.21	6.80	56.00	18.36	1.95	-	20.30	22.50	1.19	23.70
2009	46.36	2.32	48.68	21.25	2.89	2.95	27.10	23.01	1.22	24.22
2010	48.22	3.08	51.30	19.87	2.02	2.92	24.82	22.60	1.28	23.88

Table 3: Fisher Panel Unit Root Tests

Variable		Augmented Dickey-Fuller		Phillips-Perron	
$Reserves$	Level	150.03	***	113.71	***
	Difference	226.22	***	401.89	***
$GDPGr$	Level	-2.21	**	-8.54	
	Difference	-2.54	**	-16.14	***
$DomCred$	Level	-2.19	**	-3.12	
	Difference	-2.42	**	-3.2	
$LendRate$	Level	-0.98		-3.71	*
	Difference	-1.79	**	-13.19	***
$NEER$	Level	-1.71	**	-2.01	
	Difference	-2.32	**	-8.09	
$CapInfl$	Level	-0.66		-7.79	
	Difference	3.31	***	-25.8	***
LTA	Level	189.65	***	102.46	*
	Difference	305.82	***	473.75	***
$ROAE$	Level	110.3	***	314.12	***
	Difference	152.59	***	668.33	***
$LoanGr$	Level	242.93	***	515.06	***
	Difference	509.17	***	1114.66	***

Notes: $Reserves$ is the ratio of reserves for impaired loans to total loans; $GDPGr$ is the growth rate in GDP; $DomCred$ is the ratio of domestic credit to private sector to GDP; $LendRate$ is the aggregate lending rate; $NEER$ is the nominal effective exchange rate; $CapInfl$ is capital inflows; LTA is the ratio of loans to total assets; $ROAE$ is the return on average equity; and $LoanGr$ is the growth in total loans. *, **, and *** denote significance at 10 percent, 5 percent, and 1 percent, respectively.

Table 4: Pairwise Correlation among Macroeconomic Variables

	GDPGr	LendRate	DomCred	NEER	CapInfl
$GDPGr$	1				
$LendRate$	-0.1351***	1			
$DomCred$	-0.1737***	0.6738***	1		
$NEER$	-0.3268***	0.1121**	0.3228***	1	
$CapInfl$	0.1004**	-0.1130***	-0.2555***	-0.2363***	1

Notes: $Reserves$ is the ratio of reserves for impaired loans to total loans; $GDPGr$ is the growth rate in GDP; $DomCred$ is the ratio of domestic credit to private sector to GDP; $LendRate$ is the aggregate lending rate; $NEER$ is the nominal effective exchange rate; $CapInfl$ is capital inflows; LTA is the ratio of loans to total assets; $ROAE$ is the return on average equity; and $LoanGr$ is the growth in total loans. $GDPGr$, $DomCred$, and $NEER$ are included in levels, and $LendRate$, $NEER$, and $CapInfl$ are included in differences. *, **, and *** denote significance at 10 percent, 5 percent, and 1 percent, respectively.

Table 5: Random Effects Estimation Results

	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6	Model 7	Model 8	Model 9	Model 10
$Reserves_{t-1}$	0.833	0.816	0.821	0.82	0.847	0.798	0.84	0.797	0.836	0.794
	(0.033)***	(0.045)***	(0.036)***	(0.045)***	(0.034)***	(0.055)***	(0.034)***	(0.054)***	(0.037)***	(0.054)***
$MktShare\ State_{t}$	0.000	-0.001	0.000	-0.001	0.000	-0.001	0.000	-0.001	0.000	-0.001
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
$MktShare\_F$	-0.008	-0.005	-0.008	-0.005	-0.008	-0.007	-0.008	-0.006	-0.006	-0.006
	(0.003)***	(0.003)*	(0.003)***	(0.003)*	(0.003)***	(0.003)**	(0.003)***	(0.003)**	(0.003)**	(0.004)*
$GDPGr_{t-1}$	-0.048	-0.013	-0.037	-0.007	-0.046	0.006	-0.039	-0.006	-0.039	0.003
	(0.013)***	(0.014)	(0.014)***	(0.014)	(0.024)*	(0.020)	(0.014)***	(0.015)	(0.024)*	(0.020)
$DomCred_{t-1}$			0.007	0.005					0.010	0.007
			(0.002)***	(0.002)**					(0.003)***	(0.003)**
$LendRate_{t-1}$					0.077	0.020	0.063	0.031		
					(0.026)***	(0.031)	(0.023)***	(0.023)		
$NEER_{t-1}$					0.003	-0.003			0.005	0.000
					(0.004)	(0.003)			(0.004)	(0.003)
$CapInfl_{t-1}$					-0.019	-0.023			-0.017	-0.021
					(0.008)**	(0.007)***			(0.007)**	(0.007)***
LTA_{t-1}		0.003		0.002		0.003		0.003		0.002
		(0.002)*		(0.002)		(0.002)		(0.002)		(0.002)
$ROAE_{t-1}$		-0.008		-0.007		-0.008		-0.008		-0.008
		(0.003)***		(0.003)***		(0.003)**		(0.003)**		(0.003)***
$LoanGr_{t-1}$		-0.018		-0.008		-0.016		-0.018		-0.01
		(0.016)		(0.017)		(0.014)		(0.015)		(0.017)
Observations	431	293	431	293	398	273	398	273	398	273
R-squared	0.7859	0.8269	0.7930	0.8324	0.7976	0.8314	0.7935	0.8524	0.8042	0.8375

Notes: The dependent variable is $Reserves$ or the logistic transformation of the ratio of reserves for impaired loans to total loans. $MktShare\_State$ and Mkt_Share_For represent the market share in assets of state and foreign banks, respectively, in a given year. $GDPGr$ is the growth rate in GDP; $DomCred$ is the ratio of domestic credit to private sector to GDP; $LendRate$ is the aggregate lending rate; $NEER$ is the nominal effective exchange rate; $CapInfl$ is capital inflows; LTA is the ratio of loans to total assets; $ROAE$ is the return on average equity; and $LoanGr$ is the growth in total loans. All variables are included in levels except for $LendRate$, $NEER$, and $CapInfl$ that are included in differences. A constant in included in all models but not reported. Robust standard errors appear in parentheses. *, **, and *** denote significance at 10 percent, 5 percent, and 1 percent, respectively.

Table 6: One-step Generalized Method of Moments Dynamic Estimation Results

	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6	Model 7	Model 8	Model 9	Model 10
$Reserves_{t-1}$	0.797	0.83	0.741	0.798	0.786	0.879	0.786	0.838	0.81	0.835
	(0.034)***	(0.044)***	(0.034)***	(0.040)***	(0.039)***	(0.046)***	(0.040)***	(0.051)***	(0.039)***	(0.049)***
$MktShare\_State_{t}$	-0.003	0.000	-0.005	-0.001	-0.003	0.001	0.000	0.002	-0.002	-0.002
	(0.002)	(0.002)	(0.002)**	(0.002)	(0.002)	(0.002)	(0.003)	(0.002)	(0.002)	(0.002)
$Mkt_{Share}\_For_{t}$	-0.011	-0.004	-0.014	-0.007	-0.013	-0.006	-0.013	-0.004	-0.009	-0.006
	(0.003)***	(0.004)	(0.004)***	(0.004)*	(0.005)***	(0.005)	(0.004)***	(0.004)	(0.004)**	(0.004)
$GDPGr_{t-1}$	-0.029	0.005	-0.023	0.003	-0.052	-0.005	-0.025	0.01	-0.041	0.012
	(0.010)***	(0.011)	(0.010)**	(0.010)	(0.015)***	(0.016)	(0.011)**	(0.011)	(0.014)***	(0.015)
$DomCred_{t-1}$			0.012	0.016	0.029	0.017				
			(0.004)***	(0.004)***	(0.007)***	(0.007)**				
$LendRate_{t-1}$							0.054	0.011	0.066	0.006
							(0.022)**	(0.023)	(0.023)***	(0.026)
$NEER_{t-1}$					0.006	0.004			-0.002	-0.002
					(0.003)**	(0.003)			(0.002)	(0.002)
$CapInfl_{t-1}$					-0.025	-0.036			-0.026	-0.035
					(0.007)***	(0.007)***			(0.007)***	(0.007)***
LTA_{t-1}		0.005		0.005		0.001		0.005		0.003
		(0.002)***		(0.002)***		(0.002)		(0.002)***		(0.002)
$ROAE_{t-1}$		-0.008		-0.004		-0.007		-0.01		-0.011
		(0.003)***		(0.003)		(0.003)**		(0.003)***		(0.003)***
$LoanGr_{t-1}$		-0.018		-0.003		-0.002		-0.008		-0.026
		(0.015)		(0.014)		(0.017)		(0.017)		(0.017)
Observations	431	293	431	293	398	273	398	273	398	273
AR(1) p-value	0.0006	0.0065	0.0006	0.0124	0.0014	0.0026	0.0007	0.0044	0.0017	0.0027
AR(2) p-value	0.9073	0.9244	0.9344	0.8222	0.8019	0.7194	0.8200	0.5148	0.7218	0.5821

Notes: The dependent variable is $Reserves$ or the logistic transformation of the ratio of reserves for impaired loans to total loans. $MktShare\_State$ and Mkt_Share_For represent the market share in assets of state and foreign banks, respectively, in a given year. $GDPGr$ is the growth rate in GDP; $DomCred$ is the ratio of domestic credit to private sector to GDP; $LendRate$ is the aggregate lending rate; $NEER$ is the nominal effective exchange rate; $CapInfl$ is capital inflows; LTA is the ratio of loans to total assets; $ROAE$ is the return on average equity; and $LoanGr$ is the growth in total loans. All variables are included in levels except for $LendRate$, $NEER$, and $CapInfl$ that are included in differences. A constant in included in all models but not reported. Robust standard errors appear in parentheses. AR(1) and AR(2) are the diagnostic tests of first and second order serial correlation in first-differenced errors. *, **, and *** denote significance at 10 percent, 5 percent, and 1 percent, respectively.

Table 7: Effect of Changing to a Managed Exchange Rate Regime

	Random Effects Estimation Results				One-step GMM Dynamic Estimation Results			
	Model 1	**Model 2**	**Model 3**	**Model 4**	**Model 5**	**Model 6**	**Model 7**	**Model 8**
$Reserves_{t-1}$	0.847	0.801	0.84	0.806	0.793	0.89	0.813	0.844
	(0.033)***	(0.054)***	(0.036)***	(0.052)***	(0.039)***	(0.047)***	(0.039)***	(0.050)***
$MktShare\_State_t$	0.000	-0.001	0.000	-0.001	-0.003	0.001	-0.002	-0.001
	(0.001)	(0.001)	(0.001)	(0.001)	(0.002)	(0.002)	(0.002)	(0.002)
$MktShare\_For_t$	-0.008	-0.007	-0.006	-0.006	-0.015	-0.006	-0.009	-0.006
	(0.003)***	(0.003)**	(0.003)**	(0.003)*	(0.005)***	(0.005)	(0.004)**	(0.004)
$GDPGr_{t-1}$	-0.039	0.012	-0.033	0.005	-0.045	-0.001	-0.034	0.018
	(0.024)	(0.022)	(0.024)	(0.021)	(0.015)***	(0.016)	(0.015)**	(0.015)
$DomCred_{t-1}$			0.009	0.007	0.03	0.018		
			(0.003)***	(0.003)**	(0.007)***	(0.007)**		
$LendRate_{t-1}$	0.064	0.010					0.045	-0.006
	(0.026)**	(0.035)					(0.025)*	(0.027)
$NEER_{t-1}$	0.003	-0.003	0.006	0.001	0.006	0.004	-0.003	-0.003
	(0.004)	(0.003)	(0.004)	(0.003)	(0.003)**	(0.003)	(0.002)	(0.002)
Post 2003 x $NEER_{t-1}$	0.002	0.001	0.002	0.001	0.002	0.001	0.002	0.001
	(0.001)*	(0.001)	(0.001)**	(0.001)	(0.001)**	(0.001)	(0.001)**	(0.001)*
$CapInfl_{t-1}$	-0.018	-0.022	-0.016	-0.021	-0.024	-0.036	-0.024	-0.035
	(0.008)**	(0.007)***	(0.007)**	(0.007)***	(0.007)***	(0.007)***	(0.007)***	(0.007)***
LTA_{t-1}		0.003		0.002		0.001		0.003
		(0.002)		(0.002)		(0.002)		(0.002)
$ROAE_{t-1}$		-0.008		-0.007		-0.006		-0.009
		(0.003)**		(0.003)***		(0.003)*		(0.003)***
$LoanGr_{t-1}$		-0.018		-0.01		-0.005		-0.031
		(0.014)		(0.016)		(0.017)		(0.017)*
Observations	398	273	398	273	398	273	398	273
AR(1) p-value					0.0158	0.0170	0.0094	0.0094
AR(2) p-value					0.3651	0.6942	0.2762	0.5054

Notes: The dependent variable is $Reserves$ or the logistic transformation of the ratio of reserves for impaired loans to total loans. $MktShare\_State$ and Mkt_Share_For represent the market share in assets of state and foreign banks, respectively, in a given year. $GDPGr$ is the growth rate in GDP; $DomCred$ is the ratio of domestic credit to private sector to GDP; $LendRate$ is the aggregate lending rate; $NEER$ is the nominal effective exchange rate; *Post 2003* is a dummy variable equal to 1 if the year is 2003 or later; $CapInfl$ is capital inflows; LTA is the ratio of loans to total assets; $ROAE$ is the return on average equity; and $LoanGr$ is the growth in total loans. All variables are included in levels except for $LendRate$, $NEER$, and $CapInfl$ that are included in differences. A constant in included in all models but not reported. Robust standard errors appear in parentheses. AR(1) and AR(2) are the diagnostic tests of first and second order serial correlation in first-differenced errors. *, **, and *** denote significance at 10 percent, 5 percent, and 1 percent, respectively.

Table 8: Summary Statistics for Key Variables Entering the PVAR Model

	Observations	Mean	St Deviation	Min	Max
$CapInfl_t$	524	382.78	2,490.00	-3,957.40	7,050.30
$GDPGr_t$	586	4.74	1.33	2.37	7.16
$LendRate_t$	586	13.72	1.67	11.01	18.30
$LoanGr_t$	559	14.59	19.21	-38.30	91.66
$Reserves_t$	491	-2.17	0.77	-4.82	-0.52
$ROAE_t$	485	14.23	11.42	-38.27	43.80

Notes: All variables are included in levels except for $CapInfl$ that is included in differences.

Table 9: Coefficient Estimates for the Baseline PVAR Model

	$\mathbf{CapInfl_t}$	$\mathbf{GDPGr_t}$	$\mathbf{LendRate_t}$	$\mathbf{LoanGr_t}$	$\mathbf{Reserves_t}$	$\mathbf{ROAE_t}$
$CapInfl_t - 1$	-0.42	0.00005	0.00002	0.00039	-0.00002	-0.00017
	-8.06	2.01	3.20	1.18	-2.32	-1.32
$GDPGr_{t-1}$	-780.15	0.55	0.01	1.27	-0.05	-0.30
	-3.23	7.76	0.62	1.16	-2.38	-0.77
$LendRate_{t-1}$	-1899.22	-0.18	0.88	1.80	-0.003	-0.18
	-6.77	-1.62	31.43	1.35	-0.11	-0.36
$LoanGr_{t-1}$	39.95	0.01	0.00	0.20	0.0003	0.10
	3.01	2.24	-2.03	3.03	0.21	3.37
$Reserves_{t-1}$	3250.25	0.47	0.003	-0.74	0.68	3.48
	4.17	1.77	0.03	-0.26	10.77	2.79
$ROAE_{t-1}$	25.20	0.02	-0.01	0.28	-0.01	0.57
	0.64	1.97	-1.06	1.52	-2.01	6.80

Notes: Panel vector auto-regression model is estimated by system GMM. The first row for each variable presents coefficient estimates and the second row presents t-statistics. All variables are included in levels except for $CapInfl$ that is included in differences.

Table 10: Impulse-Response Magnitudes

	Time	$\mathbf{CapInfl_t}$	$\mathbf{GDPGr_t}$	$\mathbf{LendRate_t}$	$\mathbf{LoanGr_t}$	$\mathbf{Reserves_t}$	$\mathbf{ROAE_t}$
$CapInfl_t$	0	3600	0	0	0	0	0
$CapInfl_t$	1	-1400	-680	-760	262	838	152
$CapInfl_t$	2	184	-230	-280	-190	182	-98
$CapInfl_t$	3	-190	-180	-270	-74	133	-94
$CapInfl_t$	4	-1	-64	-180	-63	6	-86
$CapInfl_t$	5	-8	-13	-160	-16	-29	-50
$CapInfl_t$	6	21	23	-130	7	-48	-20
$GDPGr_t$	0	0.08	1.15	0.00	0.00	0.00	0.00
$GDPGr_t$	1	0.26	0.68	-0.08	0.13	0.08	0.15
$GDPGr_t$	2	0.06	0.35	-0.15	0.13	0.16	0.18
$GDPGr_t$	3	0.03	0.17	-0.14	0.08	0.16	0.13
$GDPGr_t$	4	-0.01	0.07	-0.12	0.04	0.14	0.09
$GDPGr_t$	5	-0.01	0.03	-0.09	0.01	0.10	0.05
$GDPGr_t$	6	-0.02	0.00	-0.07	0.00	0.07	0.02
$LendRate_t$	0	-0.11	-0.12	0.43	0.00	0.00	0.00
$LendRate_t$	1	-0.02	-0.10	0.38	-0.06	0.01	-0.04
$LendRate_t$	2	-0.06	-0.11	0.32	-0.07	0.04	-0.05
$LendRate_t$	3	-0.05	-0.10	0.27	-0.07	0.04	-0.06
$LendRate_t$	4	-0.04	-0.09	0.23	-0.07	0.03	-0.07
$LendRate_t$	5	-0.04	-0.08	0.20	-0.06	0.03	-0.06
$LendRate_t$	6	-0.03	-0.07	0.17	-0.06	0.02	-0.06
$LoanGr_t$	0	2.12	2.02	0.72	15.70	0.00	0.00
$LoanGr_t$	1	2.07	1.85	0.66	3.43	-0.76	1.66
$LoanGr_t$	2	0.27	0.88	0.28	1.37	0.10	1.49
$LoanGr_t$	3	0.17	0.37	0.30	0.56	0.37	0.96
$LoanGr_t$	4	-0.09	0.02	0.28	0.21	0.49	0.54
$LoanGr_t$	5	-0.14	-0.15	0.30	-0.01	0.45	0.22
$LoanGr_t$	6	-0.16	-0.22	0.30	-0.11	0.36	0.03
$Reserves_t$	0	-0.04	-0.03	0.02	-0.12	0.27	0.00
$Reserves_t$	1	-0.10	-0.08	0.02	-0.08	0.20	-0.04
$Reserves_t$	2	-0.06	-0.07	0.03	-0.08	0.12	-0.06
$Reserves_t$	3	-0.04	-0.06	0.03	-0.06	0.07	-0.06
$Reserves_t$	4	-0.03	-0.05	0.03	-0.05	0.03	-0.05
$Reserves_t$	5	-0.02	-0.03	0.03	-0.03	0.01	-0.04
$Reserves_t$	6	-0.01	-0.02	0.02	-0.02	0.00	-0.03
$ROAE_t$	0	1.12	0.66	-0.88	1.02	-2.01	6.03
$ROAE_t$	1	0.11	0.15	-0.46	1.73	-0.20	3.47
$ROAE_t$	2	0.09	-0.08	-0.06	0.97	0.34	1.94
$ROAE_t$	3	-0.15	-0.26	0.13	0.42	0.54	1.02
$ROAE_t$	4	-0.20	-0.34	0.25	0.08	0.51	0.45
$ROAE_t$	5	-0.21	-0.34	0.30	-0.09	0.41	0.12
$ROAE_t$	6	-0.18	-0.31	0.31	-0.16	0.30	-0.05

Notes: Each cell shows a response of the row variable to a shock in column variable (at a given time). All variables are included in levels except for $CapInfl$ that is included in differences.

Table 11: Variance Decomposition

	$\mathbf{CapInfl_t}$	$\mathbf{GDPGr_t}$	$\mathbf{LendRate_t}$	$\mathbf{LoanGr_t}$	$\mathbf{Reserves_t}$	$\mathbf{ROAE_t}$	**Row Total**
$CapInfl_t$	0.868	0.032	0.047	0.007	0.043	0.003	1
$GDPGr_t$	0.035	0.838	0.034	0.018	0.042	0.035	1
$LendRate_t$	0.028	0.088	0.808	0.038	0.007	0.032	1
$LoanGr_t$	0.031	0.030	0.006	0.906	0.005	0.022	1
$Reserves_t$	0.074	0.086	0.022	0.157	0.590	0.071	1
$ROAE_t$	0.022	0.015	0.022	0.078	0.075	0.789	1

Note: Each row represents the variance decomposition of the row variable. Each cell shows how much the column variable affects the variance of each row variable. All variables are included in levels except for $CapInfl$ that is included in differences.