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South African bank regulation

Basel III, default risk, and contagion

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Abstract: This paper sets out to ascertain the appropriateness of the Basel III macroprudential policy mechanisms as South African bank distance-to-default determinants. Using a hybrid model embedded within a linear dynamic panel data estimation technique, the author finds that when macro- and microeconomic bank influences are controlled for, the predictors of the distance to default for the five largest South African retail banks over the 2004–15 period include: the Basel Tier 1 capital ratio; the liquidity coverage ratio; the net stable funding ratio; the United States distance to default pre-, mid- and three-year post-crisis interaction terms; simple leverage ratio; banks' market betas; and the South African Reserve Bank repo rate. Variables that found no support as predictors of distances to default were the gross market value of derivatives and liquid assets. These findings endorse the Reserve Bank's adoption of the Basel III policy recommendations for the South African banking context.

Keywords: South African banks, distance to default, Basel III, leverage, contagion risk, South African Reserve Bank
JEL classification: G21, G28, G32, G33

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1 Introduction

1.1 Background

Basel III framework

Against the backdrop of the recent global financial crisis (2007–09), various bank supervisory and regulatory measures were introduced by the Bank for International Settlements' Basel Committee on Bank Supervision so as to enhance banks' resilience to systemic risk and the associated spillover effects (i.e. the risk of contagion) (SARB 2013). The Basel III accord implements improvements to banks' maturity mismatches and procyclicality, capital base consistency, and risk coverage, and limits banks' liquidity risk (Babic 2011). Of the Basel regulations, this paper focuses on three policy recommendations: the Tier 1 capital ratio, the short-run liquidity coverage ratio (LCR), and the long-run net stable funding ratio (NSFR).

Basel's Tier 1 capital ratio is computed by taking bank capital over total assets. The recent Basel III accord advocates that banks should retain a Tier 1 ratio of three per cent (Babic 2011). The reasoning behind this is to ensure that banks manage to cover an appropriate fraction of total assets using their own reserves, and to rein in procyclicality by constraining excessive leverage build-ups. Since this capital requirement is not based on risk, it typically restricts the banks' procyclical disposition through the separation of the total required levels of capital from any risk perception developments (Babic 2011).

Underpinning the LCR is the rationale that banks can improve their capacity to deal with both market liquidity risk and short-term liquidity requirements. Its computation entails taking the stock of high-quality liquid assets (HQLA) and then dividing them by the net cash outflows which are anticipated to inflate in the event of temporary economic and/or financial instability. Banks are obliged to carry out alterations to their balance sheets so that this ratio has at least a value of one; thus, the HQLA will cover a month's equivalence of the expected net outflows. HQLAs comprise those liquid assets which are easily convertible into cash without experiencing considerable depreciation, such as 'risk-free' government bonds, for instance. Outflows constitute various sources of funding, such as deposits, which banks stand to lose in periods of financial instability (Babic 2011).

The NSFR measures the risk of maturity mismatch, with the goal of encouraging the acquisition of more medium- to long-term funding for bank assets (Babic 2011). Therefore, the NSFR has the effect of lessening the funding liquidity risk exposures of banks. It requires that the available stable funding amount be more than or the same as the required stable funding amount. The available stable funding is constituted of capital and debts—those with a maturity of more than 12 months, or those which will not fluctuate in periods of extreme economic instability. Required stable funding focuses more on those assets which are most illiquid during periods of economic instability and therefore necessitate more reliable sources of funding (Babic 2011).

South African Banks Act 1990

The South African Reserve Bank's supervision department constantly strives to ensure that the South African legal framework for bank supervision and regulation stays abreast of both international and domestic regulatory trends. The latter implies compliance with all applicable global supervisory and regulatory principles and best practices. As a result, the department reviews all banking codes and then makes recommendations to the South African finance minister to effect

amendments thereto (SARB 2013). For instance, following the 2007–09 financial crisis, according to the South African Reserve Bank (SARB 2013), South Africa sought to align itself with the latest Basel III recommendations by effecting amendments to its regulations so as to be able to address risks which are specific to banks as well as the broader financial system. Such regulations entail:

i. increasing the quality of capital, while concentrating on the quantity of capital as well as common equity, to enhance the ability of banks to finance their own shortfalls;

ii. improving the regulatory framework's risk coverage, with the inclusion of exposures associated with counterparty credit risk and/or contagion risk;

iii. introducing capital buffers, which are to be built up in times of affluence in order that they may be relied upon in times of distress;

iv. introducing a backstop leverage ratio so as to contain capital requirements which are based on risk, as well as to limit unwarranted leverage within the financial system;

v. improving supervision and risk management standards (Basel Pillar 2), as well as public disclosures (Basel Pillar 3);

vi. introducing the tracking of recommended minimum liquidity benchmarks to enhance the resilience of banks to severe short-run distress, and to increase long-run financing;

vii. introducing additional capital buffers aimed at global systemically important financial institutions (G-SIFIs) so as to combat the issues involved in these institutions being 'too big to fail'.

According to SARB (2013), the period of implementation for the various Basel III recommendations that were to be assimilated into the South African regulations began on January 2013, and was to include the phasing-in of transitional arrangements until 1 January 2019. A key reason for these provisions was to ascertain that all relevant comments and proposals with regard to the proposed amended regulations had been duly considered, researched, and debated (SARB 2013).

1.2 Main objective and specific aims

Therefore, this paper's central objective is to investigate whether the Basel III macroprudential policy recommendations incorporated into the recent amendment to the 1990 Banks Act are in fact relevant and significant determinants of the distances to default (DTDs) (i.e. financial health) of South African banks. In particular, this paper's three aims are: firstly, to investigate whether the Basel III bank supervisory and regulatory measures—i.e. Tier 1 capital ratio, LCR, and NSFR—find support as predictors of the DTDs of South African banks; secondly, to assess the degree of cross-border contagion (risk) between the South African and United States banking sectors; and thirdly, to determine which other potential macro- or microeconomic variables might find support as determinants of the DTDs of South African banks.

1.3 Outline

The remainder of this paper is arranged as follows. Section 2 covers the data and methodology adopted. Section 3 unpacks the findings and their implications for policy. Section 4 concludes and offers a few recommendations for future research.

2 Data and methodology

In the literature consulted during the preparation of this paper, a few items present evidence which suggests that establishing the determinants of the DTD for any bank necessitates that the tests of leverage and of the business model components of a bank should take into account both micro- and macroeconomic effects on defaults/bankruptcies within any given banking context (Blundell-Wignall and Roulet 2013; Rajan 2005; White 2006). This section is structured as follows: section 2.1 covers the data set and its sources, and section 2.2 introduces the methodology adopted.

2.1 Data

The outcome variable of this paper is the South African DTD. The DTD can be defined as the quantity of standard deviations (SDs) in relation to some predetermined threshold of default. One of the assumptions for deriving this indicator is that the default/bankruptcy of a firm materializes when its assets (V_t) (at market prices) are equal to (or less than) the value of its liabilities (D_t) on its books (i.e. $V_t \leq D_t$). A firm therefore defaults when its DTD equals zero or becomes negative (Blundell-Wignall and Roulet 2013). More importantly, according to Harada et al. (2010), even if the DTD reaches zero (or turns negative), this does not directly translate into a firm's failure/default at that given point in time. For example, a DTD of zero—or a negative one, for that matter—could be interpreted as the firm being highly likely to default should its asset position not improve; however, the latter does in fact mean that the firm is technically insolvent (Harada et al. 2010). The formula for calculating the DTD metric is derived from Black and Scholes (1973) and Merton's (1973) option-pricing formula for capitalizing a firm's equity so as to compute its DTD. The formula is comprised of the following system of three equations:

$$DTD_t = \frac{log\left(\frac{V_t}{D_t}\right)+\left(r_f-\frac{\sigma_t^2}{2}\right).T}{\sigma_t\sqrt{T}} \quad [1]$$

where V_t is market-related asset values, r_f zero-risk interest rates, D_t the value of book liabilities, σ_t asset volatility, and T the debt maturity period.

The estimation of a firm's market-related asset values (V_t) and its asset volatility (σ_t) is required because holders of equity retain limited liability as well as residual claims upon the assets of a firm. Equity may be modelled as a call option using the underlying assets of a firm with a strike price equivalent to the overall liabilities on the firm's books (Merton 1977). Accordingly, by simultaneously solving equations 2 and 3, we can derive the underlying market-related asset values and volatilities of any specific firm:

$$V_t = \frac{VE_t+D_te^{-r_fT}N(d2)}{N(d1)} \quad [2]$$

$$\sigma_t = \frac{VE_t}{V_t}\frac{\sigma_{E,t}}{N(d1)} \quad [3]$$

where VE_t is equity values, $N(d_i)$ cumulative normal density function, and $\sigma_{E,t}$ equity volatility.

Using a cubic spline, total yearly liabilities (aggregate yearly assets minus aggregate yearly equity) are included to produce daily observations (D_t). The volatility of equity ($\sigma_{E,t}$) equals the SD of daily returns times $\sqrt{252}$ (252 equals the number of days available for trading in a year). Typically, the assumption is that both the expiry date (T) for the call option and the liability's maturity are

normalized to one. Finally, the yield rate of the 12-month South African government bond is used as the zero-risk interest rate (r_f).

Furthermore, this paper's explanatory variables include: the dependent variable $t-1$; United States DTD pre-, mid- and three-year post-crisis interaction terms; the simple leverage and Tier 1 capital ratios; liquidity (LCR proxy); the market betas of banks; the SARB repo rate; gross market value (GMV) of derivatives; liquid assets and wholesale funding (NSFR proxy). Table 1 lists and defines the variables used in this paper.

Table 1: List and definition of variables

Variables	Definition of Variables	Expected Outcome in Relation to the Outcome Variable
Outcome Variable:		
sa_dtd	Weighted average DTDs of SA banks	None
Lag of Out. Var.:		
sa_dtd (AR1)	This is sa_dtd at *t*-1	Positive
Four Interaction Terms:		
us_pcdtd	Pre-crisis (2004-2006) interaction term	Positive
us_mcdtd	Mid-crisis (2007-2009) interaction term	Positive
us_3pcdtd	3 years post-crisis (2010-2012) interaction term	Positive
us_6pcdtd	6 years post-crisis (2013-2015) interaction term	None (base category)
Basel III Requirements:		
t1_rwa	Tier 1 capital/total risk weighted assets	Positive
liqt	Current assets/current liabilities	Positive
whf_tl	Wholesale funding/total liabilities	Inverse
Lev. & Macro Arguments:		
lev	Total assets/(total equity less all intangible assets)	Inverse
beta	Cov(equity & market returns)/var(market returns)	Inverse
mir	SARB repo rates	Inverse
Micro Arguments:		
gms_ts	GMV of derivatives/total assets	Positive
ts_ta	Trading assets/total assets	Positive

Note: Italicized variables, i.e. *liqt* and *whf_tl*, are proxies for the Basel III LCR and NSFR respectively.

Source: author's compilation drawing on Blundell-Wignall and Roulet (2013) and author's own contributions.

This paper's sample includes the five South African retail banks with the largest market capitalizations over the period 2004–15. The sample further comprises of 28 United States banks, selected on the same criteria as the South African bank sample. The primary sources of the data are Bloomberg Terminal, McGregor, SARB, and Federal Reserve Economic Data. Given that Black and Scholes (1973) and Merton's (1973) option-pricing model relies mainly on market data, only exchange-traded banks are included within this sample.

Moreover, following suggestions by Robson (2015), this paper includes the DTDs of United States banks. In so doing, this paper intends to capture the major South African banks' United States counterparts for capital and derivatives markets products (especially for government bonds and/or derivatives instruments). Furthermore, the United States banks which declared bankruptcy during the time of the financial crisis (2007–09) are also included within this sample. Table 2 lists the South African banks, and Table 3 lists the United States banks.

Table 2: South African banks included in the sample

Ticker	Name	Market cap
SBK	Standard Bank Group	153
FRS	FirstRand	126
BGA	Barclays Africa Group	93
NED	Nedbank Group	67
CPI	Capitec Bank Holdings	12

Notes: Figures in billions of 2010 ZARs.

Source: author's calculations based on Bloomberg data.

Table 3: United States banks included in the sample

Ticker	Name	Market cap
JPM	JP Morgan & Chase	1182
BAC	Bank of America	1164
CITI	Citigroup	1144
WFC	Wells Fargo	1142
GS	Goldman Sachs	507
USB	US Bancorp	421
MS	Morgan Stanley	359
WB	Wachovia	275
PNC	PNC Financial	208
MER	Merrill Lynch	176
BBT	BB&T	156
STI	Suntrust	137
FITB	Fifith Third Bancorp	117
WAMU	Washington Mutual	96
RF	Regions Financial	88
MTB	M&T Bank	86
LEHMQ	Lehman Brothers	85
KEY	Keycorp	74
CMA	Comerica	54
HCBK	Hudson City Bancorp	45
HBAN	Huntington Bancorp	40
ZION	Zion Bancorp	38
PBCT	People's United	34
FHN	First Horizon	25
SNV	Synovus Financial	21
CSE	Capitalsource	19
BEARS	Bear Stearns	-
NYB	NY Commercial Bancorp	-

Notes: Figures in billions of 2010 ZARs.

Source: author's calculations based on data from Bloomberg, McGregor, SARB, and Federal Reserve.

Table 4: Descriptive statistics for South African banks (2004–15)

	Distance-to-default	Tier1 capital ratio	Liquidity (LCR)	Leverage	Size	Derivatives	Liquid trading assets	Beta	Cross border revenue	Wholesale funding (NSFR)
FirstRand Bank										
Mean	**1,15**	**11,52**	**0,10**	**14,19**	**25,71**	**3,23**	**1,83**	**0,96**	**4,95**	**4,69**
Median	1,01	12,75	0,08	14,88	22,65	3,69	0,00	0,95	0,00	3,90
Maximum	*2,36*	*15,00*	*0,20*	*17,69*	*62,68*	*8,47*	*5,14*	*2,02*	*19,38*	*11,27*
Minimum	*0,48*	*0,00*	*0,04*	*10,85*	*8,17*	*0,00*	*0,00*	*0,24*	*0,00*	*0,00*
Std. Dev.	0,55	4,23	0,05	2,89	15,80	3,14	2,32	0,52	6,95	3,81
Nedbank Group										
Mean	**1,12**	**10,86**	**0,05**	**15,37**	**20,88**	**1,29**	**3,48**	**0,80**	**3,75**	**1,32**
Median	0,99	11,60	0,05	15,14	16,81	1,86	3,85	0,80	3,28	1,75
Maximum	*2,01*	*13,60*	*0,09*	*19,64*	*54,78*	*3,29*	*8,31*	*1,76*	*9,82*	*2,84*
Minimum	*0,68*	*8,10*	*0,02*	*12,98*	*6,30*	*0,00*	*0,00*	*0,20*	*0,00*	*0,00*
Std. Dev.	0,40	2,02	0,03	1,98	14,40	1,20	3,36	0,45	2,55	1,22
Standard Bank Group										
Mean	**1,11**	**11,62**	**0,14**	**15,49**	**47,42**	**4,26**	**2,87**	**0,92**	**15,43**	**8,80**
Median	1,09	11,55	0,13	14,36	39,38	3,53	2,43	0,86	14,46	9,18
Maximum	*1,74*	*13,30*	*0,23*	*19,51*	*117,58*	*11,23*	*7,33*	*1,68*	*42,13*	*13,22*
Minimum	*0,58*	*8,70*	*0,08*	*12,57*	*11,92*	*0,00*	*0,00*	*0,35*	*0,00*	*5,03*
Std. Dev.	0,35	1,36	0,04	2,51	31,74	4,42	2,99	0,42	9,83	2,79
Barclays Africa Group										
Mean	**1,07**	**10,30**	**0,22**	**13,14**	**25,84**	**0,24**	**5,56**	**0,86**	**1,32**	**11,27**
Median	1,04	12,60	0,26	12,47	21,01	0,22	7,95	0,75	0,04	12,74
Maximum	*1,66*	*14,10*	*0,32*	*15,83*	*67,73*	*0,64*	*11,98*	*1,26*	*3,99*	*16,36*
Minimum	*0,64*	*0,00*	*0,09*	*11,04*	*5,90*	*0,00*	*0,00*	*0,10*	*0,00*	*1,72*
Std. Dev.	0,26	4,97	0,09	1,69	18,17	0,25	5,03	0,36	1,83	5,07
Capitec Bank Holdings										
Mean	**0,81**	**33,63**	**0,45**	**3,51**	**0,73**	**0,04**	**0,00**	**0,51**	**0,00**	**0,00**
Median	0,81	31,10	0,30	3,92	0,21	0,00	0,00	0,43	0,00	0,00
Maximum	*1,21*	*83,40*	*1,63*	*5,56*	*3,19*	*0,44*	*0,00*	*1,80*	*0,00*	*0,00*
Minimum	*0,55*	*0,00*	*0,19*	*1,19*	*0,01*	*0,00*	*0,00*	*-1,20*	*0,00*	*0,00*
Std. Dev.	0,21	22,07	0,41	1,42	1,06	0,13	0,00	0,89	0,00	0,00

Notes: Panel data sample of the five largest South African retail banks traded publicly over 2004–15. All statistics shown in percentage terms, with the exception of liquidity (LCR), beta, leverage, and distance to default.

Source: author's calculations based on data from Bloomberg, McGregor, SARB, and Federal Reserve.

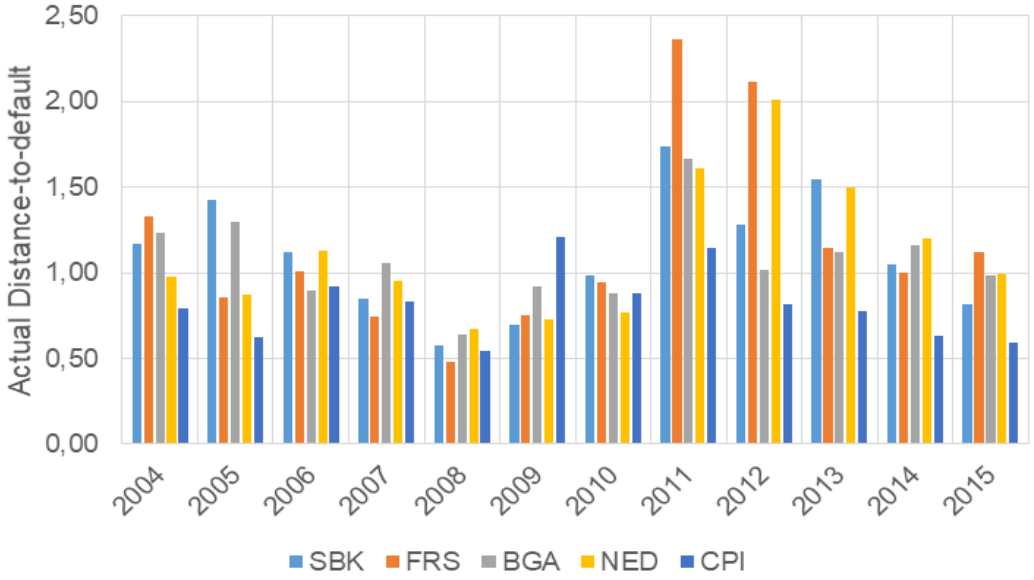
The descriptive statistics for the data for the five South African retail banks are presented in Table 4. The data have been grouped in descending order according to each individual bank's DTD. FirstRand Bank heads the group with a mean DTD of 1.15 SDs, followed closely by Nedbank Group at 1.12 SDs. The difference between Standard Bank Group and Nedbank Group is a mere 0.01 SDs. In fourth place is Barclays Africa Group with a DTD of 1.07 SDs. Capitec Bank Holdings is the bank most likely to default over the period of study, with a DTD of 0.81 SDs—a 0.34-SD shortfall behind the leading bank (i.e. FirstRand). Thus, overall, the five major South African banks are found to exhibit positive DTD figures (indicative of the existence of financial stability). In retrospect, this observation is consistent with what transpired in the South African banking environment during this period—particularly during the time of the 2007–09 financial meltdown.

In Table 4, some interesting features warrant emphasis. Capitec Bank is not only the riskiest bank within the sample, but also happens to have the smallest size, leverage, and GMV of derivatives statistical values compared with the other four banks. However, Capitec Bank happens to have the largest Basel Tier 1 and liquidity ratios (LCR proxy), traits which might otherwise have been expected of the safest bank (i.e. FirstRand). The latter statistics might be suggesting that, when

looked at holistically, Capitec Bank was actually well shielded against any default risk—at least in the short run, given its strong short-run liquidity position. The remainder of the statistics fail to offer any consistent patterns; thus, they are disregarded at this stage.

Figure 1 depicts the evolution of the actual DTDs (raw figures) for each of the five major South African retail banks during 2004–15. It suggests that three years before the 2007–09 financial crisis, a noticeable downward trend had already developed in the DTD figures of these banks. As expected, 2008 was the year when the five banks' DTDs attained their lowest levels (all undoubtedly under one SD) in comparison with the other years in question. In retrospect, the latter observation matches the prevalent market conditions of that period (i.e. 2008). The DTDs corresponding to the year 2008 further depict what can arguably be deemed the worst period of the recent financial crisis: this was the year when a number of multinational United States banking institutions also experienced below-one SD figures, and some even negative SD values. The latter led to the following United States institutions filing for bankruptcy: Merrill Lynch, Bear Stearns, Lehman Brothers, Washington Mutual, Wachovia, etc. (Blundell-Wignall and Roulet 2013). Interestingly, although not a single major South African retail bank (of the sampled banks) filed for bankruptcy during this period, the evolution of the South African banks' DTDs is indicative of a possible correlation with their United States counterparts. The three years after 2008 provide some evidence to suggest that there was an improvement in South African banks' DTDs. However, this upward trend seems to have been short-lived, as there is evidence of a steady reversal during 2011–15. Looked at holistically, the evolution of South African banks' DTDs seems to suggest that South African banks have a targeted DTD mean of one SD; this hypothesis is probable, as the DTD figures of South African banks tend to oscillate around the mean figure of one SD. This is of course notwithstanding some rare occurrences which might introduce a shock within the financial system, such as the 2007–09 financial crisis, and also 2011, when there was an overcompensation in all DTD figures (perhaps due to government/SARB interventions).

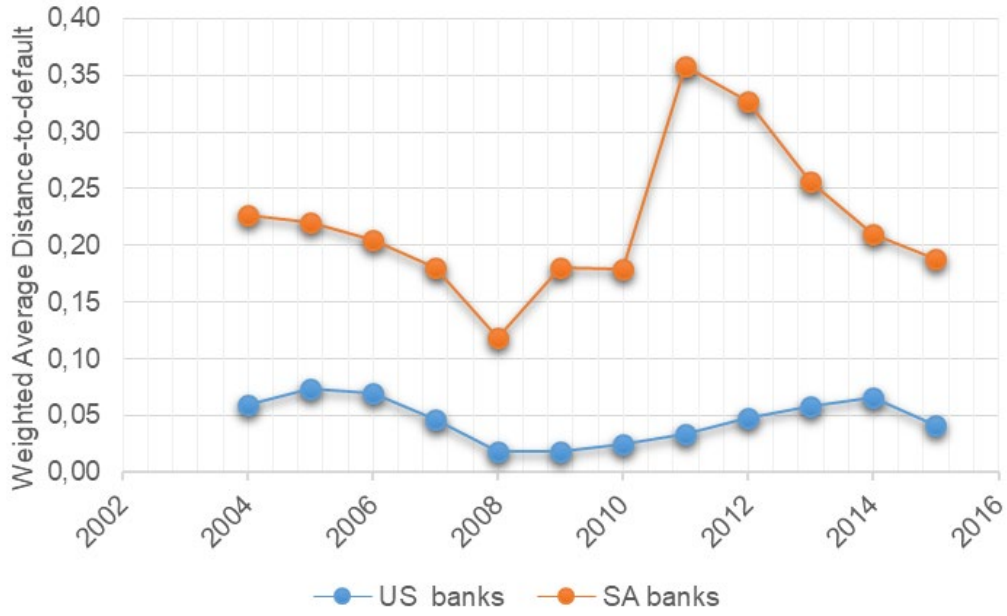
Figure 1: Evolution of the DTDs of South African banks before, during and after the 2007–09 global financial crisis



Source: author's illustration based on Bloomberg data.

Figure 2 offers some graphical visualizations of the weighted averages of both the South African and United States banks' DTDs, superimposed on each other in an attempt to discern the degree of co-integration, if any. A similar picture emerges as in Figure 1: the three years preceding the worst period of the crisis (i.e. 2008) present a strong downward trend for the South African case. A similar picture emerges for the United States banks, although the year 2007 offers a false sense of improvement before the banks' DTDs assume a downward trend similar to that of South African banks. Figure 2 leaves very little doubt about the existence of co-integration between the South African and United States banking industries, especially since both industries' DTD values appear to be co-trending. Moreover, both industries' DTDs experience marked dips in the midst of the 2007–09 financial crisis, before contemporaneously exhibiting improvements and further deteriorations during the post-crisis period, albeit at varying levels.

Figure 2: South African and United States banks' weighted average DTDs



Source: author's illustration based on Bloomberg data.

Generally speaking, analysing data within tables and figures will not suffice for the purposes of this paper: it is not possible to arrive at any credible conclusions, since it is impossible to control for macroeconomic influences, distinctive bank business model (microeconomic) characteristics, diversification, and leverage arguments without having employed econometric analysis techniques.

2.2 Methodology

For the purposes of this paper, a panel data estimation technique is employed in order to explain the variations in South African banks' DTDs over the period 2004–15. The framework employed uses the variables discussed in Table 1, which include both micro- and macroprudential arguments, leverage, and United States-to-South Africa contagion risk factors, among others. The equation is estimated twice, using two leverage ratio alternatives (i.e. the Tier 1 capital and simple leverage ratios). Equation 4 specifies the empirical form of the model, where bank and year are denoted by subscripts i and t respectively:

$$sa_{dtd_{it}} = \beta_{0,it} + \beta_1 sa_{dtd_{it-1}} + \beta_2 us_{pcdtd_t} + \beta_3 us_{mcdtd_t} + \beta_4 us_{3pcdtd_t} + \beta_5 k_{r_{it}} + \beta_6 liqt_{it} + \beta_7 gms_{ts_{it}} + \beta_8 ts_{ta_{it}} + \beta_9 beta_i + \beta_{10} whf_{tl_{it}} + \beta_{11} mir_t + \rho_i + \varepsilon_{it} \quad [4]$$

$K_{r_{it}}$ represents lev_{it} and $t1_{rwa_{it}}$ respectively, since the equation is estimated twice: once including lev_{it} and excluding $t1_{rwa_{it}}$; and once including $t1_{rwa_{it}}$ and excluding lev_{it}. First, the regression results are produced as arguments tested separately using bivariate estimation techniques. Consequently, these bivariate estimations are followed up by a model (equation 4) believed to be a superior simulator of reality (i.e. a multivariate regression), which accounts for the influences of other variables upon South African banks' DTDs.

3 Results and discussions

Having specified our model in the preceding section, we now present and analyse the econometric results. The contents are arranged as follows: section 3.1 unpacks the bivariate and multivariate models' estimated results and their related a priori expectations; section 3.2 discusses results-based macroprudential policy implications.

3.1 Bivariate and multivariate models

Table 5: Determinants of South African banks' DTDs: bivariate regression results

SA DTD (AR1)	Leverage	Basel tier 1 capital ratio	Liquidity	Gross market value of derivatives	Liquid assets	Market beta	Whole-sale funding	SARB repo rate	Intercept
.2795***	-.0657***								1.5513***
(.0861)	(.0250)	-	-	-	-	-	-	-	(.3746)
.4132***		.0040**							.5420***
(.0660)	-	(.0017)	-	-	-	-	-	-	(.0786)
.4217***			1.2590***						.3796***
(.0683)	-	-	(.4145)	-	-	-	-	-	(.0429)
.4135***				4.6218***					.5159***
(.0742)	-	-	-	(1.1059)	-	-	-	-	(.0850)
.3628***					4.4674***				.5277***
(.0562)	-	-	-	-	(1.5115)	-	-	-	(.0575)
.4051***						-.1862**			.7666***
(.0662)	-	-	-	-	-	(.0822)	-	-	(.0715)
.4566***							3.4125**		.3765***
(.0782)	-	-	-	-	-	-	(1.5452)	-	(.1133)
.2151***								-.0906***	1.7784***
(.0576)	-	-	-	-	-	-	-	(.0195)	(.2423)

Notes: Bivariate regression results using a balanced panel data sample of the five largest South African retail banks over the period 2004–15. A-Bond linear dynamic panel estimation technique used. Standard errors in parentheses. * Statistical significance at 0.1 level. ** Statistical significance at 0.05 level. *** Statistical significance at 0.01 level.

Source: author's calculations based on Bloomberg data.

The regression results, in which the arguments are tested independently using bivariate models, are presented in Table 5. With the exception of the coefficient of the wholesale funding variable, all the other variables' coefficients possess the correct expected signs. Furthermore, all the coefficients are found to have a 0.05 level of statistical significance, including the Tier 1 ratio—a finding contrary to Haldane and Madouros (2012), who, using a single variable model, found no support for the Basel Tier 1 ratio. This divergence may be a result of the inability of Haldane and Madouros's model to control for other influential variables upon the DTDs of banks.

Nevertheless, the significance of the Basel Tier 1 ratio in the results in Table 5 is testimony to the extraordinary efforts invested in the Basel Tier 1 ratio during the last two decades, as well as the overwhelming support it continues to receive among banking and regulatory bodies alike.

Additionally, the variables which are well determined at the 0.01 level of significance within the bivariate model estimations are leverage, liquidity, GMV of derivatives, liquid assets, and the SARB repo rate. However, as noted earlier, controlling for the influences of other variables may produce entirely different levels of significance and signs for the individual arguments within the multivariate model estimations. The multivariate model estimation results are presented in Table 6. The regression is run for the two bank capital leverage ratio alternatives (i.e. the Basel Tier 1 and simple leverage ratios).

DTD determinants for the five largest South African banks

To turn our attention to Table 6, the coefficient on the simple leverage ratio within the simple leverage regression is fairly determined at the 0.05 level of significance. Again, the Basel Tier 1 ratio in the Basel Tier 1 regression is well supported by the data as a predictor/determinant of the DTD of South African banks at the 0.01 level—a finding contrary to some international studies, for example Milne (2013) and Blundell-Wignall and Roulet (2013). As a side note, the ratios were also both included simultaneously within the same regression (although the results are excluded from Table 6), and only the simple leverage ratio found support this time. Nonetheless, with regard to these two variables and from a South African bank perspective, the multivariate regression results align with those of the bivariate models: that is, both ratios appear to be vital determinants of South African banks' DTDs—particularly the Basel Tier 1 ratio.

From this point onwards, the rest of our discussion in this section will focus on the Basel Tier 1 ratio and the simple leverage ratio regressions concurrently, given that both ratios are supported by the data.

Moreover, with respect to cross-border contagion risk, all of the United States banks' DTD interaction terms possess the expected signs; however, their levels of significance vary at 0.01, 0.05, and 0.1 for both regression results. The significance of the interaction terms seems to suggest that the nexus between the South African and United States DTDs is reliant upon the year variable in addition to the United States DTD values themselves. Regarding macroprudential arguments, the SARB repo rates and the banks' market betas also display the anticipated signs, and have varying levels of statistical significance at 0.05 and 0.01 respectively.

Finally, with respect to micro arguments, both the liquid trading assets and the GMV of derivatives have the expected signs; however, they remain statistically insignificant even at the 0.1 level for both regressions. On the other hand, wholesale funding possesses a sign which is now correct and displays statistical significance at the 0.05 level. The finding by Blundell-Wignall and Atkinson (2011) with respect to the statistical significance of derivatives contracts and their contribution to increased bank default for G-SIFI banks is inconsistent with the current paper's findings. This disparity may be explained by the negligible values of derivatives contracts held by the five largest South African retail banks in relation to their G-SIFI counterparts. Next, the potential policy implications of the above results are discussed.

Table 6: Determinants of South African banks' DTDs: multivariate regression results

	Bank Capital Ratio Alternatives	
	Simple Leverage	Basel Tier 1
SA DTD (AR1)	.0402	.1039*
	(.0683)	(.0611)
US pre-crisis DTD	.1307**	.0738***
	(.0638)	(.0260)
US mid-crisis DTD	.4063***	.2728*
	(.1434)	(.1576)
US 3 years post-crisis DTD	.2839***	.2547**
	(.1083)	(.1033)
Leverage	-.0559**	-
	(.0278)	-
Basel tier 1 capital ratio	-	.0046***
	-	(.0016)
Liquity	.5799*	.8563***
	(.3235)	(.0875)
Gross market value of derivatives	-1.1517	.1150
	(1.3102)	(1.5145)
Liquid assets	1.4998	1.1116
	(1.0890)	(1.3028)
Market beta	-.2401**	-.2048**
	(.1034)	(.1050)
Wholesale funding	-2.0461	-2.1610**
	(1.4003)	(.9282)
SARB repo rate	-.1052***	-.1121**
	(.0352)	(.0461)
Intercept	2.4026***	1.6003***
	(.5739)	(.5520)
Wald test (model)	43.95***	11.75**
No. of instruments	49	49
Root MSE (SEE / σ_v)	5.3690	6.1739
A-Bond test (AR1), (AR2)	(-2.1859**), (-.1540)	(-2.2204**), (-.2658)
Total observations	50	50

Notes: Multivariate regression results using a balanced panel data sample of the five largest South African retail banks over the period 2004–15. A-Bond linear dynamic panel estimation technique used. Standard errors in parentheses.
* Statistical significance at 0.1 level. ** Statistical significance at 0.05 level. *** Statistical significance at 0.01 level.

Source: author's calculations based on data from Bloomberg, McGregor, SARB, and Federal Reserve.

3.2 Potential policy implications based on results

First and foremost, some of the variables which were statistically significant in the individual bivariate regressions are excluded from this point onwards, since they produced spurious regression results within the multivariate model estimations. Second, in deducing the economic meaning or policy implications of these results, one ought to bear in mind that no one financial crisis is identical to another; that is, every financial crisis harbours its own unique characteristics. The focus of this paper is limited to data covering the period 2004–15 (12 years), which nonetheless includes the recent (2007–09) financial crisis. Broadly speaking, there are many other reasons which may have led to bank defaults, or even cases where the need to rescue failing banks—for example, through state intervention—may have materialized within the same period. Indeed, within the South African banking industry, one such event occurred when African Bank Ltd filed for bankruptcy in 2014. However, according to Blundell-Wignall and Roulet (2013), there is a consensus that, historically, the key contributors of risk for banks have tended to be:

i. macroprudential risk: relates to business cycle risk usually associated with lax monetary authority policies and credit-backed asset bubbles that subsequently contract;

ii. contagion risk: associated with the business of derivatives, which grew exponentially from the late 1990s;

iii. leverage risk: relates to inadequate levels of bank capital to curb balance sheet losses;

iv. liquidity risk: relates to banks' dependence on unstable wholesale funding of a short-run nature, which tends to dry up in periods of economic or financial distress;

v. diversification risk: relates to a lack of diversification where the lending and/or acquisition of securities by banks is highly correlated with national economic cycles of commodities, real estate, or technology, for instance.

The endeavours of policymakers to combat these risks continue at various levels:

- macroeconomic level: through well-targeted macroprudential and monetary policy controls;
- regulatory level: through an approach to policy that tends to advocate
    - risk-weighted capital and/or asset unweighted controls to guide leverage,
    - auxiliary controls for capital directed at counterparty and market risks,
    - auxiliary liquidity ratio controls, and
    - policies aimed at the isolation of high-risk activities within bank business models;
- supervisory level: Pillar 2 of Basel III, which deals with bank supervision, is held in high esteem, and SARB, which has overall responsibility in terms of the supervision of South African banks, has recently adopted the Basel III recommendations.

The exploratory evidence offered by this paper's results might assist in the discussion relating to the comparative relevance of these policy measures.

Macroprudential risk

Based upon the fairly strong panel data estimation results for the SARB repo rate and the market betas, there is sufficient evidence of the potential role monetary and possibly macroprudential policies can play in the mitigation of risk. For instance, an unforeseen cut in the repo rate of 10 per cent (125.7 basis/percentage points, based on the 1998–2018 SARB average repo rate of 12.57

per cent) can be expected to increase the South African banks' DTDs by 1.26 SDs. These results suggest that lower repo rates would particularly favour the most vulnerable banks.

Systemic and contagion risks

With increased financial and trade openness, the growth in recent years in cross-border contagion risk, arising from the manifestation of individual country-specific systemic risks, should come as no surprise. This paper uses 2004–15 United States DTD values, which have been brought into interaction with yearly categorical variables so as to assess the extent of cross-border contagion risk between the South African and United States banking industries for the pre-, mid- and post-crisis periods. For the Tier 1 ratio regression, a cumulative decline of two SDs in the United States DTDs in the three years before the financial crisis appears to have decreased the South African banks' DTDs by 0.15 SDs, relative to the base category of more recent times (2013–15). For the same regression, a cumulative decline of two SDs in the United States DTDs in the midst of the financial crisis appears to have significantly stunted the South African banks' DTDs by 0.55 SDs, relative to the base category of 2013–15. In the three years after the crisis, a similar cumulative decline in the United States DTDs seems to have lowered the South African banks' DTDs by 0.51 SDs, again relative to the base category—using the Tier 1 ratio regression.

If we turn to the simple leverage ratio regression, cumulative United States DTD declines equivalent to those above seem to have affected the South African banks' DTDs, as follows. During the three years leading up to the financial crisis, reductions (of two SDs) in the United States DTDs may have lowered the South African banks' DTDs by 0.26 SDs, relative to the base category. In mid-crisis years, a two-SD United States DTD decline seems to have hammered the South African banks' DTD figures by a significant 0.82 SDs, relative to the base category. Finally, for the three years after the crisis, a two-SD reduction in United States DTDs reduced the South African banks' DTDs by 0.57 SDs, relative to the base category.

The order of magnitude of the above effects leaves absolutely no doubt that there is a cause-and-effect relationship between the United States and South African banking industries. The model provides compelling evidence of the need for South African supervisory and regulatory authorities to shield domestic banks from United States-South Africa cross-border contagion risk spillovers flowing from the materialization of neighbouring country financial markets' systemic turmoil.

Basel III and leverage risk

Both the Basel Tier 1 and simple leverage ratios find support in the data as predictors of South African DTDs—but even more so for the former. Moreover, in South Africa it would appear that there is effective control over leverage, notwithstanding the fact that under the Basel accord, banks are provided with the freedom to determine risk weights by running their own models. If, for instance, the Basel III Tier 1 ratio were lowered to 15 times equity from its current ratio of 33 times equity (the Tier 1 ratio sits at three per cent), then according to the Tier 1 ratio regression, this cut might be expected to lower the South African banks' DTDs by 0.10 SDs. The reverse is true for a 15-times-equity simple leverage ratio ceiling, lowered from the greatest ratio of 19.6 times (Nedbank Group, Table 4): this cut could result in a 0.27-SD increase in South African banks' DTDs, according to the leverage ratio regression. If we compare the two ratio regressions, the results seem to suggest that lowering the Basel Tier 1 ratio might lead to riskier banks, whereas lowering the simple leverage ratio might actually produce safer banks. With regard to the order of magnitude, the simple leverage ratio appears to be the superior macroprudential policy instrument relative to the Basel Tier 1 ratio.

Short-run and long-run liquidity risks

Due to the lack of availability and/or accessibility of data concerning Basel III's LCR and NSFR measures, this paper uses the liquidity (current ratio) and wholesale funding ratios as proxies for Basel III's LCR and NSFR measures respectively. If we focus on the Basel Tier 1 ratio regression, LCR (liquidity) retains a high level of statistical significance as a South African bank DTD determinant, whereas NSFR (wholesale funding) is moderately significant. The bank with the greatest liquidity (Capitec Bank Holdings, Table 4) is at 163 per cent of debt obligations. A lessening of this figure to its median value of 30 per cent can be expected to reduce the bank's DTD by 0.25 SDs. The evidenced significance of liquidity with respect to bank stability aligns well with theory and with the Basel III accord's recent introduction of liquidity buffers such as the LCR. Moreover, the bank with the greatest wholesale funding value (Barclays Africa Group, Table 4) sits at 16.36 per cent of liabilities. Here, if the bank were to cut this percentage to its median figure of 12.74 per cent, this change might be expected to increase the bank's DTD by 0.28 SDs. The latter case also aligns with theory and the Basel III accord, in that it seems to suggest that retail banks with lower proportions of wholesale funding (within their NSFRs) tend to be more financially stable.

Basel III regulatory framework

Table 7 presents the correlation matrix for the four macroprudential measures which found support in the data for the sample of the five largest South African banks. These measures are the Basel Tier 1 capital ratio, the simple leverage ratio, liquidity (LCR proxy), and wholesale funding (NSFR proxy).

Table 7: Correlation matrix: Basel III and the leverage ratio

	Leverage	Basel Tier 1 capital ratio	Liquidity (*LCR*)	Wholesale funding (*NSFR*)
Leverage	1			
Basel Tier 1 capital ratio	-0.65	1		
Liquidity (*LCR*)	-0.62	0.20	1	
Wholesale funding (*NSFR*)	0.29	-0.26	-0.05	1

Source: author's calculations based on regression results presented in Table 6.

The greatest correlation (-0.65), which is found between the simple leverage and Basel Tier 1 ratios, comes as no surprise. The high magnitude of correlation between these two ratios may be a testament to the fact that both ratios actually measure the degree of institutional leverage, although they go about it in somewhat differing ways, as already evidenced by the opposing signs on their coefficients in the bivariate and multivariate regression results. Their contradictory approaches to the measurement of leverage are here further supported by the negative sign on their correlation coefficient. This finding further validates this paper's two-equation estimation technique. For instance, if done concurrently with the business model of South African banks, administering a 10 per cent reduction in the simple leverage ratio might be expected to inflate the Basel Tier 1 ratio by 90 per cent, using the coefficient of -0.65.

The conflicting nature of these measures has some noteworthy implications for macroprudential policy mechanisms. Firstly, these findings seem to propose that the South African supervisory and regulatory authorities ought to select only one of the two policy measures as a macroprudential tool for the South African banking industry. Secondly, in selecting the preferred ratio, the authorities need to further consider the respective interplays of each measure with regard to the other statistically significant determinants of South African bank DTDs. These interplays are discussed next.

The Basel Tier 1 ratio appears to have a positive correlation with liquidity (LCR), exhibiting a modest 0.20 coefficient. Notwithstanding the modest magnitude of this level of correlation, the sign on the correlation value does offer some consolation relating to the overall functionality of the Basel III framework. Put differently, the positive correlation between these two Basel ratios (i.e. liquidity (LCR) and the Tier 1 capital ratio) aligns with expectations, and seems to suggest that any improvements (increases) in the Basel Tier 1 capital ratio might be expected to consequently improve a bank's short-run liquidity position. Such an improvement in the liquidity position of a bank—as already demonstrated above—can lead to an improvement in its DTD, thereby restraining its risk of default.

The final correlation value necessitating discussion is that between the Basel Tier 1 ratio and wholesale funding (proxy for the NSFR). This interaction exhibits a negative and reasonably sized coefficient of -0.26. Again, this discovery ought to delight the Basel Committee policymakers, and the South African regulatory authorities in general, as it serves as yet another validation of the consistency of the current Basel III accord. The negative correlation between the Tier 1 ratio and wholesale funding (NSFR) seems to suggest that an improvement in the Tier 1 ratio might be expected to result in a reduction in the proportion of wholesale funding forming a share within South African banks' balance sheets. The implications of this are more financially stable banks, especially during times of crisis, since wholesale funding tends to dry up in periods of financial and/or economic distress.

Bank supervision

The econometric results above tend to leave very few doubts with regard to the importance of the SARB repo rate, which makes self-evident the position SARB needs to take as a macroprudential regulatory and supervisory body over the South African banking industry. Furthermore, during Tito Mboweni's term as SARB governor in 2009, South African authorities did a stellar job of keeping the disastrous United States-formed financial market systemic risks from severely affecting the South African financial markets and economy through contagion risk spillover effects. This paper's results additionally serve to endorse the sequence of decisions and actions taken over the years by the SARB authorities in keeping abreast of and aligned with the latest Basel Committee on Bank Supervision recommendations.

4 Conclusion and recommendations

As stated at the outset, this paper sought to achieve the following specific aims: firstly, to investigate whether the Basel III supervisory and regulatory framework recommendations find support as determinants of the DTDs of South African banks; secondly, to examine the degree of cross-border contagion risk between the United States and South African banking industries; and thirdly, to establish any other potential micro- or macroeconomic variables that might be supported as predictors of the DTDs of South African banks. The approach adopted in this paper in order to attain its stated objectives involved the incorporation of the KMV-Merton DTD metric

into a hybrid econometric model. This latter model was embedded within a linear dynamic panel data estimation technique formulated by Arrellano and Bond (1991). To the best of the author's knowledge, this is the first South African paper—particularly from the realm of academia—to attempt to model the DTDs of the five largest South African retail banks employing a hybrid econometric model.

Furthermore, the predictors of the DTDs within a panel data sample including five of the largest South African retail banks over the period 2004–15—controlling for banks' market betas—included the Basel Tier 1 capital ratio, LCR and NSFR proxies, SARB repo rates, three United States DTD interaction terms, and simple leverage. All of these variables, including GMV of derivatives and liquid assets, found support in the data for the bivariate model estimations; however, GMV of derivatives and liquid assets were not supported by the data as DTD determinants for the multivariate model estimations. More elaborately, the paper's findings with regard to the three Basel ratios (i.e. Tier 1 capital ratio, LCR, and NSFR) serve as validation of SARB's recent adoption of the Basel III accord's bank regulatory and supervisory policy recommendations and the related amendments to South Africa's 1990 Banks Act. All the above Basel III macroprudential measures (ratios) find both individual and collaborative support within this paper's data. The latter finding serves to confirm that the Basel III accord is a prudently assembled bank regulatory and supervisory framework.

The United States interaction terms above provide compelling evidence for the existence of some degree of contagion risk between the South African and United States banking industries. Secondly, the evidence for the simple leverage ratio seems to suggest that a potential alternative to the Basel Tier 1 capital ratio exists for the South African banking context with respect to bank capital leverage ratios. Thirdly, the significance of the bank market betas is indicative of the potential role that could be played by macroprudential policy measures. Finally, the significance of the SARB repo rate verifies the actions taken by SARB at the time of the 2007–09 financial crisis, as well as the importance of its continued role in the supervision of the South African banking landscape.

As discussions surrounding the proper supervision of banks continue, this paper has further endeavoured to offer some insight into the propositions and policy decisions that have been made thus far. The findings seem to endorse the approach to policy that concentrates on the adoption of the Basel III recommendations for all South African banks, and on the involvement of SARB as a supervisory authority—especially with regard to its use of the repo rate as a policy mechanism during times of financial distress and economic depression.

As a final word, in relation to other similar international studies, the current paper has found results which are contrary to those found by researchers such as Blundell-Wignall and Atkinson (2011), Haldane and Madouros (2012), Blundell-Wignall and Roulet (2013), and Milne (2013). The reasons for these divergences might have to do with the relatively smaller size of the South African banking industry and its individual banks, dissimilarities between local and international bank business models, and potentially, differences between the hybrid model used by this paper and the models used by the other studies. Thus, on the international front, future research focusing on these divergences might further assist policymakers in designing internationally applicable bank regulatory and supervisory frameworks which are much more relevant for G-SIFI banks. The two caveats of this paper are firstly, that there are no prior South African studies with which to compare its findings, and secondly, that data for the LCR and NSFR were not available—hence, the paper employed proxies instead. On the domestic front, therefore, it would be interesting to see more studies similar to the current paper, as this would arguably add value to the debate surrounding regulatory and policy issues, especially for the South African banking environment.

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