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Full Length Research Paper

Bank efficiency and default risk: The case of Ghana

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There seem to be inconclusive results regarding the interactions between bank efficiency, default risk and bank capital. This study tries to assess the dynamic interactions between efficiency estimates, default risk and bank capital in the Ghanaian banking industry, using bank specific panel data for 20 Ghanaian banks from 2007 to 2015. We employ panel vector autoregressive models (VAR) models which are estimated using generalized method of moments (GMM) to examine the interactions. The results give an indication that bank default risk has negative and statistically significant impact on cost efficiency but exerts only a mild influence on profit efficiency. However, there exist weaker evidence on the impact of both efficiencies on bank default risk. Bank capital on the other hand has significant positive impact on cost and profit efficiencies but both efficiencies have insignificant impact on bank default risk.

Key words: Efficiency, bank capital, Stochastic Frontier Approach (SFA), default risk.

INTRODUCTION

The measurement of bank efficiency plays a pivotal role in the accurate assessment of the performance of individual banks and the industry as a whole, whiles providing information concerning the overall stability of the entire financial system. Inefficiencies in the banking industry can cause banking crisis and impede economic growth since they are the main financial intermediation channels.

Similarly, risk is an important determinant of financial stability. Miss-assessment of risk has several repercussions including bank failure, stifling money supply and credit flow, losses for investors and depositors, banking crisis and destabilization of the financial services industry.

With the inception of Financial Sector Adjustment Program (FINSAP) in 1988, the Ghanaian banking industry has evolved over the past decade from a regime characterized by controls to a market based regime, with sound financial liberalization and integration, rapid growth of new financial products and technologies, consolidation in the industry as well as increased competition (BOG, 2013). This development brings extra burden on the banks with respect to the management of their risk, and achieving the desired level of efficiency in their operations. It also poses a challenge to regulators in ensuring financial stability and promoting financial efficiency. The rapid growth and major structural transformation of the Ghanaian financial system have brought many opportunities but not without increased risk. Regardless of efficiency growth and stringent

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regulation, a stable risk return position of banks can unexpectedly be impaired. The measurement of bank efficiency and accurate assessment of risk and the identification of the interrelationship between risk and efficiency have therefore become crucial as a result of these reasons mentioned above.

There exist a large strand of literature that analyses bank efficiency theoretically and empirically, focusing on particular types of efficiency such as technical, allocative, cost, profit and revenue efficiencies, using both parametric and non-parametric frontier techniques (Berger and Mester, 1997; Dietsch and Lozano, 2000; Fiorentino et al., 2006; Tahir and Haron, 2008; Akoena et al., 2009; Olson and Zoubi, 2011; Isshaq and Bokpin, 2011; Said and Tumin, 2011).

Some studies sought to establish the interrelationship between bank specific variables (size, capital, and liquidity), industry specific variables (market share and concentration), macroeconomic variables (inflation and GDP) and different types of bank efficiency (Kwan and Eisenbeis, 1997; Dietsch and Lozano-Vivas, 2000; Berger and DeYoung, 2001; Chaffai et al., 2001; Carvallo and Kasman, 2005; Williams, 2004; Altunbas et al., 2007; Goddard et al., 2007; Ioannidis et al., 2008; Hughes and Mester, 2009). Some studies also determined the relationship between product diversification, market valuation and risk (Stiroh and Rumble, 2006; Leaven and Levine, 2007; Lepetit et al., 2008).

Despite threatening implications of inefficiency and miss-assessment of risk and the relevance of identifying the interactions between bank risk and efficiency, there is limited literature on the Ghanaian banking industry. This study therefore attempts, using panel Vector Autoregression (VAR), which is estimated using generalized method of moments (GMM), to identify the causal relationship between efficiency (cost and profit) estimates, derived from Stochastic Frontier Approach (SFA) and bank default risk (determined by the distance to default approach) in the Ghanaian banking industry.

Secondly, we measure the impact of bank capital on default risk and efficiency trade-offs, since the relationship between bank efficiency and default risk might be impacted on by the proportion of capital to total loans. As part of a sensitivity analysis, we extend our study to investigate the relationship between bank efficiency and default risk for listed and unlisted banks. Said and Masoud (2014) confirm that on average, listed banks are cost efficient than unlisted banks. We therefore identify the interactions between efficiency and risk for listed and unlisted banks by classifying our sample into listed and unlisted banks.

This study contributes to literature in many ways. Firstly, it examines the underlying dynamic interaction between bank efficiency, capital and default risk within the context of pane VAR for Ghanaian banks, which enables us to provide empirical evidence on the Ghanaian banking industry. Secondly, we estimate efficiency using two alternative efficiency measures (cost and profit) in order to strengthen the validity of our results. Thirdly, we perform sensitivity analysis and determine whether the interaction between risk and efficiency is influenced by whether a bank is listed or not. Finally, we investigate the interactions between bank efficiency, capital and risk by forming a broader set of variables accounting for these concepts.

We expect an increase in bank default risk to cause a decrease in bank efficiency, since a rise in default probability will cause a decision making unit (DMU) to operate less efficiently. This is because DMUs that face high default risk incur extra risk monitoring costs in order to preserve the quality of bank portfolio and defend its financial soundness to regulators. A rise in default risk may temporally precede a decrease in cost efficiency arising from lower credit screening. This is in consonance with the 'bad luck' hypothesis (Berger and DeYoung, 1997).

In accordance with the 'bad management' hypothesis of Berger and DeYoung (1997), we expect a rise in a bank's inefficiency to cause an increase in bank default risk. There is high probability that inefficient managers that do not properly control their operating cost, or do not generate increased profitability, resulting in cost and profit inefficiency, might also engage in ineffective risk management practices. Deterioration in efficiency could be an indication of poor or ineffective management practices which might lead to investing in poor quality loans. Decrease in bank efficiency as a result of bad management might lead to increased default risk.

We also theorize that a reduction in a bank inefficiency leads to an increase in default risk. In relation to the 'skimming' hypothesis of Berger and DeYoung (1997), banks in order to increase their efficiency may rather limit operating costs at the expense of facing higher future risk. This gives an indication that increase in bank inefficiency in the short run could lead to a decrease in risk taking transactions that will lead to a decline in bank default risk, implying an inverse relationship between risk and inefficiency.

We expect the relationship between bank efficiency and default risk to be affected by the proportion of capital to total loans. Moral hazard challenges might provide sufficient incentives for banks that thinly capitalized to extend their level of risk by taking on high non-performing loans in future. On the other hand, highly capitalized banks might face lower moral hazard challenges and may be better than thinly capitalized banks in terms of efficiency.

The study findings seems to be in consonance with the bad 'luck hypothesis' and supports the fact that highly capitalized banks might face lower moral hazard challenges and may be better than thinly capitalized banks in terms of efficiency. Bank default risk has negative and statistically significant impact on cost efficiency but exerts only a mild influence on profit efficiency. However, there exists weaker evidence on the impact of both efficiencies on bank default risk. Bank capital on the other hand has significant positive impact on cost and profit efficiencies but both efficiencies have insignificant impact on bank default risk.

LITERATURE REVIEW

Empirical investigations have utilized two main methodologies to measure bank efficiency: SFA and Data Envelopment Analysis (DEA) (Mester, 1996; Berger et al., 1999; Dietsch and Weill, 1999; Dietsh and Lozano, 2000; Hao et al., 2001; Fries and Taci, 2004; Sufian, 2009; Thagunna and Poudel, 2013).

Some researchers also explored different aspects of bank efficiency and estimates from different techniques (Berger and Mester, 1997; Bauer et al., 1997), the effects of off-balance sheet items, (Tortosa-Ausina, 2003; Pasiouras, 2007), and the contribution of environmental factors, markets, regulation and control (Altunbas et al., 2007; Dietsch and Lozano-Vivas, 2000; Chaffai et al., 2001; Berger and DeYoung, 2001; Cavallo and Rossi, 2002).

Literature on bank default risk has utilized two main methods in determining default probability as benchmarks: structural credit and reduced form credit models (Merton, 1974; Duffie et al., 2000; Collin-Dufresne et al., 2001; Huang, 2003; Leaven and Levine, 2007).

The reduced form model does not provide an implicit link between default risk and the firm's structure whereas the structural credit model produces default probabilities from financial and accounting information, which can provide and update credit information on time, based on the financial constraints of different firms. Credit risk is usually proxied by problem loans, loan loss provision or bad loans. The commonly used structural credit measures are the distance to default and index numbers. The Merton type distance to default market based measure of risk is considered as a more comprehensive estimate of default risk compared to the widely used index number proxies which are based on accounting information. An extension of Merton's distance to default measure was proposed by Liu et al. (2004), by integrating stochastic interest rates. Chan-Lau and Sy (2007) propose distance to capital model, which is also an extension of the Merton's type distance to default measure that takes in consideration pre-default regulatory actions.

There seem to be inconclusive results regarding the interaction bank efficiency and default risk. Goodhart et al. (2004) identified that stability in the financial system and default risk, which is the main determinant of financial stability are endogenously ascertained together with economic efficiency within a general equilibrium model, and there exist some trade-off between them.

This seems to imply a possible inverse relationship between bank efficiency and default risk. Other studies, (Allen and Gale, 2004; Boyd and De Nicolo, 2005), however assert that there exist no such trade-off.

The Granger-causality techniques and simultaneous equation framework are the commonly used techniques in literature for testing hypotheses about the interactions between bank efficiency and default risk. A major contribution in literature was made by Berger and DeYoung (1997) who utilized granger-causality technique in examining the possible relationships between bank efficiency, risk and capital, developing four alternative hypotheses, that is, bad management, bad luck, skimping and moral hazard hypotheses.

Kwan and Eisenbeis (1997), assess the interrelationships between bank efficiency and asset quality estimated by past due and non-accrual loans. They identify a direct relationship between inefficiency and risk, taking into consideration not only credit risk but also interest risk. Berger and DeYoung (1997) examine the relationship between efficiency and risk taking behavior of banks, estimating risk by problem loans. Their results show that among highly efficient banks, a rise in cost efficiency tend to precede an increase in non-performing loans, indicating a short operating cost reduction at the expense of long run loan quality.

Altunbas et al. (2007), measured the relationship between bank efficiency and risk, using loan loss reserves to measure asset quality. They identify that least efficient banks take less risk with decreasing cost efficiency and that their efficient counterparts appear more risk. Mamatzakis and Koutsomanoli-filippaki (2009) and Fiordelisi et al (2011), asses the interaction between bank efficiency and default risk, measured by the Merton type distance to default, which incorporate market information such as stock price, volatility and leverage. Their results show that an increase in bank efficiency is followed by a decrease in default risk.

Podpiera and Weill (2008) identify the interaction between cost efficiency and non-performing loans among banks in Czech Republic in order to examine whether either of these factors is a key determinant of bank risk and find evidence supporting the bad management hypothesis. Their results imply that deteriorations in cost efficiency precede increases in bank default risk.

Williams (2004) assess the inter-temporal relationships among default risk, cost efficiency, and bank capital of European savings banks, using Granger causality techniques and finds that banks that are bad at managing their efficiency are also bad at managing risk. Pastor and Serrano (2005) also examine the interaction between efficiency and risk taking for a sample of European banks, while they also differentiate between exogenous and endogenous default risk and find that risk precedes profit efficiency but not cost efficiency.

METHODOLOGY

This study seeks to find the efficiency-risk-capital relationships by constructing a broader set of variables accounting for each of these concepts. In achieving this objective, two dimensions of bank efficiency are measured (cost, profit), using parametric frontier technique (SFA). In estimating risk, we employ the traditional method, which uses the ratio of total to non-performing loans as proxy for bank default risk. Capital is also measured by the ratio of total capital (equity, retained earnings and other disclosed reserves) to total assets, which is a wider measure of bank capital.

The Battese and Coelli (1995) stochastic frontier for panel data, which allows for the estimation of efficiency in a one-step procedure is employed because it eliminates some of the anomalies in the two step procedure. The standard translog specification is utilized to estimate the cost frontier and profit frontier since it has well known advantage of including a flexible form and as a particular case, Cobb-Douglas specification. The stochastic frontier cost efficiency model is specified as follows:

$$lnTC_{i,t} = \ln f\left(P_{i,t} Q_{i,t};\ \beta\right) + \left(V_{i,t} + U_{i,t}\right) \quad (1)$$

Where: $TC_{i,t}$ represents total cost of the ith firm in the ith period, $P_{i,t}$ and $Q_{i,t}$ are the vectors of input prices and output quantities. β represents a vector of unknown parameters; $V_{i,t}$ are random errors which are assumed to follow a symmetrical normal distribution and are independently distributed of $U_{i,t}$; and $U_{i,t}$ are independently distributed inefficiency effects. The profit efficiency model is also specified as follows:

$$lnTP_{i,t} = \ln f\left(P_{i,t} Q_{i,t};\ \beta\right) + \left(V_{i,t} + U_{i,t}\right) \quad (2)$$

Where: $TP_{i,t}$ measures total profit before tax but after interest of the i^{th} firm in the t^{th} period and all other variables are as defined in the total cost function. In measuring the efficiency under the profit function, the composite error term is considered as $E_i = V_i - U_i$. We employ the standard translog function for this study because though the translog and the Fourier flexible functional form yield essentially the same average level and dispersion of measured efficiency, Altunbas and Chakravarty (2001) identified limitations with the Fourier suggesting that the translog is preferred (Berger and Mester, 1997). The standard translog functional model for multi products is specified as follows:

$$\mathrm{TC}_n = a_0 + \sum_{i=1}^{2} a_i lnQ_i + \sum_{j=1}^{3} ß_j lnP_j + {}^1\!/_2 \left[\sum_{i=1}^{2}\sum_{j=1}^{2} §_{ij} lnQ_i lnQ_j + \sum_{i=1}^{3}\sum_{i=1}^{3} ð_{ij} lnP_i lnP_j\right] + \sum_{i=1}^{2}\sum_{i=1}^{2} þ_{ij} lnQ_i lnP_i + \varepsilon\mathrm{n} \ldots\ldots\ldots \quad (3)$$

TC represents total production cost, comprising total total operating expense and interest expense; Q_i (i = 1,2) represent output quantities, where $Q_1$is total loans; Q_2 is other earning assets; P_j (j = 1,2,3) are input prices, where P_1 is the price of labour (total personnel expense divided by total assets); P_2 the price of deposits (interest expense divided by corresponding liabilities (deposits, and other short term funding).); P_3 the price of equity (total capital expense divided by total fixed assets), εn is a two component stochastic error term; and $a, ß, §,$ ð are parameters to be estimated.

Profit functions are estimated in the same manner as the cost functions in equation (3) except that the dependant variable is replaced with total profit on the left side of the equation. The study focuses on cost and revenue efficiencies as tey reflect managerial abilities to minimize costs and maximize revenues respectively. Although at an initial stage of our study, we thought of using the distance to default method in estimating bank default risk, we could not obtain data on market values for some banks because most of them are unlisted. We proxy bank default risk in accordance with the study of Berger and De Young (1997) and Williams (2004), by the ratio of non-performing to total loans. This method is a widely used accounting indicator of banks' risk and accounts for realized credit risk.

Capital is estimated by the ratio of total capital (equity, retained earnings and other disclosed equity reserves) to total assets, which is a wider measure of bank capital. This estimate is able measure capital adequacy and management better than the narrow equity to total assets ratio (Santos, 1999).

We follow the methodology and analysis of Mamatzakis and Koutsomanoli-filippaki (2009), and employ Sims (1980) Vector Autoregressive methodology to investigate the relationship between bank efficiency, risk and capital as this approach allows us to test unique relationships among variables. The Vector Autoregressive method is appropriate for this research because of the absence of a proiri theory of the interactions between the variables of our model, since it deals with the issue of endogeneity of the variables. This model is constructed on the basis that all variables enter as endogenous system of equations where the short run dynamic interrelationships can be subsequently identified.

Essentially, the Vector Autoregression methodology would allow us to examine the underlying causal relationships between our main variables: bank efficiency, default risk and capital. Though a common difficulty that emerges in panel VAR analysis is the heterogeneity across banks (Arellano and Bover, 1995), this can be addressed by setting individual specific terms. By this, our panel data vector autoregression recognizes all the variables in the system as endogenous, while allowing for unobserved individual heterogeneity. We specify a first order Vector Autoregression model as follows:

$$W_{it} = U_i + \Phi_{i,t-1} + e_{i,t}, i = 1 \ldots\ldots\ldots N, t = 1, \ldots\ldots T \quad (4)$$

Where $W_{it}$is a vector of two random variables, efficiency, risk and capital, Φ is a 2x2 matrix of coefficients, U_i is a vector of m individual effects and $e_{i,t}$, is a multivariate white-noise vector of m residuals.

As indicated by Mamatzakis and Koutsomanoli-filippaki (2009), all variables in standard VAR models depend on the past of all variables in the system, the main difference being the presence of the individual specific terms μi. We follow the work of (Mamatzakis and Koutsomanoli-filippaki, 2009), regarding estimation and inference, and utilize a system-based GMM estimator for each equation, according to the study of Arellano and Bover (1995).

We then obtain parameters by regressing the endogenous variables on the set of lagged endogenous variables. (Mamatzakis and Koutsomanoli-filippaki, 2009), indicate that the above system of equations is stated in the reduced form, so that once estimated it can be used to implement dynamic simulations. This analysis would include the estimation of impulse response functions (IRF) or variance decomposition (VDC) and requires solving complex identification problem.

According to Mamatzakis and Koutsomanoli-filippaki (2009), this problem can be tackled by the study of Love and Zicchino (2006). We assume that bank default risk affects the efficiency with a lag, while it is simultaneously affected by its own innovation and that of the default the default risk. The reverse causation will also be tested. It also assumes that capital affects the efficiency with a lag, while it is simultaneously affected by its own innovation and innovation in the default risk and the reverse causation will also be tested. In detail, we model efficiency and bank default risk and later efficiency and bank capital in two- equations VAR with the following structure:

Table 1. Summary statistics over the period 2007 to 2015.

Variable	Mean	Median	Maximum	Minimum	std deviation	coeff variation
loans and advances (Q1)	651,855,053	496,043,000	2,124,530,000	161,854,211	477,763,690.22	0.732929335
O I E assets (Q2)	598,156,315	284,961,021	1,882,269,000	32,028,186	610,342,253.65	1.020372499
price of labour (P1)	0.038373743	0.040673456	0.077142892	0.020838024	0.012115733	0.315729770
price of deposits (P2)	0.053560551	0.050888786	0.160315374	0.009523156	0.036605488	0.683441210
price of equity (P3)	1.120600867	0.989816346	2.573696145	0.543011123	0.548753056	0.489695370
Total Cost (TC)	104,707,195	72,926,038	270,364,000	19,669,664	84,023,373.11	0.802460359
Total profit (TP)	74,658,657	41,083,353	311,223,000	6,725,040	83,202,011.67	1.114432203
Equity/Total assets	0.14827157	0.153114251	0.216669797	0.072355957	0.036978242	0.25
NPL	6.36666667	6.6	9.1	3.9	2.088659857	0.33
GDP	12.44444444	13.1	18.1	6.1	3.682428245	0.30
Total assets	1,510,031,888	1,159,345,000	4,624,405,000	258,285,415	1164903063	0.77144269

Source: Computed by the researchers 2017.

$$E_{it} = \mu_{1t0} + \mu_{10t} + \sum_{J=1}^{J} a_{11}\, I_{it-j} + \sum_{j=1}^{J} a_{12}\, DD_{it-j} + e_{1i,t}$$

$$NPL_{it} = \mu_{2t0} + \mu_{20t} + \sum_{J=1}^{J} a_{21}\, I_{it-j} + \sum_{j=1}^{J} a_{22}\, DD_{it-j} + e_{2i,t} \quad (5)$$

Here, E_{it} and NPL_{it} capture the bank efficiency and default risk respectively, while μ_{i0} and μ_{0t} are the industry and time dummies respectively. Capital is estimated similarly as NPL in eq. 5 expect that the dependent variable is replaced with capital (ratio of total bank capital to total bank assets) on the left side of the equation.

In order to impose that the underlying structure is the same for each cross-sectional unit we follow the study of Mamatzakis and Koutsomanoli-filippaki (2009), greatly influenced by Love and Zicchino (2006), by allowing for 'individual heterogeneity' in the levels of the variables by introducing fixed effects. The regressors are correlated with the fixed effects because of the lags of the dependent variables and as a result the mean differencing procedure commonly used to eliminate fixed effects would create biased coefficients This problem is avoided by using forward mean differencing, also referred to as the 'Helmert procedure' (Arellano and Bover, 1995). This transformation maintains the orthogonality between transformed variables and lagged regressors, so that we can use lagged regressors as instruments and estimate coefficients by system GMM.

The study employed a balanced panel data from twenty commercial banks operating in the Ghanaian financial services industry, over the period 2007 to 2015. The banks in the sample were selected because they have been operating continuously over the chosen period and there is continuous financial data for all of them over the entire period. The published annual financial statements and reports of the banks were obtained from their respective official sites.

RESULTS

Table 1 presents the main descriptive statistics of default risk, and the input and output variables of cost and profit functions.

The cost efficiency estimates based on parametric frontier technique (SFA) are reported in Table 2. The measure of efficiency takes a maximum value of 100, which corresponds to the most efficient bank in the sample. The cost efficiency estimates range between 73.7 and 82.6%, with an average of 79.5%, thereby indicating average inefficiency of approximately 20.5%. The average cost efficiency is estimated at 80.73 and 78.84% for listed and unlisted banks respectively, indicating that listed banks are cost efficient than unlisted banks.

Table 3 also presents the profit efficiency estimates. The profit efficiency estimates range between 53.6 and 73.9%, with an average of 63.6%, thereby indicating average inefficiency of 36.4%. Profit efficiency estimates show an average of 60.52% and 65.29% for listed and unlisted banks respectively, indicating that listed banks tend to outperform their unlisted counterparts in terms profit efficiency.

The average non-performing loans are approximately 6.37% of total bank loans and total equity are on average, around 14.83% of total bank assets. Consistent with literature, cost efficiency estimates are higher compared to profit efficiency estimates. The estimates show an average cost efficiency score of 79.5% compared to an average profit efficiency score of 63.6% for all the banks, indicating that there are significant inefficiencies on the revenue side. This might be showing that banks are much interested in increasing their investment activities (Dietsch and Lozano-Vivas, 2000). The overall trend for cost and profit efficiency estimates is not consistent but there is some improvement over the years. The rank order correlation between cost and profit efficiency estimates is estimated at approximately 0.43.

The cost and profit efficiency scores were estimated using SFA. Before the estimation of the panel VAR we have to determine the optimal lag order j of the right-hand

Table 2. Average cost efficiency scores over the period 2007 to 2015.

Year	Mean	Std. dev.	Coeff. variation
SFA 2007	79.435	10.212	0.129
SFA 2008	78.547	9.965	0.127
SFA 2009	79.357	10.243	0.129
SFA 2010	73.735	10.524	0.143
SFA 2011	77.273	10.179	0.132
SFA 2012	82.554	12.786	0.155
SFA 2013	80.559	11.217	0.139
SFA 2014	82.723	9.856	0.119
SFA 2015	81.734	10.556	0.129
Listed (2007-2015)	80.726	10.674	0.132
Unlisted (2007-2015)	78.841	10.992	0.139

Table 3. Average profit efficiency scores over the period 2007 to 2015.

Year	Mean	Std. deviation	Coeff. variation
SFA 2007	55.724	10.934	0.196
SFA 2008	54.872	10.904	0.199
SFA 2009	58.736	13.556	0.231
SFA 2010	53.617	15.375	0.287
SFA 2011	63.295	11.576	0.183
SFA 2012	65.359	14.937	0.229
SFA 2013	72.974	13.538	0.186
SFA 2014	73.556	16.211	0.220
SFA 2015	73.907	13.289	0.180
Listed (2007-2015)	60.524	11.734	0.194
Unlisted (2007-2015)	65.291	12.459	0.191

variables in the system of equations. In order to determine the optimal lag order, we opt for the Arellano Bover GMM estimator for the lags of j=1,2,3. We then estimate the reduced form Panel VAR for difference lag orders. Dynamic panel is estimated with the Arellano Bond GMM estimator and opt for the lag order based on Akaike Information Criterion and the optimal lag length is of order one.

In order to test for evidence of autocorrelation, more lags were added. The Sargan tests show that for lag order one, we cannot reject the null hypothesis, and the Akaike information criterion confirms that the maximum lag order is one. We also perform normality tests for the residuals, opting for the Shapiro-Wilk Test. The test shows a value greater than 0.05, indicating that the data is normal. The parameter estimates of the system of equations for efficiency (cost and profit), capital and default risk are presented in Table 4.

The results show that the impact of default risk (NPL), as measured by the ratio of non-performing to total loans, on cost efficiency (CE), is negative and statistically significant. This show that an increase in the lagged default risk coefficient precedes a decrease in cost efficiency. This is in consonance with the 'bad luck' hypothesis of Berger and DeYoung (1997), which states that an increase in a bank's default risk will cause managers to operate less efficiently.

This is because managers that face high risk will have to put in measures and to incur additional risk monitoring costs so as to preserve the quality of bank portfolio. It can also mean that banks that are bad at managing their risks are also bad at managing their costs. This finding is consistent with the study of Maudos et al. (2002). Cost efficiency however has a positive impact on default risk but surprisingly and unlike most of the previous literature the impact is statistically insignificant for our period of study. This shows that cost efficiency does not exert significant influence on bank default risk.

Default risk impacts positively on profit efficiency (PE) but the impact is statistically insignificant. Profit efficiency is also positively related to default risk but statistically insignificant. This implies that bank default risk and profit efficiency have mild influences on each other.

On the other side, cost efficiency impacts positively on

Table 4. Parameter estimates of the system of equations for efficiency (cost and profit), capital and default risk.

Panel VAR of a two variable model		
Dependent variable	**CE-1**	**NPL-1**
CE	0.567* (0.18)	0.027***(0.005)
NPL	0.083(0.17)	0.352***(0.29)
-	PE-1	NPL-1
PE	0.397* (0.36)	0.078 (0.09)
NPL	0.176 (0.18)	0.407* (0.37)
-	EC-1	CE-1
EC	0.41*6 (0.29)	0.067 (0.08)
CE	0.309** (0.13)	0.507* (0.27)
-	EC-1	PE-1
EC	0.467* (0.31)	0.076 (0.009)
PE	0.107* (0.067)	0.569* (0.43)

***, **, and * denote significant level at 0.01, 0.05 and 0.1 respectively. PE is profit efficiency; EC is bank capital; CE is cost efficiency; and NPL is default risk. The VAR models are estimated using GMM. Reported numbers show the coefficients of regressing the dependent variables on lags of the independent variables.

capital (EC) as measured by the ratio of total capital to total assets but are insignificant. Capital however has a positive and statistically significant impact on cost efficiency. This suggests that moral hazard incentives appear to plummet when bank capital increases and these banks are more likely to reduce costs. Shareholders in highly capitalized bank may be more active in controlling bank costs or capital allocation than thinly capitalized banks. Profit efficiency on the other hand has insignificant positive impact on capital.

The impact of capital on profit efficiency is positive and statistically significant. This shows that highly capitalized banks might benefit from lower cost of capital and transfer gains into profits thereby performing better than thinly capitalized banks in terms of profit efficiency.

Tables S1, S2, S3, and S4 in the appendix present the variance decompositions of cost efficiency, profit efficiency, cost efficiency (listed), profit efficiency (unlisted) respectively. We present the total accumulated effect over the 10, 20 and 30 years. The results provide further evidence favouring the importance of risk in explaining the variation of cost efficiency. Specifically, approximately 15% of cost efficiency forecast error variance after thirty years is explained by default risk disturbances. The VDCs results would imply that the causality runs from bank default risk to efficiency. On the other side, approximately 1.6%, of the variation of default risk is explained by cost efficiency. 12% of profit efficiency forecast error variance after thirty years is explained by default risk disturbances whereas over 9% of the variation of default risk is explained by profit efficiency.

With regards to the interactions between efficiency and capital, we find that approximately 12% of cost efficiency forecast error variance after thirty years is explained by capital disturbances. On the other hand, 8% of the variation of capital is explained by cost efficiency. Thus, the VDCs results would imply that the causality runs from bank capital to cost efficiency. On the other side, over 10% of profit efficiency forecast error variance after thirty years is explained by capital disturbances whereas close to 3% of the variation of capital is explained by profit efficiency disturbances. This VDCs results would imply that the causality runs from bank capital to profit efficiency.

We also present variance decomposition estimates for efficiencies of listed and unlisted banks. approximately 15% of cost efficiency forecast error variance after thirty years is explained by default risk disturbances for listed banks whereas 7% of default risk forecast error variance is explained by cost efficiency. The results would imply that the causality runs from bank default risk to cost efficiency for listed banks. On the other hand, approximately 10% of profit efficiency forecast error variance after thirty years is explained by default risk whereas 15% of default risk forecast error variance is explained by profit efficiency.

In the case of unlisted banks, close to 21% of cost efficiency forecast error variance after thirty years is explained by default risk disturbances whereas 6% of default risk forecast error variance is explained by cost efficiency. This would also imply that the causality runs from bank capital to cost efficiency for unlisted banks. On the other side, close to 23% of profit efficiency forecast error variance after thirty years is explained by default risk whereas 7% of default risk forecast error variance is explained by profit efficiency

Conclusion

There seem to be inconclusive results regarding the interaction between bank efficiency, default risk and bank capital. The results provide an indication that bank default risk has negative and statistically significant impact on cost efficiency but exerts only a mild influence on profit efficiency.

However, there exists weaker evidence on the impact of both efficiencies on bank default risk. Bank capital on the other hand has significant positive impact on cost and profit efficiencies but both efficiencies have insignificant impact on bank default risk. Listed banks are efficient than unlisted banks and causality runs from bank default risk to cost efficiency for both listed and unlisted banks.

The study findings have some policy implication. Assuming bank default risk is a measure of financial stability, we find evidence that a trade-off between financial stability and bank efficiency does not exist. The majority of our results show clearly that bank efficiency and financial stability are positively related and the causality runs from default risk to efficiency. Essentially, default risk may act as an early warning mechanism for financial stability and efficient operation.

Effective monitoring of default risk could enhance financial markets and regulators ability to effectively deal with crises and improve efficiency.

CONFLICT OF INTERESTS

The authors have not declared any conflict of interests.

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Appendix

Table S1. VDC for cost efficiency.

Variable	N	CE	NPL	Variable	N	CE	EC
CE	10	0.85113	0.14887	CE	10	0.87913	0.12087
NPL	10	0.01628	0.98372	EC	10	0.08258	0.91742
CE	20	0.85113	0.14887	CE	20	0.87913	0.12087
NPL	20	0.01628	0.98372	EC	20	0.08258	0.91742
CE	30	0.85113	0.14887	CE	30	0.87913	0.12087
NPL	30	0.01628	0.98372	EC	30	0.08258	0.91742

Note: NPL: default risk, CE: cost efficiency, EC: capital and N notes the number of time periods ahead.

Table S2. VDC for profit efficiency.

Variable	N	PE	NPL	Variable	N	PE	EC
PE	10	0.87906	0.12094	PE	10	0.02824	0.97176
NPL	10	0.09534	0.90466	EC	10	0.89165	0.10835
PE	20	0.87906	0.12094	PE	20	0.02824	0.97176
NPL	20	0.09534	0.90466	EC	20	0.89165	0.10835
PE	30	0.87906	0.12094	PE	30	0.02824	0.97176
NPL	30	0.09534	0.90466	EC	30	0.89165	0.10835

Note: NPL: default risk, PE: profit efficiency, EC: capital and N notes the number of time periods ahead.

Table S3. VDC for cost and profit efficiency: Listed banks.

Variable	N	CE	NPL	Variable	N	PE	NPL
CE	10	0.07945	0.92055	PE	10	0.90167	0.09833
NPL	10	0.84739	0.15261	NPL	10	0.14863	0.85137
CE	20	0.07336	0.92664	PE	20	0.90667	0.09333
NPL	20	0.84639	0.15361	NPL	20	0.14376	0.85624
CE	30	0.07073	0.92927	PE	30	0.90529	0.09471
NPL	30	0.84607	0.15393	NPL	30	0.14067	0.85933

Note: NPL: default risk, CE: cost efficiency, PE: profit efficiency, EC: capital and N notes the number of time periods ahead.

Table S4. VDC for cost and profit efficiency: Unlisted banks.

Variable	N	CE	NPL	Variable	N	PE	NPL
CE	10	0.79056	0.20944	PE	10	0.77054	0.22946
NPL	10	0.06303	0.93697	NPL	10	0.07448	0.92552
CE	20	0.78724	0.21276	PE	20	0.78775	0.21225
NPL	20	0.06075	0.93925	NPL	20	0.07973	0.92027
CE	30	0.78697	0.21303	PE	30	0.78631	0.21369
NPL	30	0.06454	0.93546	NPL	30	0.07453	0.92547

Note: NPL: default risk, CE: cost efficiency, PE: profit efficiency, EC: capital and N notes the number of time periods ahead.

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The impact of capital flight from beautiful places: The case of the small open economy of Trinidad and Tobago

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This paper examines the relationship among capital flight, domestic investment and economic growth in the small resource based economy of Trinidad and Tobago. The study utilized capital flight estimates from previous work. A Vector Error Correction Model (VECM) combing short run and long run analysis is presented. The results confirm the a priori expectation that the financial haemorrhage of capital flight is a fundamental problem, which is affecting both the levels of domestic investment and economic growth. Therefore, a reduction of capital flight may provide a stimulus to the overall economy. These findings provide clear evidence of the harmful effects of capital outflows and provide support for the potential re-introduction of capital controls.

Key words: Capital flight, domestic investment, economic growth, Trinidad and Tobago.

INTRODUCTION

Capital flight can be defined as ‘the transfer of assets abroad in order to reduce loss of principal, loss of return, or loss of control over one’s financial wealth due to government-sanctioned activities’ (Epstein, 2005). These undeclared, undocumented or illicit transfers can deprive capital scarce economies of critical financial resources. This is a challenge faced by many economies and several studies have examined the country specific costs of capital flight (Beja, 2011; Chakrabarty et al., 2006; Forgha, 2008; Henry, 1996; Ndikumana and Boyce, 2008; Vukenkeng and Mukete, 2016; Wahyudi and Maski, 2012). Capital flight has been identified as a threat to scarce financial resources, domestic resource allocation, tax revenue, monetary aggregates and macroeconomic objectives of a country.

Given this context, an empirical analysis is important since estimates of capital flight, adjusted for trade misinvoicing and inflation, show an approximate transfer of resources amounting to US$40.9 billion, or 9.1% of GDP from Trinidad and Tobago for the period of 1971 to 2011[1]. Further, there was a substantial increase in capital flight in more recent years, peaking at US $5,564 million in 2008. This is despite the conventional wisdom of a decrease in such outflows post liberalisation. Both Bennett (1989) and Henry (1996) discussed the possibility of capital flight having adverse effects on this resource based developing economy, but neither went into any detailed empirical analysis. Furthermore, there has been no published work on this subject since. This

[1]The study utilized capital flight estimates from previous work, and is presented in Appendix.

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study aims to fill this void by examining the relationship between capital flight and domestic investment and the level of GDP. It also contributes to the scarce literature on capital flight from the small economies of the Caribbean.

Impact of capital flight on investment and growth

Capital flight has been associated with reductions in domestic investment. For example, the Franc Zone experienced a reduction in domestic investment during 1970 to 2005 (Ndiaye, 2009). Umoru (2013) and Adesoye et al. (2012) also presented arguments to support the adverse impact of capital flight on domestic investment in Nigeria. Umoru's (2013) results show that a 1% increase in capital flight induced a 1.83% decline in domestic investment for the period of 1980 to 2010. AfDB et al. (2012) also pinpoints that capital flight reduced investment by $3.6 billion per annum in Angola, and $10.7 billion per annum in Nigeria over the period of 2000 to 2008. Additionally, Fofack and Ndikumana (2010) indicated that capital flight from Africa during the period 2000 to 2004 reduced average domestic investment to GDP by 11.1%.

Capital flight is also linked to reductions in GDP. For example, the Philippines lost an average of US$432 million to US$864 million in output between 1970 and 1999, South Africa lost US$13 billion in 2000 (9.2% of GDP), China lost US$109 billion in 1999 (10.2% of GDP), Chile lost US$4.7 billion in 1998 (6.1% of GDP), and Indonesia lost US$14 billion in 1997 (6.7% of GDP). Additionally, Umoru (2013)[1] estimates that a 1% increase in capital flight induced a 1.059% decline in GDP growth from 1980 to 2010. Whereas, Ajayi (2012)[2] showed that 66.67% of the variation in GDP in Nigeria was associated with the components of the residual measure from 1970 to 2009. Iran's growth rate has also been significantly impacted by the past levels of capital flight. Khodaei (2012) showed that lagged capital flight in Iran had a significant impact on economic growth. The estimates showed that a 1% increase in the ratio of capital flight to GDP in the previous year reduced economic growth by 0.9% from 1979 to 2010.

The negative association between capital flight and reduced domestic investment can occur through various channels. The removal of domestically available resources can directly alter the desire for investment by individuals and therefore lead to a fall in aggregate investment. Capital flight indirectly affects domestic investment, as decreases in domestically saved capital reduces bank resources and can inhibit their ability and willingness to provide credit to the private sector for domestic investment (Saheed and Ayodeji, 2012; Ndiaye, 2012). The lower levels of private sector credit can in turn reduce longer term investments generally enhanced by domestic forces rather than external sources (Adegbite and Adetiloye, 2013).

Capital flight also lowers the taxable income and government revenue[3] (Forgha, 2008; Khodaei, 2012; Saheed and Ayodeji, 2012). Ndiaye (2009) also links this loss in public investment to declines in private investment. Capital flight can also indicate the possibility of future economic failures such as: increases in the level of external indebtedness, taxes and exchange rate instability. This expectation of economic failures can also make domestic investors to become more cautious (Collier et al., 2001; Nkurunziza, 2012; Ndiaye, 2009) Considering that an economic axiom of investment is a main component in the calculation of GDP, it is not implausible to conclude that its' decline reduces GDP (Lesotlho, 2006; Dutta, 2011; Adegbite and Adetiloye, 2013) as it reduces the productive capacity for sustainable long term development (Ndiaye, 2009).

This reduction in the rate of growth occurs via the loss in resources, lower investment and reduction in productivity (Saheed and Ayodeji, 2012; Kapoor, 2009; Gusarova, 2009; Forgha, 2008; Ndiaye, 2009; Chakrabarty et al., 2006). Capital flight also undermines sustainable development by increasing the dependence on external resources such as aid that are needed to replace the gap left by the fleeing of domestic capital (Kapoor, 2009, p.3). In particular, the inability of domestic firms to repay foreign debts may force them to lay off workers, causing unemployment and a further decrease in real output. Growth is also reduced as the capital to labour ratio is reduced. Gusarova (2009) and Collier et al. (2001) showed that as the capital to labour ratio declines so does the productivity of capital and the levels of output. Chakrabarty et al. (2006) also supported this finding and added that the additional effects of capital flight such as redistributive taxation and human capital investments also affect long term growth. The AFDB (2012) report stated, 'If flight capital was saved and invested in the domestic economy of the country of origin, it would increase income per capita and help to reduce poverty'.

METHODOLOGY

Data

Capital flight estimates for Trinidad and Tobago were previously

[1]The regression model examined by Umoru (2013) is $LnGDP = F(LnCFLT,\ LnRXRC,\ LnDOMV,\ LnPUDT,\ LnINDQ)$.
Where GGDP is the growth rate of the Nigeria economy as measured by the growth rate of GDP, CFLT is capital flight, EXRC exchange controls, DOMV is the domestic investment, PUDT is public expenditure, INDQ is the level of industrial output

[2]Ajayi (2012) used model of the functional form $GDP = F(\delta EXDEBT,\ DFI, CAB, \delta RES)$ Where:
GDP represents the gross domestic product; Δexdebt represents the change in external debt; DFI represents the Direct foreign investment; δRES represents the change in external reserves; CAB represents the current account balance.

[3]This loss of government revenue is described by Forgha (2008) as the "Tax-Depressing Thesis".

calculated using the Residual or Broad Estimate of capital flight adjusted for Trade Misinvoicing and inflation for the period, 1971-2011. This commonly used measure is supported by several economists including Ajilore (2010), Cerra et al. (2005), Henry (1996), Schneider (2000) and Vukenkeng and Mukete (2016) and calculated as shown by the equations below:

KF = KF* + MIS (1)

KF = [Δ ED + NFDI – CAD – ΔFR] + [Export Misinvoicing + Import Misinvoicing] (2)

RKF = KF/PPI (3)

where KF is estimated capital flight adjusted for trade misinvoicing, KF* is the Residual or Broad Estimate of capital flight, RKF is the estimate of capital flight adjusted for inflation using the United States producer price index (PPI) for 2000 as the deflator, Δ denotes change, ED is stock of gross external debt reported by the World Bank, NFDI is the net foreign investment, CAD is the current account deficit and FR is the stock of official foreign reserves.

The data for the dependent variables; domestic investment (INV) and gross domestic product (GDP) were sourced from the Central Statistical Office of Trinidad and Tobago. Domestic investment was measured by gross capital formation and output measured by GDP. Both variables were adjusted for inflation using the United States producer price index (PPI) for 2000. Significant micro, macro and financial variables were also sourced from the CSO and the Central Bank were utilised as control variables for the functional form.[4] The vector of control variables utilised for the parsimonious domestic investment model was real government expenditure (RGE), the growth rate of GDP (RCGDP) and interest rate differential (RD). The a priori expectations ceteris paribus were as follows:

1. RGE was measured by the final expenditure of the Trinidad and Tobago government in US $Million using data from the World Bank, and is adjusted for inflation using the United States producer price index (PPI) for 2000 as the deflator. It can positively (government infrastructure investment or development spending can support domestic investment) or negatively (can increase interest rates and crowd out private investment) affect domestic investment.
2. CGDP, which is proxied by percentage changes in the real GDP using data from the World Bank, is used to account for the effects of macroeconomic stability and growth on investment. Thus, higher growth rates are signal higher estimated returns and to generate higher levels of domestic investment.
3. $CGDP_{-1}$ represents lagged changes in the growth rate, and it is measured by lagged changes in CGDP. It acts as an indicator for the investment climate and its effect on current investment decisions. Thus, past increases in growth is expected to positively affect the current investment climate.
4. RD is measured by the gap between the domestic and foreign real rate where, RD = (US Tbill rate – US inflation rate) - (TT Tbill rate - TT inflation rate) using data from the IMF, the International Financial Statistics. It is used to account for the proposed negative effects of the cost of capital. Therefore, domestic investment is expected to fall as lower domestic rates provide greater incentive for foreign asset holdings.

On the other hand, the parsimonious GDP model comprised of domestic investment (INV), the terms of trade (TOT), population growth (POP) and the real exchange rate (RER) as control variables. The a priori expectations ceteris paribus are as follows:

1. INV is sourced from Central Statistical Office (CSO) in US $Million and is expected to have a positive impact on the level of GDP.
2. POP, which is proxied by percentage population growth sourced from the World Bank, is used to account for the positive effect of the development of human capital on GDP. However, Belford and Greenidge (2002) also showed that high population growth rates can negatively influence economic growth, since an expansion in the number of persons in the non-working age group exerts greater pressure on social services, resulting in limited availability of resources.
3. RER is measured as $e \times \frac{PPI_{US}}{CPI_{TT}}$, where e represents the exchange rate between the Trinidad and Tobago dollar and the US, PPI_{US} represents the Producer Price Index for the US, and CPI_{TT} represents the Consumer Price Index for Trinidad and Tobago sourced from Central Bank. RER accounts for the uncertainty created by exchange rate overvaluation, which can make the domestic environment unattractive for investment and reduce the level of GDP.
4. TOT is sourced from the World Bank and is measured as the percentage of the country's export prices in relation to its import prices, and controls for the positive effects of international trade on the level of GDP.

Model specification and regression analysis

To ensure the regression analysis did not produce spurious results, the independent and dependent variables were tested for stationarity and the order of integration I(d) using the Augmented Dickey Fuller and Phillips Perron tests. In response to the loss of long run information due to regression analysis with first differenced variables and misspecification due to its omission, the non-stationary time series were tested for the possibility of cointegration among the variables. The presence of a cointegrating vector of variables allowed for an OLS regression to be performed keeping the long run and short run aspect via a Vector Error Correction (VEC) model (Enders, 1995).

The long run cointegrating relationship among the non-stationary variables (the linear combination of the I(1) variables which create a stationary I(0) process) was identified using the Johansen-Julius Cointegration test. This test was performed using the appropriate predetermined lag length by the Schwarz Bayesian Criterion (SC). Additionally, the cointegrating rank r and the number of cointegrating equations were determined by the Max Eigenvalue statistic. Thus, with an established long run cointegrating relationship or cointegrating vector, Equation 4 was used to estimate the impact of capital flight on domestic investment (INV) and the impact of capital flight on real GDP (GDP) in the long run (lagged variables at level) and in the short run (first difference).

$$\Delta DEP_t = \alpha_0 + \alpha_1 \Delta RKF_t + \alpha_2 \Delta RKF_{t-1} + \alpha_3 \Delta X_t + \lambda ECT_{t-1} + \varepsilon_t \qquad 4$$

Where, DEP represents INV or GDP[5], α_0 represents the constant, α_i represents the coefficients of each determinant, RKF represents real capital flight, X represents the vector of a priori control variables[6], λ represents the coefficient of the ECT (must be negative), ECT represents the error correction term or

[4] A few control variables (only subsets of these were used simultaneously in the regression) are used in the a priori functional form of investment and growth due to the limited number of annual data points. Despite the possibility of omitted variables the economic impact and significance of capital flight on investment and growth would be derived from the econometric results.

[5] The logarithm of GDP was utilised to stabilise the variance and improve trend stationarity. This improved interpretability and comparability with the model. As such, difference GDP would represent the growth rate of real GDP.

[6] This study does not consider all the potential factors determinants of investment and growth but utilizes several macroeconomic factors such as control variables for the functional form

Table 1. Stationarity of variables, 1971-2011.

Variables	Augmented Dickey Fulley				Phillips Perron				Order of integration
	Level		First difference		Level		First difference		
	Intercept	Trend	Intercept	Trend	Intercept	Trend	Intercept	Trend	
INV	-3.39**	-3.29	-2.73	-3.32**	-2.18	-2.24	-8.13*	-8.02*	I(1)
GDP	-0.47	-0.82	-4.37*	-4.32*	-1.05	-1.47	-4.54*	-4.48*	I(1)
RKF	1.98	0.68	-12.94*	-13.76*	-0.98	-2.18	-12.62*	-14.47*	I(1)
RCGDP	-2.86	-2.88	-8.31*	-8.19*	-2.77	-2.79	-8.65*	-8.53*	I(1)
RD	0.023	2.405	-5.22*	-4.90*	-1.76	-2.53	-5.22*	-5.12*	I(1)
RER	-1.73	-2.24	-6.20*	-6.11*	-1.73	-2.29	-6.20*	-6.11*	I(1)
RGE	-1.30	-1.36	-5.09*	-5.02*	-1.73	-1.80	-5.21*	-5.15*	I(1)
POP	-0.61	-1.32	-5.82*	-5.59*	-1.29	-1.92	-2.72**	-2.78	I(1)
TOT	-1.21	-1.40	-4.70*	-4.01*	-1.41	-1.62	-4.72*	-4.64*	I(1)

*Significant at 1%; **significant at 5%. Source: Eviews output.

cointegrating vector [7], ε represents the error term.

One possible weakness of the regression coefficients in the VEC model in Equation 4 is endogeneity bias resulting from unobserved heterogeneity, and the possibility of basic bi-causal relationships such as that between economic growth rate and investment. The models were then estimated using the Generalised Methods of Moments (GMM)[8] estimation technique to correct for possible endogeneity bias, any functional measurement error (Umoru, 2013), and to test the robustness of the VEC model.

The GMM model specifications shown below by Equation 5, estimated the respective stationary dependent variables using stationary first differenced independent variables, including their lag as instruments.

$$\Delta DEP_t = \beta_0 + \beta_1 \Delta RKF_t + \beta_2 \Delta RKF_{t-1} + \beta_3 \Delta X_t + \varepsilon_t \quad (5)$$

Where, DEP represents INV or GDP, β_0 represents the constant, β_i represents the coefficients of each determinant, RKF represents capital flight, X represents the vector of a priori control variables, ε represents the error term.

The significance of each parsimonious model was determined by the residual, coefficient diagnostics and stability. The residual of the VAR model was tested for serial correlation, homoscedasticity and normality[9] at the 5% level using the ARCH LM, Breusch-Godfrey and Jarque-Bera tests. The F test ensured the observed variables jointly influenced capital flight, while the correlation matrix ensured results were not affected by multicollinearity. The CUSM test assessed the stability of the residuals, and confirmed cumulative sums were located within the two standard deviation bands. The validity of the instruments used in the GMM model were verified with the use of the Hansen J statistic.

RESULTS AND DISCUSSION

The results of the stationarity test indicate that all dependent and independent variables are characteristic of one unit root [I(1)] (Table 1). The econometric results of the investment models presented by the VEC (Panel A) and GMM (Panel B) estimation in Table 2 and the results of the GDP models shown by the VEC (Panel C) and GMM (Panel D) estimation show in Table 3 highlight the negative impact of capital flight.

The VEC model in Table 2 Panel A has an adjusted R^2 of 66% and includes both significant long run and short run variables. The long run cointegrating variables were established with a lag length of 1 as specified by the Schwarz information criterion (SC), and one cointegrating rank as specified by the Unrestricted Johansen Cointegration Max Eigenvalue test. This long run stationary relationship amongst the independent and dependent I(1) variables (INV, RKF, RGE, CGDP and RD) is also supported by the significance of the error correction term (ECT) highlighted in Table 2 in the VEC model. The linear presentation of the vector of long run cointegrating is presented by:

$$INV = -43.26 - 0.242RKF + 1.415RGE + 127.868CGDP - 10.56RD \quad (6)^{10}$$
$$(-4.779) \quad (11.70) \quad (11.007) \quad (-1.225)$$

The VEC result is in accordance with the stated a priori expectations, as it confirms the significance of capital flight as a determinant of domestic investment both in the short run and in the long run. Capital flight has a coefficient of -0.242 in the long run and -0.214 in the short run. This result exhibits the inverse relationship between capital flight and domestic investment in both time periods. When capital flight increases by one dollar, investment falls by $0.24 in the long run and $0.21 in the short run *ceteris paribus*. Furthermore, the results reveal a positive influence of government expenditure and changes in the growth rate on domestic investment in the

[7] The Error Correction Term (ECT) is captured from the co-integrated variables and provides evidence of a long run relationship. It also links the long run relationship between cointegrated vectors with the short run adjustment mechanism by restoring equilibrium in the presence of any disequilibrium shocks.

[8] Cragg (1983) was the first to discover that one can improve ordinary least squares in the presence of heteroskedasticity and serial correlation of unknown form by applying generalised method of moments (Wooldridge, 2001, 90).

[9] The GMM residual was only tested for normality.

[10] t-ratios in parentheses ( ).

Table 2. Determinants of investment (INV): VEC and GMM estimation, 1971-2011.

Panel A VEC Dependent variable: D(INV)		**Panel B GMM Dependent variable: D(INV)**	
Constant	5.133 (0.107)	Constant	59.423 (1.581)
D(RKF)	-0.214 (-4.572)	D(RKF)	-0.314 (-3.131)
D(RGE)	1.169 (5.481)	D(RGE)	0.733 (3.782)
D(RCGDP)	58.981 (4.487)	D(RCGDP)	30.62 (5.585)
D(RCGDP(-1)	-41.858 (-3.319)	D(RKF(-1)	-0.108 (-1.662)
ECT	-0.956 (-6.059)		
DIAGNOSTICS			
R^2	0.71	R^2	0.40
Adjusted R^2	0.66	Adjusted R^2	0.32
Functional Form F-test	16.07 (0.00)	J-Statistic (p value)	0.61
Serial Correlation	0.09	Durbin-Watson stat	2.38
Heteroskedasticity	0.52		
Normality	0.05	Normality	0.12
CUSM test	Within bands		

t-ratios in parentheses ( ); Source: Eviews output.

Table 3. Determinants of GDP: VEC and GMM estimation, 1971-2011.

Panel C VEC Dependent Variable: D(GDP)		**Panel D GMM Dependent Variable: D(GDP)**	
Constant	-0.018 (1.420)	Constant	0.021 (1.921)
D(TOT)	0.004 (4.914)	D(TOT)	0.004 (3.251)
D(RER)	-0.106 (-3.848)	D(RER)	-0.093 (-3.946)
D(INV)	0.00006 (2.475)	D(INV)	0.00005 (3.369)
ECT	-0.01(-2.249)	D(RKF(-1))	-0.00003 (-2.783)
		D(POP)	0.130 (1.468)
DIAGNOSTICS			
R^2	0.66	R^2	0.59
Adjusted R^2	0.63	Adjusted R^2	0.52
Functional Form F-test	17.34 (0.00)	J-Statistic (p value)	0.53
Serial Correlation	0.94	Durbin-Watson stat	1.66
Heteroskedasticity	0.01		
Normality	0.79	Normality	0.44
CUSM test	Within bands		

t statistics are in parentheses ( ); Source: Eviews output.

long and short run. Conversely, the interest rate differential has an observed negative impact in both time periods.

The expected negative relationship is also supported by the GMM estimation results shown in Table 2 Panel B. The result of the GMM INV model show that a one-dollar increase in capital flight reduces domestic investment by $0.31 *ceteris paribus*. Additionally, a one-dollar increase in capital flight in the previous year reduces the level of real domestic investment by $0.11 in the current year. The controlled variables also retain the same signs.

The VEC model for GDP in Table 3 Panel C includes both significant long and short run variables. Thus, the

[11]Instruments: (rkf), d(rkf(-1 to -2), d(rge), d(rge(-1 to -2), d(rcgdp), d(rcgdp(-1 to -2).
[12]Instruments: d(rkf), d(rkf(-2), d(pop), d(pop(-1), d(rer), d((rer(-1), d(inv), d(inv(-1), d(tot), d(tot(-1)

theoretically proposed hypothesis whereby capital flight is associated with reduced GDP in Trinidad and Tobago is supported. This best fit regression model which includes four control variables has an adjusted R^2 value of 63% for an optimal lag length of 2 as specified by the Schwarz information criterion (SC), and one co-integrating rank established by the Unrestricted Johansen Cointegration Max Eigenvalue test. The long run stationary relationship amongst GDP, RKF, INV and POP, is also established by the significance of the error correction term (ECT) highlighted in the VEC model Table 3 Panel C. This long run co-integrating equation is presented by:

$$GDP = 7.460 - 0.003RKF + 0.003INV - 7.132POP \quad (7)$$[13]

$$(-2.724) \quad (10.313) \quad (3.747)$$

The sign of the coefficient of capital flight and all control variables conform to economic theory. The coefficient of -0.003 shows that holding all other factors constant in the long run, a one percent increase in capital flight reduces the real GDP by 0.3%. The VEC results also show that the domestic investment positively impacted GDP in the long run, while the effect of population growth was negative. Unlike the long run result, the result for the first differenced short run control variables displayed in Table 3 Panel C are partially confirm stated a priori expectations. The positive coefficient of the terms of trade and domestic investment, and the negative coefficient of the real effective exchange rate are as expected. However, the insignificant effect of population growth and real capital flight on real GDP did not conform to a priori expectations and were eliminated from the model shown in Table 3.

The GMM model in Panel D of Table 3 shows that capital flight is associated with a reduction in GDP in the following year. This lag effect shows that a one-dollar increase in real capital flight reduces real GDP by 0.0003% in the following year. This lag in the adverse impact of capital flight on GDP shown in both the VEC and GMM models was unexpected. Additionally, this seemingly small impact of capital flight on real GDP could have resulted because the impact on GDP is masked by several other factors. One of such factor is the influence of the oil sector. The non-energy tradable sector in the last 50 years has been constantly shrinking as a share of GDP, making the economy energy-dependent, and increasing the risks for the entire economy to energy prices shocks (Artana et al., 2007).

The results presented in Tables 2 and 3 shows diagnostic tests. The models are normally distributed, show no sign of serial correlation or heteroskedasticity in the residual. The Hansen test for over identifying restrictions did not reject the null at any conventional level of significance since both estimations featured p values of 0.75 and 0.56. Thus, the instruments and the results of both GMM models were accepted.

[13]t-ratios in parentheses ( ).

CONCLUSION AND POLICY RECOMMENDATIONS

Capital flight is arguably a fundamental problem for Trinidad and Tobago. It has amounted to a real adjusted sum of US$40.9 billion or an average of 9.1% of GDP from 1971 to 2011. After 20 years of financial liberalization, the observed results contradict the conventional wisdom of reduced capital outflows post reforms. The results show that capital flight is associated with a reduction in domestic investment and GDP. This result remains robust with respect to other macroeconomic control variables and with different estimation techniques (VEC and GMM). The financial haemorrhage of capital flight is found to be associated with a reduction of domestic investment and GDP. In particular, the negative impact of capital flight for such a small open economy contradicts the view that capital outflows for portfolio diversification, due to limited domestic absorptive capacity, are harmless or even beneficial. Thus, this loss can further impair development as social sectors can be affected directly or indirectly.

Policy makers should not be passive to this source of potential instability. The reason for increased capital flight should be identified before appropriate policies can be utilized. Firstly, the determinants or causes of capital flight from Trinidad and Tobago should be clearly understood. Secondly, the domestic investment environment should be evaluated because capital flight may not only indicate poor regulative measures, but also an unfavourable investment environment. Thirdly, capital management techniques may also be needed to restrict the continuous outflow of capital from such an economy. Thus, capital flight can be added to the list of fears or reasons identified by Magud and Reinhart (2006) which support the use of capital controls. These results here can be a lesson for similar resource dependent developing economies of Africa and Latin America, some of whom are in the early phases of developing energy based industries.

CONFLICT OF INTERESTS

The authors declare that there is no conflict of interest.

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Appendix. Dataset 1971-2011.

Year	RKF	GDP[2]	INV	RCG DP	RD	RER	RGE	POP	TOT	OP
1971	-380.86	8.05	1069.75	1.04	-0.97	8.97	494.68	1.03	48.60	2.13
1972	36.19	8.19	1132.95	5.78	6.53	8.40	579.90	0.80	39.10	2.46
1973	416.56	8.26	1001.37	1.66	10.55	8.45	550.63	0.69	48.30	3.14
1974	62.04	8.53	1108.18	3.81	13.45	8.60	574.38	0.73	83.60	12.44
1975	77.62	8.62	1517.75	1.48	10.12	8.50	682.24	0.89	99.00	13.88
1976	433.58	8.60	1352.99	6.41	6.09	9.04	662.41	1.06	104.60	13.47
1977	660.28	8.77	1711.22	9.12	6.17	8.45	824.54	1.20	107.30	14.53
1978	169.84	8.82	2043.43	10.02	6.80	8.25	907.90	1.34	99.10	14.56
1979	-70.11	8.96	2258.34	3.60	10.18	8.10	1079.27	1.48	127.00	21.54
1980	346.09	9.13	2820.56	10.39	12.27	7.87	1111.15	1.59	175.90	33.97
1981	542.05	9.14	2636.29	4.58	15.07	7.51	1190.84	1.73	171.70	37.07
1982	279.97	9.27	3148.20	4.04	13.07	6.86	2230.19	1.84	145.20	33.59
1983	556.90	9.23	2616.71	-9.20	17.54	6.03	2134.52	1.82	143.10	29.35
1984	529.30	9.20	2382.38	-5.75	15.18	5.45	2229.57	1.64	142.00	28.87
1985	319.83	9.16	1780.87	-4.12	8.02	5.14	2158.17	1.36	137.00	27.00
1986	457.36	8.76	1372.12	-3.28	7.78	6.82	1487.65	1.04	98.20	15.04
1987	-173.73	8.73	1197.08	-4.56	8.32	6.32	1337.58	0.77	90.00	19.17
1988	607.94	8.63	728.98	-3.92	5.30	6.51	873.54	0.59	77.20	15.98
1989	-52.57	8.54	847.25	-0.83	4.21	6.78	677.53	0.56	84.70	19.64
1990	855.69	8.66	799.18	1.51	5.71	6.32	690.72	0.62	100.00	24.47
1991	-60.84	8.72	986.42	2.68	-2.66	6.11	768.54	0.72	86.50	21.50
1992	514.22	8.74	849.76	-1.65	-2.40	5.77	790.65	0.77	91.98	20.56
1993	237.92	8.54	734.87	-1.45	1.37	6.65	641.84	0.79	87.07	18.45
1994	1163.69	8.60	1111.58	3.56	0.47	6.85	654.28	0.75	87.90	17.19
1995	824.93	8.64	1189.77	3.95	-0.50	6.78	675.22	0.67	80.01	18.44
1996	-362.47	8.70	1456.96	3.95	-4.90	6.77	762.20	0.59	79.18	22.11
1997	624.88	8.69	1797.76	2.70	-3.46	6.80	691.68	0.52	73.79	20.40
1998	626.76	8.77	2158.26	7.77	-3.11	6.33	759.04	0.46	75.36	14.45
1999	706.81	8.88	1520.18	4.39	-4.54	6.17	783.36	0.43	83.14	19.26
2000	1151.50	9.01	1373.04	6.13	-4.52	6.30	761.31	0.40	100.00	30.30
2001	1356.12	9.07	2344.13	4.09	-2.40	5.97	1197.70	0.38	100.80	25.95
2002	1618.01	9.12	2075.99	8.01	-0.72	5.62	1239.64	0.36	94.60	26.11
2003	1349.78	9.29	2751.67	14.43	-2.20	5.74	1380.20	0.34	103.90	31.12
2004	2314.75	9.36	2334.49	7.90	-2.40	5.88	1376.95	0.35	108.10	41.44
2005	1216.96	9.52	3911.35	5.80	1.79	5.91	1577.46	0.36	122.10	56.49
2006	5221.41	9.60	2327.47	13.20	3.75	5.72	1642.02	0.38	137.00	66.02
2007	3522.38	9.72	2146.11	4.80	2.50	5.57	1748.10	0.40	132.40	72.30
2008	5563.94	9.88	2161.41	3.39	2.65	5.43	1848.63	0.40	152.10	99.60
2009	2280.88	9.60	2275.29	-4.39	4.87	4.65	2123.65	0.40	125.20	61.80
2010	3149.13	9.62	2087.68	-0.09	8.18	4.53	2050.51	0.38	122.10	79.40
2011	2007.25	9.69	2226.91	0.01	1.53	4.70	1956.26	0.36	139.60	95.10

Source: [2] Logarithm of GDP.


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